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ON SCIENCE AND TECHNOLOGY

PROCEEDINGS
OF PAPERS

BUILDING SUSTAINABLE FUTURE THROUGH TECHNOLOGICAL TRANSFORMATION

FACULTY OF TECHNOLOGY
SOUTH EASTERN UNIVERSITY OF SRI LANKA
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MESSAGE FROM THE VICE CHANCELLOR

Faculty of Technology of the South Eastern University of Sri Lanka (SEUSL) is the youngest, but growing Faculty at South Eastern University of Sri Lanka. It has proven over the years that it possess excellent traits including novel areas of teaching. research and innovations, and also caters to the needs of the region and country by producing abled and capable undergraduates. Further, the Faculty of Technology is the pioneer Faculty at South Eastern University of Sri Lanka to have commenced start post-graduate degree programme by research.

This is the second that the Faculty of Technology organizes its annual International Conference on Science and Technology, ICST 2022 entitled "Building Sustainable future through Technological Transformation". The faculty has taken steps to disseminate the valuable research outputs generated in Science & Technology by its students, staff, stakeholders from other faculties of the University, other Universities and research organizations from Sri Lanka and overseas. This conference provides a platform for all researchers to present their findings with the presence of an audience of experienced researchers and scholars and with their, endorsements, such research will be disseminated through the proceedings published today.

Moreover, selected research outputs presented will be given the option of publishing in the Sri Lanka Journal of Technology (SLJOT) of the faculty. Hence, this annual research conference of the Faculty of Technology will contribute to achieve the vision of the SEUSL as a hub of world class academic and research institution. The commitment and enthusiasm shown by organizing committee of this conference is commendable. The leadership given by the Dean of the Faculty, Dr. UL. Abdul Majeed as the Conference Chair and Mr. R.K. Ahmadh Rifai Kariapper as the Coordinator of the Conference together with the team of energetic staff made this a very successful event. I hope that this conference will be remembered as one of the annual events that is in the forefront of disseminating science and technology related research in the Country.

I am greatly honoured and pleased to welcome all the paper presenters and the participants to this conference. I extend my gratitude to all who are part of this conference and wish all the researchers who present their findings all the success. I am sure that with all your contributions, the South Eastern University of Sri Lanka could retain its role as a leading University in the country.

Professor A. Rameez, PhD (NUS)
Vice Chancellor
South Eastern University of Sri Lanka

MESSAGE FROM THE CHAIRMAN

As the Dean of the Faculty of Technology, I am privileged to write this felicitation message to the second International Conference on Science & Technology -ICST 2022, proudly organized by the Faculty of Technology of South Eastern University of Sri Lanka. The theme of the conference is- "Building Sustainable Future through Technological Transformation". Here, the theme is the need of the hour and timely as far as the present global phenomena is concerned. The era of technology and its organized transformation will definitely pave the way for a sustainable future. More technologies are needed to tackle the prevailing challenges by the present world. The technologies developed throughout the globe have to be shared again throughout the world to maintain a balanced application so as to encounter the challenges successfully.

Sometimes, the negative reaction of the globe more outweighs than the technologies developed and applied all over the world. It means there is still a gap to develop technology further and extend its application to encounter the challenges to maintain a sustainable future. I strongly believe that technological conferences like this provide an immense and indispensable opportunity for academicians, researchers, scientists, professionals and other stakeholders from all over the world to share and express their views and discuss the ways and means to react for the challenges so as to uphold the sustainable world for the future generations to come.

Based on the above illustrations, the theme of the second international conference of this faculty is very significant and timely. I am very pleased to state that more than fifty research papers have been received from local and international research scientists covering a variety of disciplines. It is a great achievement and endorsement for the commitment extended by the faculty of technology due to its continuous involvement in the field of research and development for the sake of the society.

I wish to congratulate all the researchers, scholars and presenters for their active participation at this international forum to share their views and discuss their research findings/output to facilitate its application to maintain a sustainable future.

Finally, I would like to express my sincere thanks and gratitude to the chief guest of this conference Professor. A. Ramees, Vice Chancellor of South Eastern University of Sri Lanka, the keynote speaker Senior Professor. M.M.M. Najim, the former Vice Chancellor of South Eastern University of Sri Lanka and senior academic, the Department of Zoology and Environmental Management, Faculty of Science, Kelani University of Sri Lanka, the guest speaker Professor H.P. Hewagamage, University of Colombo School of Computing (UCSC), distinguished guests, scholars, presenters, the organizing committee, staff of the faculty, students and the administrative staff for their fullest cooperation and enormous support extended to make this historic event a success. I also wish to extend my thanks for all who directly and indirectly supported during the different stages of this conference to make a very success one.

Sincerely,

Dr. U. L. Abdul Majeed
Dean
Faculty of Technology
South Eastern University of Sri Lanka

MESSAGE FROM THE COORDINATOR

It gives me immense pleasure that the Faculty of Technology, South Eastern University of Sri Lanka, is organizing the 2nd International Conference on Science and Technology 2022 (ICST 2022) on the 24th of August 2022 at the Faculty of Technology, South Eastern University of Sri Lanka.

Conference speakers will focus on "Building Sustainable Future through Technological Transformation" as the conference theme. Researchers, engineers, scientists, and technologists from all around the world can come together to discuss the latest developments in technology at ICST 2022. Topics covered at the conference include: computing and information systems; multimedia and gaming technologies; networking and security technologies; software and ubiquitous computing; agriculture economics and entrepreneurship; animal and aquatic science and technology; biosystems engineering; crop and food science and technology; and more.

I hope that the distinguished speakers will offer novel insights into their respective fields of expertise. It's an honor for me to declare that this conference will provide useful insights for addressing global problems and promoting long-term growth. The success of this Conference is due entirely to the hard work and dedication of an infinite number of people who have been preparing for it in various ways for nearly a year. To wrap up, I want to say how much I appreciate everyone's time and effort. I hope that ICST 2022 will be a huge success.

Mr. RK. Ahmadh Rifai Kariapper
Coordinator
2nd International Conference on Science and Technology (ICST 2022)
Faculty of Technology
South Eastern University of Sri Lanka

MESSAGE FROM THE KEYNOTE SPEAKER

The youngest Faculty in the South Eastern University of Sri Lanka (SEUSL) is the Faculty of Technology; however, the Faculty has proven to possess excellent traits, including research, postgraduate studies, research dissemination, leadership, novel areas, and modes of teaching, etc. The research and researcher pool in the Faculty caters to the country's needs by producing abled undergraduates and postgraduates. Even though the Faculty is new, it has pioneered driving the University toward the 21st Century research and educational needs giving leadership in many areas. In these aspects, the Faculty's continuous struggle to cope with the external challenges and fulfill the mission of the University, it has organized the second international conference in 2022.

The theme of the ICST 2022 is entitled "Building Sustainable Future through Technological Transformation." Sustainability in all aspects of resource utilization, production, and consumption is vital, and it requires all stakeholders' contributions to achieve sustainability in the future. Achieving sustainability requires appropriate technological inputs, and I am happy to witness the initiative taken by the Faculty in this process. This conference provides the opportunity to present technological transformations in building sustainability in many different aspects with an audience of experienced researchers. Hence, this annual research conference of the Faculty of Technology will contribute to the achievement of the vision of the SEUSL of becoming a world-class academic and research institution.

I am greatly honored to deliver the keynote address at this conference. I would like to extend my gratitude to all who are party to this conference. I wish all the researchers who present their findings all the success.

Senior Professor M.M.M. Najim
Faculty of Science
University of Kelaniya

MESSAGE FROM THE GUEST SPEAKER

I would like to congratulate the organizing committee of ICST2022 on planning a vital conference to present and discuss research and technology findings based on the technology transformation in order to build a sustainable future.

We are facing a lot of challenges in the current context of our society due to various issues, mainly due to social health conditions due to covid-19 and other various viruses, as well as economic downfall due to high expenses and low income. Hence, the future has become uncertain in all sectors of life. When we have problems, we usually try to take many actions to solve them, considering both the short-term and long-term requirements. A sustainable future could be built based on our activities that will be able to retain the solutions for these problems. These long-term activities should be based on different transformation processes in our societies. In other words, it is the change of technology on which these processes are based to carry out different activities. This technology transformation is a must for the future sustainability of our society. A good example to justify this transformation is QR code-based fuel distribution in Sri Lanka for all vehicles based on a single policy. The supply and demand could be affected due to various reasons, including wrong or misinformation in society. The fuel distribution created social unrest, and technology transformation supported through Information Technology-based solution resolved it to a significant extent. All viruses created a society preventing us from interacting as a normal human beings in a F2F context. The Work From Home (WFH) is a new methodology in our society. However, technology facilitated our society, transforming our normal interaction into a new model of interaction through Internet while maintaining the sustainability of society. The best example is online education in all public universities during the last two years, and it helped all universities to reduce the impact on higher education. The integration of different technologies in the transformation process will develop a new society to face all challenges in the future. Hence, this conference presents an important theme for our society, and I highly appreciate all the academic and other staff members who contributed to organizing this important conference. We are eagerly waiting to watch fruitful presentations based on this theme at ICST2022 and congratulate all presenters in advance

Professor K. P. Hewagamage
Professor in Computer Science
University of Colombo School of Computing (UCSC)

ABSTRACT OF KEYNOTE SPEECH

Building Sustainable Future through Technological Transformation

M.M.M. Najim

Faculty of Science, University of Kelaniya

In 1987, Brundtland Report defined sustainable development as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs." The sustainability concept is being considered in managing resources, production processes, consumption, etc. Gaining a sustainable future requires multidimensional, interdimensional, and integrated decision-making under a complex social, economic and environmental context where any of these components can be omitted. Sustainability has become more vital in the current context where climate change is unexpectedly challenging all the systems. In 2015, 193 countries agreed on 17 sustainable development goals (SDGs) to offer the basis for a sustainable future. These SDGs have guided the nations to address poverty, inequality, global warming and climate change, hunger, poor sanitation, diseases, pollution, loss of biodiversity, etc., in achieving a suitable future. Our ability to secure the well-being of the human communities and maintain the health of natural ecosystems determines sustainable future that we can achieve. This process requires facing all the challenges, from very complex phenomena such as global warming and climate change to minor issues such as sharing limited resources.

Sustainable future for people and nature can only be achieved with the existing and expected technology and consumption, however, with major changes in production and consumption processes. In this process, harnessing and maximizing the potential of technological innovations is vital. Technologies such as carbon capture and storage, efficient and effective irrigation systems, essential medical facilities, safe drinking water for households to face challenges of pollution, contamination, and related diseases, waste minimization and abating pollution, etc. are vital in achieving a sustainable future. Existing and expected technology can handle the challenges at national and international levels. However, those have proven inadequate in achieving the sustainability goals and needs of the poorest, the most vulnerable, and marginalized communities. Technologies need transformation to equitably cater to the needs of such communities in ensuring a sustainable future for all. Technological transformations, therefore, play a major role in achieving a sustainable future for all.

ABSTRACT OF GUEST SPEECH

Virtual University: A model to apply Digital Transformation in Higher Education for the Professional Development of Graduates

K. P. Hewagamage

University of Colombo School of Computing (UCSC)

Employability is a key performance indicator of a Higher Education Institute (HEI), and it shows the results of outcome-based education in the curriculum. In some degree programmes, employability is not an issue since there is an external assurance of providing employment for the graduates due to pre-arrangements, such as in Medicine. However, many graduates will have to face the challenge of employability after graduation, and it is a socio temporal issue in society. Economic recession in society directly impacts employability irrespective of academic qualification. However, the common criticism is that graduates do not have the required competency expected by the employers or educational qualification doesn't match with opportunities in the job market.

In Sri Lanka, 35% of graduates are unemployed after one year of their graduation in public universities, where all degrees are offered under the free education system. A careful analysis shows this problem is worst in the non-technical education streams since unemployability moves to 70%. It is not an easy thing to convert these graduates to technical students after graduation, and the conversion should be started early in their education. The current demand for graduates with good IT knowledge and skills is around 22,000 graduates, and both state and non-state universities/institutes cannot produce more than 8000 graduates/diploma holders in a year. If it is possible to convert at least 50% of unemployed graduates and it will have a significant effect on the socio-economical development of Sri Lanka.

The current and future demand for knowledge and skills in the IT industry is very challenging, and it is more than how to use computers to do routine work. This includes the technology which directly affects the 4th industrial revolution, such as Artificial Intelligence, the Internet of Things, Data Science, Blockchain, etc. Traditionally, Professional Development is considered to be necessary after graduation in order to sustain work routines in the organization. If we want to start converting non-technical students to technical streams, professional development needs to be introduced as early in the academic career as a parallel scholarly activity. Continuing Professional Development (CPD) credits could be introduced to indicate the portfolio of the graduate. Virtual universities could play a central role in facilitating the professional development of graduates of all universities while they are engaging in studies in their formal disciplines. Professional development is based on the target employment, and undergraduates could follow different courses from the Virtual University as a part of their CPD to increase their chance of employability in high-demand job environments. Hence, the virtual university could play a significant role in the digital transformation of future graduates, considering the professional development for employability.

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TRACK - UBIQUITOUS COMPUTING TECHNOLOGIES (UCT)

Density-Based Real-Time Traffic Controlling System Using Image Processing

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Abstract

The vehicle population is growing rapidly with the growth of the population. Therefore, traffic congestion is increasing in urban areas. Associated problems such as accidents, stress, and pollution also increase in proportion to traffic problems. In most cities, traffic light systems are used to reduce traffic congestion. Most traffic lights work with a pre-programmed method, or Traffic Police control traffic congestion manually. In Sri Lanka, there is usually heavy traffic congestion during peak hours. During peak hours, Traffic Police control traffic congestion manually. Since this manual procedure is inadequate to control heavy traffic congestion, a real-time traffic controlling system is needed to solve this problem. Our proposed system is implemented to control this traffic congestion problem using real-time traffic density. Further, it is expected to avoid or minimize traffic congestion using image processing techniques.

Keywords: Traffic light systems, Traffic congestion, Image processing, YOLO, Queuing Theory

I. INTRODUCTION

Traffic light systems are used to control and reduce traffic congestion at intersections. In addition, they are one of the best ways to guarantee safe traffic flow everywhere. There is a universal code for traffic lights to follow with a sequence of illuminating lamps or LEDs (Light Emitting Diodes) of three standard colors which are red, green, and yellow. In most cases, traffic light systems are programmed according to the time allocation for each directional traffic flow during the cyclic process. It is the mainly used timer model. They operate according to preset times stored in memory, which is processed by a processor and powered by electricity. Most developed modern counties use sensor-based traffic control methods to detect the number or the density of vehicles and produce the appropriate signals (Nafeel, 2015). The traffic control system, based on vehicle density with image and video processing techniques, is a better alternative to time-based systems (Sable et al., 2020). This system is based on the actual traffic density of the road and real-time traffic monitoring. Python Open CV can be used as an image processing tool to detect and count the number of vehicles in each lane. This system is mainly implemented for four-lane junctions and considered when pedestrians cross the road.

An implementation of a video-based real-time traffic controlling system and respective methodologies are presented in this study. The rest of the paper is structured as follows. Section II describes related work. Section III discusses the methodologies used, Section IV Discussion and section V presents the conclusion of this paper.

II. RELATED WORK

This section discusses the related work used to develop traffic light control systems, and it briefs the variety of methods that can be used in traffic control. There are two main traffic light controlling methods. One is the Fixed Time Technique (Siddamma and Pashupatimah, 2018). Here, the system is programmed based on the time allocation provided to each directional traffic flow during the cycle. This is a fixed-time technique, i.e. for a specific time interval, say 15 seconds, the

cyclic pattern of time distribution will remain the same (Subramaniam, Esro and Aw, 2012). The second one is Vehicle Activated Time Technique. This is a pre-defined mode, and adjustments can be made based on the approaching traffic flow detected by the sensors. These observations made by the sensors are then processed and appropriately timed by the traffic controller. However, this method has not been introduced in Sri Lanka. The comparison between the fixed time technique and the vehicle's activated time technique is shown in Table 01.

Table 01: Comparison between the fixed time technique and vehicle activated time technique

Fixed time technique	Vehicle activated time technique
Based on a pre-programmed sequence	Based on sensors
Operates without any consideration of real-time behavior	Operates in real-time
A time-allocated cyclic process	Commonly used sensors are inductive loops, cameras, radars, infrared sensors

Some of the traffic control methods which can be used as alternatives for traffic problems are described in the following.

A. Density-based Traffic Controlling

With the rapid development of road infrastructure, the density of vehicles on the road network has increased. This is mainly due to the rapid increase in vehicles in a certain area in a short period. The density-based traffic control system is a better solution to overcome those kinds of problems. Using real-time video and image processing techniques, this can be achieved. In most cases, electronic sensors embedded in the pavements are used to detect vehicles in a lane. Magnetic loop sensors are the most used sensors in vehicle detection, but the maintenance and installation costs are inconvenient (Guerrero-Ibáñez, Zeadally and Contreras-Castillo, 2018). Therefore, cameras can be used as image sensors to capture images. They can be analyzed using digital image processing for vehicle detection, and according to the density of traffic, traffic lights can be controlled (Raj A.M. *et al.,* 2020).

B. Traffic Controlling Using Image Processing

Traffic parameters can be estimated using real-time traffic monitoring. Vision-based cameras are more versatile for traffic parameter estimation. The captured images provide quantitative and qualitative parameters (Guerrero-Ibáñez, Zeadally and Contreras-Castillo, 2018). Speeds of vehicles and vehicle count are some quantitative traffic parameters. It can give complete traffic flow information to meet traffic management requirements (Prakash *et al.*, 2018). An example of vehicle tracking is shown in Figure 01(a). The real-time traffic density on the road can be measured using image processing. The images are continuously captured and stored in a server and compared with live images captured by the camera to determine density. This process can be used to determine the traffic density on both sides of the roads and enable traffic signal control options for drivers or users by using a software application. Some image processing techniques which can be used in vehicle detection are described below.

(a) (b) (c) (d)

Figure 01: (a) Vehicle tracking using image processing (George, George, and George, 2018) (b) Image computed by GMMs input (Bhaskar, 2014), (c) output (Bhaskar, 2014) (d) Detected image using background subtraction(Sobral, 2015)

1) YOLO (You Only Look Once) Algorithm:

Traffic sign detection is a challenging task due to obstacles such as occlusions in natural scenes, changing lighting conditions, and camera perspective. Deep convolutional networks are used for image recognition and object detection as they provide the desired performance in terms of speed and accuracy (Vikram, 2018). Test time latency is one of the important factors in real-time traffic detection. Due to the complex computation, Convolution Neural Networks (CNNs) are considered unsuitable for real-time traffic detection. You Only Look Once (YOLO) architecture can be explored to detect and classify the signs in real-time. It can be used to exhibit object detection in real-time and classification at a rate of around 45 frames per second (Redmon *et al*., 2016).

2) Background Subtraction:

This is a common method used to detect moving objects in a series of frames from cameras. It is

based on detecting moving objects from the difference between the current frame and reference frame which is called the 'background image' of the 'background model'. This is usually done through detection; foreground detection is the main task. All current detection techniques are based on modelling the image background, i.e. setting the background and detecting changes that occur. Defining a proper background can be difficult when the background contains shadows, shapes moving objects, etc. When defining the background, all techniques assume that the color and intensity of stationary objects will change over time. Figure 01(d) shows an example image detected by the Background subtraction technique.

3) Gaussian Mixture Model:

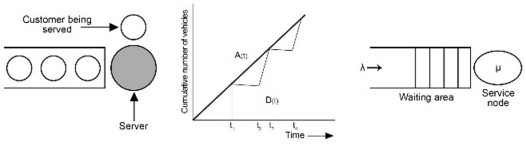
Gaussian Mixture Models (GMM) are used to measure parametric probability densities, expressed as a weighted sum of Gaussian component densities (Dahiya, 2021). GMM is used for various applications in different fields such as astronomy, machine learning, computational biochemistry, and other applications (Reynolds, 2009). GMM sorts the foreground and background from image frames by learning the background of a certain scene. In vehicle detection and tracking, GMM uses the common observable attribute change factor between the current image and the reference image to deal with the changes in the image frames and automatic gain by the camera. Then, the Mahalanobis distance of the Gaussian is calculated based on the common observable property change factor, the current color intensity, and the Gaussian component means estimate. The threshold is calculated to determine the similarity of an objective norm of color quality, regardless of its brightness between the background and the pixels in the foreground where the currently observed image is learned by obtaining GMM. Figure 01(b) and (c) show an example image computed by GMM and the output (Bhaskar, 2014).

C. Fuzzy Rule-Based Control

Adaptive Neuro-Fuzzy based modules are used for the analysis of traffic data. A set of 40 fuzzy decision rules are used to adjust the signal timing parameters (Wannige and Sonnadara, 2009). The rules for adjusting cycle time, phase splitting, and offset are decoupled so that these parameters can be adjusted independently (Mohanaselvi and Shanpriya, 2019). Adjusting the cycle time is used to maintain good saturation when the top is close to the saturation (George, George, and George, 2018). Saturation is defined for a given method as the actual amount. The vehicles passing through the intersection during the green light time are divided by the maximum number of vehicles that can pass through the intersection during that time (Mohanaselvi and Shanpriya, 2019). Adjust the offset to coordinate adjacent signals to minimize the direction of dominant traffic flow. The controller first determines the number of dominant directions of the vehicle according to each method. The arrival time of the convoy leaving the upstream intersection can be calculated based on the time of the next green light at the upstream intersection.

D. Queueing Theory

Queuing theory is a mathematical study of the movement of people, objects, or information through lines to identify and correct points of congestion in processes (Gosvi, 2020). Queue theory is used to break in down the line into six elements such as the arriving processes, the serving and departing processes, the number of serving and departing processes, the number of servers available, the queue capacity, and the number being held (The Investopedia Team, 2022). When creating a model of the whole process from beginning to end, it is necessary to identify and resolve the cause of congestion.



(a) (b) (c)

Figure 02: (a) Queuing System (Gosvi, 2020) (b) Analyzing the traffic flow using queue theory (Papacostas and Prevedouros, 1993) (c) M/M/1 Queuing system (Anokye, Annin and Oduro, 2013).

1) Traffic Flow Analysis Using Queue Theory:

Vehicle traffic provides the basis for measuring operational performance on the road. Various dimensions of traffic, such as the number of vehicles per unit of time, vehicle type, vehicle speed, the variation of traffic flow over time, and highway operations can affect the performance of

highways (Chandra, Mehar and Velmurugan, 2016). It is important to use theoretically consistent quantitative techniques to analyze traffic conditions. These techniques can be used to simulate traffic flow, speed, and temporal fluctuations (Srinivas *et al.*, 2013). Queuing theory can be used to analyze the traffic flow approaching and passing through intersections controlled by traffic lights. This is used to analyze the cumulative transit time of vehicles as a function of time. The above queuing diagram (Figure 02(b)) for interrupting flow shows the flow on one intersection approach. t_1 to t_2 time of Figure 02 (b) is the red signal interval, then the traffic is stopped. Traffic starts to leave the intersection at the start of the green interval (t_2) at the saturation traffic flowing rate (qG) and continues until the queue runs out. The departing rate $D(t)$ equals the arriving rate $A(t)$ until t_3, which is the beginning of the next red signal. This process is started over at this point (Papacostas , C.S. and Prevedouros, 1993).

2) M/M/1 Queuing Theory:

M/M/1 refers to negative exponential arrival and service times with a single server. This is the widely used queuing system for analysis purposes. M/M/1 is a good approximation for large queuing systems (Anokye, Annin, and Oduro, 2013). The conditions of the M/M/1 queuing system are, (1) The number of objects (vehicles) in the system is very large, (2) A single object consumes a small percentage of system resources, and (3) All vehicles are independent, i.e. their decision to use the system is independent of other users (Schwarz *et al.*, 2006).

III. METHODOLOGY

This research presents a solution for traffic light management using cameras. In this system, the cameras are used as image sensors for capturing vehicles. Images will be analyzed, and image processing techniques will be used for detecting and counting vehicles. Vehicle types and their traffic parameters will be measured for implementing an algorithm for traffic light waiting time. It will be mainly based on quantitative traffic parameters such as the speed of a vehicle, arrival time, size of a vehicle, etc. The system will not be dependent on the type of camera and the number of lanes in the road structure. It will depend only on the traffic parameters. There are two main parts included in this proposed methodology. They are (1) Vehicle detection and counting using image processing and (2) Creating an algorithm for traffic light control using Queuing Theory.

1) Vehicle Detection and Counting Using Image Processing

This part is done by using Python OpenCV background subtraction. Firstly, the relevant video was cropped using the algorithm and converted into grayscale, and filters such as blur, dilate, and the kernel were used. After that, the number of vehicles in each lane of the four-way intersection was counted.

2) Creating an Algorithm for Traffic Light Controlling

The traffic controlling algorithm is based on queuing theory. We have considered the traffic flows which follow the M/M/1 Queuing Theory. This algorithm mainly finds the green light time of the traffic light, and according to Traffic Engineering, it is equal to the waiting time of a vehicle.

(a) (b)

Figure 03: (a) Sample frame for detection and counting vehicle (b) Grayscale image of the sample frame

The main assumptions we have made in this method are that the arrival pattern follows the positioning process, the arrival of vehicles is from one direction, there is no turning lane at the intersection, and the queue process follows the FIFO discipline.

The commonly used equation for traffic light waiting time calculation is given below. In this equation, λ refers to the arrival rate, and μ refers to the departure rate of vehicles. W is referred to as the waiting time.

$$W = \frac{1}{\mu - \lambda} \quad (1)$$

The waiting time of each lane can be calculated by using equation (1) and then can control the traffic light according to the number of vehicles at the relevant time.

IV. DISCUSSION

Throughout this project, we have tested several image processing techniques and we have chosen

Python OpenCV as our image processing algorithm among them because the highest accuracy has been achieved by using that. We have achieved more than 90% accuracy using vehicle detection algorithm. It has been tested using several video sets. Most of them have more than 90% accuracy.

Real-time traffic control can be done using sensors and this paper is based on image sensors and image processing techniques. This project is mainly focused on four-lane junctions and these algorithms are independent of types of cameras and number of lanes. This can be developed into any number of lanes. We have used the Python-OpenCV background subtraction method and it can be changed for certain image processing methods and also can be developed to connect several traffic nodes and it can be easy to use a IoT platform for node-to-node communication.

V. CONCLUSION

This paper is based on developing a density-based traffic-controlling system. The proposed method consists of two main parts for detecting and calculating the vehicle density and the waiting time according to the vehicle density. Python OpenCV background subtraction method was used in vehicle detection and counting, and creating a waiting time algorithm was done based on M/M/1 Queuing Theory. This system would be a real-time traffic-detecting system. With the help of this system, we can manage and control traffic congestion and minimize the number of road accidents.

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Automated Vehicle Parking Slot Recognition and Monitoring using Optimised Image Processing Techniques

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Abstract

Due to the increase in individual vehicle usage, detecting an unoccupied parking slot and collecting payment for parking in an ample parking space have become monotonous tasks in the modern era. Traditional and manual parking slot management in large parking slots was inefficient and required a number of human resources. To address these issues, an automated, intelligent, and efficient parking system is required. This work presents an automated parking slot identification and monitoring technique that can be used to search for unoccupied parking spaces, a guide to parking spaces, negotiate parking fees, and track vehicles using number plate recognition. The proposed method employs optimized image processing and optical character recognition techniques to implement the system. When a vehicle approaches the parking entrance, cameras automatically capture its image and number plate information (registration number) and process it to direct the driver to an unoccupied parking slot. The system counts the number of parked vehicles and displays the current parking status. The system can also be used to collect electronic parking fees based on number plate information and parking duration. The presented method in this paper was tested in a modelled environment and yielded more acceptable performance (accuracy 94.28%) with very little use of hardware resources to keep the system cost as low as possible.

Keywords: Image Processing, Parking Slot Detection, Optical Character Recognition (OCR), MATLAB

I. INTRODUCTION

Due to the growth of vehicle production and individual usage of vehicles, people spend a tremendous amount of time and effort finding a parking space in a vehicle parking. Even after finding a parking space, some may occupy it before reaching it (Dutta, Bhattacharjee and Gupta 2021). Therefore, we require a huge parking space with proper management. Presently, most existing vehicle parks do not have systematic monitoring and management. Most of them are manually managed with little effect. The majority of the parking system is based on the technique used to determine whether or not a vehicle is parked in the space. This technique could be as simple as an ultrasonic sensor or as complex as cloud-based solutions. The time spent searching for available parking spaces is the most significant concern in the car park (Mufassirin and Naleer 2017). Drivers will circle the parking lot until they locate an open spot. This problem is most common in urban areas and supermarkets, where the number of motor vehicles exceeds the number of parking places available (Ding, X. and Yang 2019). Parking slots management should be responsible for informing the availability and location of parking spaces at the entrance. If the status of the parking slots is shown at the entrance, it would be very convenient for the drivers to locate and park their vehicles in an appropriate place.

However, manually managing such a parking space system necessitates a large number of people (Moranduzzo and Melgani 2014). As a result, numerous systems have used unsupervised parking slots detection to ensure smooth traffic at vehicle parking zones by measuring the number of parking spaces, identifying their position, and tracking changes in space status over time (Karunamoorthy, Suresh and Jaya 2015). In recent years, various researchers have proposed many methods for improving parking slot detection systems, such as ultrasonic sensors, IR sensors, and magnetic sensors (Karunamoorthy, Suresh and Jaya 2015). Magnetic sensors have recently been suggested for parking space occupancy detection. However, these methods are affected by

adjacent interference problems, i.e. the magnetic signal is easily interfered with by the vehicles parking in adjacent spaces (Dong, Zhang & J Chen 2019). A parking management system with image processing technology provides the latest and innovative solution for temporary parking places: where no approach is used for parking a car, reducing the hustle at a rushed time, helping to park and manage properly and efficiently (Waqas *et al.*, 2021).

The proposed system in this paper is based on image processing and Optical Character Recognition (OCR) which consists of three subsystems working simultaneously to ensure security and integrity. In this research, a camera is used as a sensor for video image detection. This camera is used to capture images at the entrance and the parking slot. These images are used to detect the parking space and vehicle identity. The image captured from the entrance identifies the number plate and the type of vehicle. The image acquired from the parking slot area detects the free parking space and counts the total number of vehicles parked in the area. Based on this information, the vehicles are directed to appropriate parking spaces. MATLAB is used as a software development tool in this research to implement and test the system.

The rest of this paper is structured as follows. Section 2 describes the existing studies and motivation. Section 3, it is presented the proposed system and objective. The methodology is presented in Section 4. Section 5 describes the results and discussion, and we conclude this paper in Section 6.

II. EXISTING WORKS

The industrialisation and enhanced lifestyle of people accelerated the advancement in automobile technology. Thus, many people started to use their own vehicles for travelling. On the other hand, these advancements have become hard at times, requiring a vast number of parking spaces in busy cities and developed organisations (Juneja, Kochar and Dhiman 2018). Various technologies are used in vehicle tracking, identification, and related fields (Maalik and Pirapuraj, 2021) (Razeeth, Kariapper and Nawaz, 2021). Moranduzzo and Melgani (2014) proposed a technique for automatically detecting and counting the vehicle in uncrewed aerial vehicle (UAV) images. SVM is used as a classifier for detecting and counting cars.

Karunamoorthy, Suresh and Jaya (2015) suggested a parking space detection and vehicle classification system based on image processing. Image segmentation and area calculation were used to detect the parking space and direct the vehicle towards it, while feature extraction and Artificial Neural Networks (ANN) were employed for counting and classifying the vehicle.

There are many systems proposed and implemented for automated parking systems to solve parking problems based on magnetic, ultrasonic, and IR sensors (Mithari, Vaze, and Sanamdikar, 2014) (Kianpisheh, Mustaffa, Limtrairut and Keikhosrokiani 2012). When we looked into those systems, we discovered that they required a lot of hardware, which increased the cost and required much maintenance. In such systems, the possibilities of failure and false-positive outcomes were high. Furthermore, we discovered that vehicle tracking was impossible to implement with these systems because it would have necessitated the use of other technology.

Waqas *et al.* (2021) suggested a method for detecting and recognising vacant parking spaces in real time. The camera is mounted on the rooftop of a neighbouring building or a supporting pole at an angle that allows it to cover the entire parking lot. Then obtained image will be sent to a processing module, which is used to detect the cars within the region of interest (ROI) using a Neural Network. The parking space detection module generates virtual lines for parking, which will be visible to the user on an app assisting in vehicle parking. Overall management will be done using a mobile app.

Koushika *et al.* (2021) proposed an automated car parking system design that would decrease human control. Furthermore, the model has a user interface that directs users to available parking spaces. The car parking system counts how many cars are parked and how many idle spaces there are. Rather than using an electrical sensor, image processing was employed to detect the presence of automobiles and the number of available parking spaces. The current image of the parking space with cars is subtracted from an empty image of the parking space. As a result, the number of unfilled slots is calculated. The data will be sent from the server in response to the user's request via the user interface application. Arun, Karthick, Selvakumarasamy and James (2021) propose a

cloud-based system to improve parking vacant identification.

Therefore, we developed a single technology solution for our complete system using image processing techniques. Some existing works were done using image processing. However, those methods, such as edge detection with boundaries condition and point detection with canny operator methods, were more complex (Al-Kharusi & Al-Bahadly, 2014) and required improvement.

III. PROPOSED SYSTEM

Objectives:

- The main objective of this research is to develop and implement a fully automated parking space detection system which uses the camera video frames as input for processing.

To implement unsupervised parking slot detection for counting the number of parking spaces, identifying the location, vehicle number plate recognition and monitoring the changes in space status over time.

The proposed framework comprises three subsystems which are working at the same time. The first subsystem, which is located at the entrance to the parking space, consists of a camera that records the picture of the car number plate and uses the OCR technique to keep a log file of the vehicle registration numbers. This log file can also be used to collect parking fees electronically. The second subsystem comprises a camera in the parking slot that monitors and broadcasts real-time availability of parking slot information to the administrator and a display near the entry through a Graphical User Interface (GUI). The customer is directed to the nearest available parking spot by a

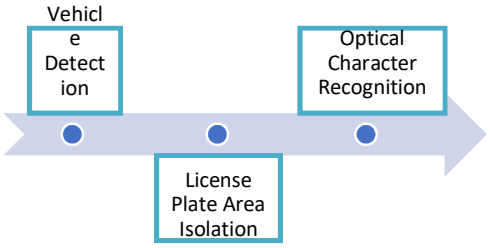

Figure 1. License Plate Recognise Layers

display at the door. The third subsystem is a back-end system that maintains a log and relates the parking slot to the car registration number, as well as the date and time stamp. It allows the user to locate his/ her vehicle's parking place from any location using the vehicle's registration number. However, in our system, we adopted a more straightforward technique using a point detection method, in which only parking spots are identified and processed; our system also has the capability of identifying the vehicle, which is a novel feature in an automated parking system. In addition, our system captures photographs of vehicle number plates, processes them to extract vehicle registration numbers using the Optical Character Recognition (OCR) approach, and keeps a log file for vehicle tracking and finding.

IV. METHODOLOGY

A. Methodology for Vehicle Number Plate Recognition

Firstly, the vehicle image was captured using a video/ CCTV camera. Then, the system extracted the number plate of the vehicle alone for the purpose of character segmentation. It was accomplished by combining a morphological procedure sensitive to specific shapes in the input image with an appropriate threshold setting for locating the number plate. The extricated number plate was then resized, and the direction was balanced for a simple procedure. Afterwards, character segmentation was done so as to isolate the character from the background. In general, the background was white or yellow with black letters. The resultant image was converted into a grayscale image. Finally, the optical character recognition (OCR) technique was used to identify the individual alphanumeric characters on the number plate. The proposed method for number plate recognition consists of three main tasks, as shown in Figure 1.

1) Vehicle Detection.

Vehicle image detection consists of the following sub-tasks.

i. Vehicle image captured by the camera

The image of the vehicle is captured using a camera, and it should be taken from a fixed angle parallel to the horizon. Usually, it should be in RGB (Red, Green and Blue) colour model. Figure 2 shows an original vehicle image captured by the camera.

Figure 2. Original Vehicle Image Captured by Camera

ii. Pre-process image

At this stage, images are taken from different backgrounds and lighting conditions to prevent low quality and contrast. Image pre-processing is normally done through image filtering. The captured images are resized into (1024 X 768) resolution. The use of pre-processing enhances the processing speed and improves the contrast of the image.

iii. Identify moving vehicle

In this step, vehicles will be identified using the background subtraction technique.

2) License Plate Area Isolation.

i. Convert into Gray Image

Converting grey images helps to reduce the noise of the image to some degree, and also it makes the processing of the images simpler.

ii. Dilation of an Image

Dilation occurs after Erosion, and it is proceeded to eliminate noise in the black-and-white image. When the complicated image erodes, the extension replaces the displaced image, and the image's primary components have been improved.

iii. Horizontal & Vertical edge processing

The dilated pictures are then passed through a variety of processing models for further analysis at this point. Vertical edge processing and horizontal edge processing are the two main types of edge processing. Both vertical and horizontal edge processing has histograms. Two RAMs are used to store the addition of the pixel values horizontally and vertically.

Figure 4. Dilated Image of the Plate

Figure 4. Eroded Image of Plate

iv. Passing histograms through low pass filter

Each histogram value should be averaged in this step, considering the values on both the right and left sides. This phase is also completed for both horizontal and vertical histograms. Filter off any regions that you do not even wish to see. The undesired areas are identified by low histogram values in the rows and columns, showing very tiny variations between adjacent pixels.

Grayscale image

Sobel vertical edge detection

Effect of threshold

Figure 5. Steps of Horizontal & Vertical Edge Processing

v. Segmentation of region of interest

This step is used to find all the areas of the high-probability image with a license plate. In the previous step, dynamic filters detected all undesirable rows and columns. As a result, these likely candidate zones are formed by additional columns and rows.

vi. Extract license plate area

Of the selected regions, the region with the highest histogram value is regarded as the most conventional choice for the license plate. This is the case because the license plate region is typically thought to have few letters on a translucent cloudy background. To locate a common region with the highest horizontal and vertical histogram values, all of the regions are processed row-by-row and column-by-column. It is thought to be the area with the most excellent chance of containing a license plate.

3) Optical Character Recognition

Optical character recognition is the final layer of the number plate recognition process. It is the process of identifying and recognising characters in a picture and converting them to intelligible text in ASCII (American Standard Code for Information Interchange) or another machine-editable format.

i. Resizing image

Compared to the whole vehicle, the license plate area is too small. As a result, the cropped license plate image may be too small, and the image size may vary depending on the vehicle type.

Isolated Number Plate

Cropped Image

Figure 6. Resizing Process of Number Plate Image

ii. Character Segmentation

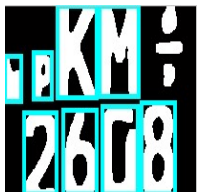

Figure 7. Character Segmented Image

Character segmentation is a kind of technique. It decomposes the image of lines or words into individual characters.

iii. Template matching.

Template matching is also known as matrix matching, and it is one of the most common classification methods. The input photos from the previous step are split for matrix matching, and the template with the highest similarity is regarded as the match. Once a certain template has been identified, its centre is used to calculate the parameters.

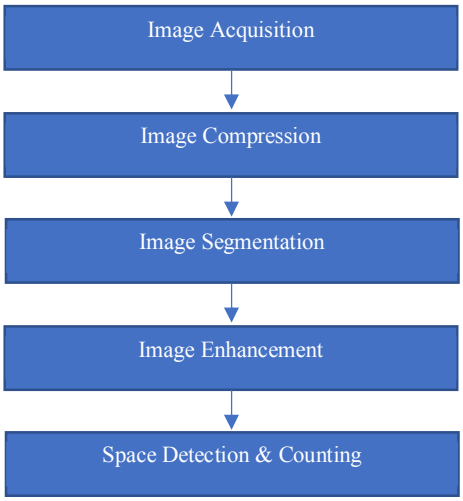

Figure 8. Schematic Illustration of the Parking Space Detection Module

B. Methodology for Parking Space Detection

The proposed method for parking space detection consists of five interrelated modules. The first module corresponds to image acquisition, which automatically captures the parking space's image and the vehicle entering it using video cameras and storing it in the system. These images can be treated as an input for the image processing element in MATLAB. The second module is responsible for image compression. The size of the acquired images through the image acquisition module is large and requires a tremendous amount of storage which will be challenging to process. Therefore, these images are compressed and stored to improve processing speed.

The third module is related to image segmentation, which distinguishes the vehicle objects from the background in order to increase the contrast. The output of this module is a matrix of black-and-

white images. The fourth module is responsible for image enhancement from which the noise is removed from the segmented image using morphology operations such as Dilation and Erosion. The last module corresponds to image detection, which is used to decide the object in each parking slot and display the occupied and unoccupied spaces. Figure 8 shows the schematic illustration overall.

The initial stage of the system is image acquisition, where the image is obtained. Capturing and storing digital images from video cameras is part of this module. After that,

a processing unit is linked to the high-definition camera that was used to capture digital photos.

The software is in real-time mode. The camera is placed inside the view of parking lots, capturing a constant scene. The camera's height must be sufficient to provide a good, unobstructed top view of the parking lots. The image obtained by the camera is shown in Figure 9.

After the image acquisition, the input RGB image was converted to a binary image using grey thresh (as shown in Figure. 10). Then perform the image segmentation, which separates the objects from the background by Dilation and Erosion and differentiates the pixels having nearby values for improving the contrast. After performing image enhancement which removes noise by using morphology functions. Then Classify available points and store them in a matrix. The matrix has the centre points of each parking space in coordinates. The coordinates are obtained using Skeletonization.

followed by Branching. The last process is image detection, which determines the object at each parking slot. The tested prototype GUI is given in Figure 11.

V. RESULTS AND DISCUSSION

The vehicle parking space detection system with parking lots status reporting and guidance parking system based on image processing was designed and tested in the simulated environment successfully. Identifying the image object of the vehicle makes the process of detecting the image as a reference more efficient than the sensor base system. To reduce the cost of sensors and the bother of wiring, the system was created utilising an integrated image processing technique. The

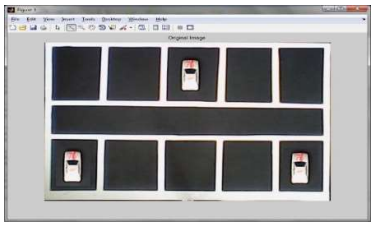

Figure 9: Original Image

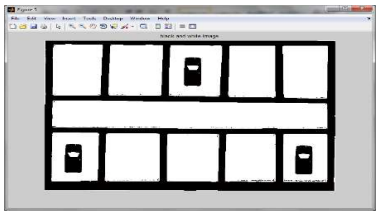

Figure 10: Binary Image

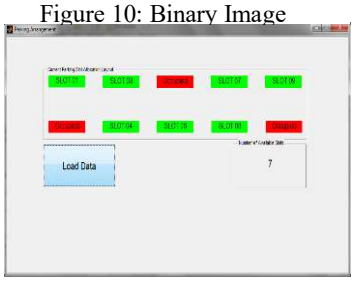

Figure 11: The Tested

performance of our proposed system is listed in Table 1.

Table 1. Performance matrix of our proposed system

Entered Vehicle	Correctly identified number plates	Incorrectly identified number plates	Accuracy	Average time taken
140	132	8	94.28	9 seconds

The performances of a few similar works were compared based on their reported results. Table 2 shows the comparison results.

Table 2: Comparison of our results with other methods

Source	Tested vehicles	Accuracy percentage
Rashid *et al*. (2012)	80	90.00
Ding and Yang (2019)	2315	91.60
Prasetyo, Wibowo and Suhendri (2021)	-	80.00
Our Method (2022)	140	94.28

The current limitation of this work is the processing time. The vehicle should wait at least 8

seconds at the entrance to get the number plate details using the camera. It may result in a long queue during a busy time.

VI. CONCLUSION

The main aim of this study to implement unsupervised parking slots detection for counting the number of parking spaces, identifying the location, vehicle number plate recognition and monitoring the changes in space status over time using video surveillance cameras. The Vehicle Parking Space Detection system with parking lots status reporting and guidance parking system based on image processing was designed and tested in the simulated environment successfully. Identifying the image object of the vehicle makes the process of detecting the image as a reference more efficient than the sensor base system. The proposed parking system integrated an image processing approach to reduce the cost of sensor and wiring issues. Number plate recognition and electronic billing system are in progress for future integration. The detection performance of the vehicle and available parking space is within an acceptable range. We intended to improve the processing time of our method by optimising the method further.

AUTHOR CONTRIBUTIONS

Both authors, M.M. Mohamed Asjath and M.M. Mohamed Mufassirin contributed equally to this work.

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IoT Based Smart Vehicle Parking System for Urban Area in Sri Lanka

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Abstract

The use of vehicles is essential to the human lifestyle. Due to the increase in the number of vehicles, the shortage of parking spaces in urban areas is increasing. Although there are many ways to solve these problems, such problems still exist. This research aims to build a smart parking system to overcome the issue of parking space availability using Internet of Things (IoT) technology. This proposed smart parking system is based on Arduino, Firebase cloud application, and android mobile application. The parking area is built and simulated with Arduino components. Further, this system is connected with an android mobile application for users. This smart parking system gives an opportunity for drivers to park their vehicles by eliminating waiting time and excess money. Drivers can see parking slot availability in the parking area using their mobile. Also, the mobile application displays parking times. On the other hand, the parking area is automated, and human interaction is not required. The gate automatically opens and closes when a vehicle enters the parking entry and exit area. This system provides real-time processes and information about the parking slot in the android application. Also, the parking owner can control the main gate remotely. This project leads to reducing fuel consumption. Also, it resolves the problem of growing traffic congestion and could reduce the human time of finding parking slots.

Keywords: Internet of Thing, Arduino, Firebase cloud, Realtime process, Android

I. INTRODUCTION

These days, almost everyone has used a personal vehicle for their transportation and it has become a basic need for humans. On that, it has been statically proven that the usage of the vehicle is increasing rapidly yearly. Due to this, there is the biggest problem in urban areas to find the parking place, especially in malls, stations, airports, schools and hospitals etc. The workers of the above public and private institutions have faced more challenges like a time consuming, trafficking and additional fuel consumption.

The Internet of Things (IoT) concept explains things with identity communication devices. The IoT devices could be tracked, controlled and monitored using remote computers or mobile phones connected with the internet. Two prominent worlds include in the IoT are “internet” and “things”. Internet means a network of devices connected via global such as servers, computers, tablets and mobiles using an internationally accepted protocol. Thing is a term used to refer to a physical object which is connected through the internet.

The microcontroller is the main element used to control IoT devices and sensors. The specific software application is used to control and monitor the IoT devices and can use an android application to access via mobile phones.

This research mainly focuses on IoT technology and android development. The author built a simulation system that was used to evaluate the performance of the system. The Internet of Things (IoT) is a new paradigm that allows electronic gadgets and sensors to communicate with each other over the internet to make human lives easier. Smart devices and the Internet are used to provide new solutions to a variety of challenges and issues faced by businesses, governments, and public/private organizations around the world (Kumar et al.,2019).

Arduino is an open-source platform used for building IoT-based electronics projects. Arduino is made up of a physical programmable circuit board (also known as a microcontroller) and software known as an IDE (Integrated Development Environment), which runs on a computer and is used to write and upload computer code to the physical board. This research has used the Arduino NodeMCU ESP8266 board as the main controller in the parking area (Louis et al.,2018). Android is an open-source Linux-based mobile operating system developed by Google. It

is used primarily for touchscreen devices, like mobile phones and tablets. Its design allows users to intuitively interact with mobile devices, with finger movements that mirror common movements, such as swiping and tapping.

The Firebase cloud application is used for this research work, and it is a Backend-as-a-Service (Baas). Firebase offers several tools and services to assist developers in creating high-quality applications and expanding their users. It is built on Google's infrastructure. Firebase is categorized under the NoSQL database program, which stores data in JSON-like documents. Firebase optimizes the applications with a number of services like Authentication, Real-time Database, Analytics, Storage, Hosting, Testing, and Monitoring (Moroney et al., 2017). This research has used the Firebase cloud application to establish the data transmission between the Arduino board and the Android mobile application.

There is a shortage of vehicle parking spaces, especially in urban areas, due to factors such as urbanization, population growth, and increased vehicle users. Particularly, Cities like Colombo and Kandy in Sri Lanka face these issues. Even, Traditional parking systems need human interaction to control their gates manual, and drivers are facing more difficulty in finding the availability of parking slots for their purpose.

Therefore, this study proposes an automated smart parking system for vehicle users in urban areas. This proposed system is based on IoT technology controlled by an Android application called Smart Parking System. Smart parking system gives details about available parking slots to drivers. Besides, it can control the gates automatically using sensors. This mobile application is user-friendly. Hence, users can access and understand parking details easily. Additionally, a smart parking system can facilitate the user to make payments through online. So, it saves time and expenses and effective uses of parking space in an urban area.

The objective of this study is to build a smart parking system that overcomes the problem of parking space availability of vehicle users in the urban area. The IoT-based smart parking system gives a user-friendly interface for the application user.

The scope of the study mainly includes Arduino, Firebase cloud application, wireless network and mobile application development.

- This research is mainly based on IoT technology. The Arduino platform plays a major role in IoT projects.
- Arduino NodeMCU ESP8266 board to build a connection in the parking area and as well as used Arduino IDE for programming codes into the Arduino board. Th s Arduino board helps to send information to a mobile app through the firebase cloud using Wi-Fi.
- Used IR sensors, servo motors and RTC modules for the operation of the parking area. IR sensor provided data to Arduino board, when the vehicle was detected or not. Se vo motor operated the parking gates and the RTC module provided time information.
- Firebase real-time database feature used to create data communication between both the NodeMCU board and the Android mobile application.
- Android Studio software is used to develop an Android mobile app. Android Studio is the official IDE for android application development.

II. LITERATURE REVIEW

Problems such as urbanization and population expansion are common in all countries. Scholar around the world proposes IoT technology to solve such kind of issue from a different angle. IoT plays many roles in people's lifestyle changes such as smart city projects, automobiles, agriculture, transportation, public security, environment monitoring etc (Alan T.,2021). This section describes and illustrates a few recent research articles more related to this research.

IoT-based cloud integrated smart parking system was presented by Khanna et al., the Smart Parking system consists of an on-site deployment of an IoT module that is used to monitor and signalize the state of availability of each single parking space. A mobile application is used to check the availability of parking slots and confirm the slot accordingly. This presents a high-level view of the smart system architecture. The working model is explained with a use case model that proves the correctness of the proposed model (Khanna et al., 2016). Gulam et al., proposed a framework based on a deep long short-term memory network to predict the availability of parking space. The authors use IoT, cloud and sensor networks to produce the Birmingham parking sensors dataset data. The experimental results showed the superiority of the proposed model over the state-of-the-art prediction models (Gulam et al., 2020). Luque-Vega et al., presented a novel sensing

solution that is the cornerstone of the smart parking system for vehicles. The system is named as SPIN-V. The SPIN-V is built with a small single-board computer, distance sensor, camera, LED indicator, buzzer, and battery and is devoted to obtaining the status of a parking space (Luque-Vega et al., 2020). Vehicular Crowdsourcing for Congestion Support in Smart Cities (VACCS) proposed by Olariu, Stephan. VACCS provide benefits to Smart City and driving the public to use resource efficiently. Timing planes respond to current traffic conditions, overall traffic flow will improve, fume emissions will be reduced and economic impact will mitigate. VACCS system work efficient in certain conditions (Olariu, Stephan, 2021). Ashok et al., proposed a Smart Parking Energy Management solution for a structured environment. The authors presented an IoT technology to mold with advanced Honeywell sensors and controllers to obtain a systematic parking system for drivers. Unused vehicle parking slots are indicated using emitting lights and users are guided to an empty parking slot, thus eliminating the users' searching time for a parking slot. The entire system that is fully automated reduces workforce involvement and improves the lighting aesthetics of the parking area. This paper aims to improve the time value of the user and the convenience of the parking system (Ashok D, et al., 2020)

III. METHODOLOGY

Research methodology is the specific procedures or techniques used to achieve the research objectives. This section explains how the parking simulation systems are built, software and hardware requirements, data flow diagram, etc.

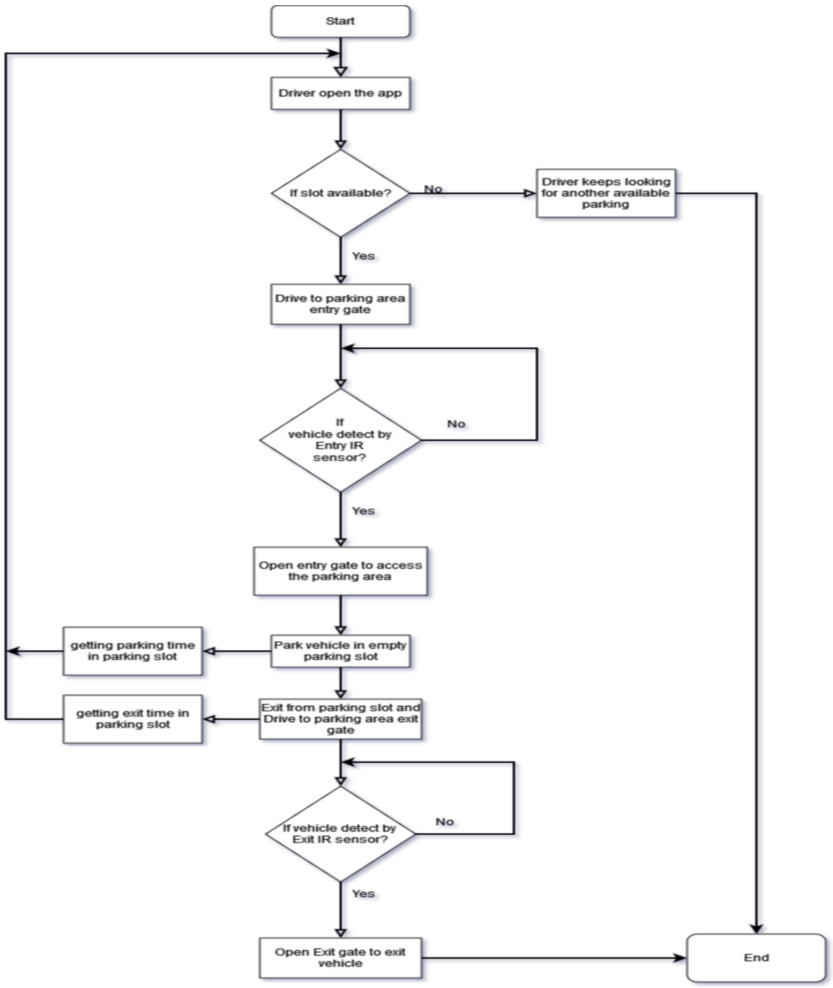

Figure 9: Data flow diagram of the smart parking system

A. *Smart parking system overview*

Figure 1 describes the data flow diagram of the parking simulation system. The parking simulation system consists hardware system controlled by an Arduino microcontroller and android application software for controlling the hardware devices. The Firebase cloud is always connected with both the Arduino system and the android application. Figures 2 and 3 explain the top and front views of the simulation system.

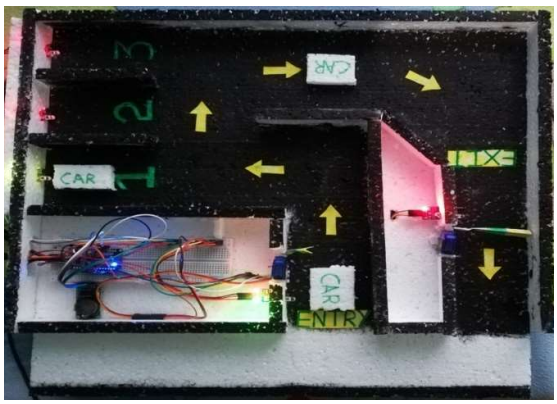

Figure 2: Top view of parking simulation

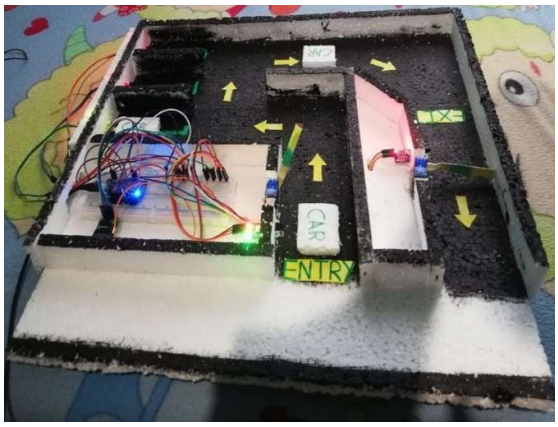

Figure 3: Front view of parking simulation

Whenever the driver wants to park his vehicle, the driver should access the android application. While the driver searches for a parking slot, then the system notifies the availability of the parking slot. If the parking slot is available, then the driver will move to the parking area. If the vehicle comes near the entry gate of the parking area, the IR sensor detects the vehicle near the gate and sends a signal to the Arduino microcontroller. The Arduino microcontroller sends instructions to the servo motors to open the entry gate. Then the vehicle moves to the parking slot, and the microcontroller sends the parking information such as time and date to the android application via the Firebase cloud. The same procedures will follow when the vehicle exit from the parking slot. All these information is sent to the user's mobile phone.

The researchers are building a simulation system to evaluate the research objectives. This system is built using the following electronic hardware item and software.

- Hardware
  - NodeMCU ESP8266 Arduino Wi-Fi board
  - Five IR sensors
  - Two Servo motors
  - DS1302 RTC module
- Software
  - Firebase application
  - Android Studio
  - Arduino IDE

1) *NodeMCU ESP8266*

The Arduino platform plays a major role in IoT projects. There are many kinds of Arduino microcontrollers available for different usage, but in this project, the researchers used NodeMCU ESP8266 Arduino Board because it enables the Wi-Fi module.

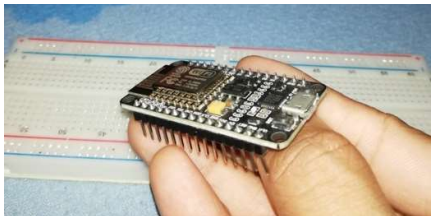

Figure 4: NodeMCU ESP8266

2) *IR sensor (infrared sensor)*

The IR sensor is a type of electronic component that emits or detects IR radiation to detect specific characteristics in its surroundings. An IR sensor can detect motion as well as measure the heat of an object. These sensors only measure infrared radiation rather than emitting it, which is known as a passive IR sensor. IR sensor detection range is 2cm – 30cm, and it can be adjustable using a potentiometer. Vacuum, atmosphere and optical fibers media are used for infrared transmission.

This project used two IR sensors to send data to the entry and exit gates. Another 3 IR sensors are used to detect if the parking slot is available or occupied and send the data to NodeMCU. The IR sensors placed in parking slots identify a car has or is not in their slots. After that, the sensor sends

data to NodeMCU. NodeMCU program for sending those data to firebase database. This database stores those data & sends it to the android app for the view.

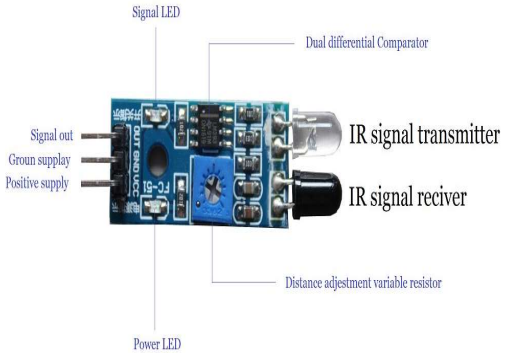

Figure 5: IR Sensor overview

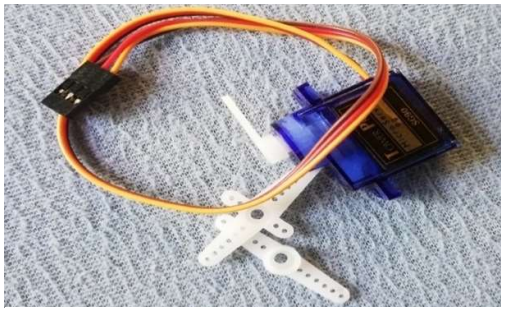

Figure 6: Servo Motor

3) *Servo motor*

Figure 7: Servo Motor Pin

A servo motor is a linear actuator or rotary actuator that allows for precise control of linear or angular position, acceleration, and velocity. If we want to rotate an object at some specific angles or distance, then can use a servo motor. A servo motor is made up of a control circuit that provides feedback on the current position of the motor shaft; this feedback enables servo motors to rotate with great precision.

In this project, two servo motors are used as an entry and exit gate, so whenever the IR sensor detects a car, the servo motor automatically rotates and returns to its initial position after a delay.

4) *RTC module*

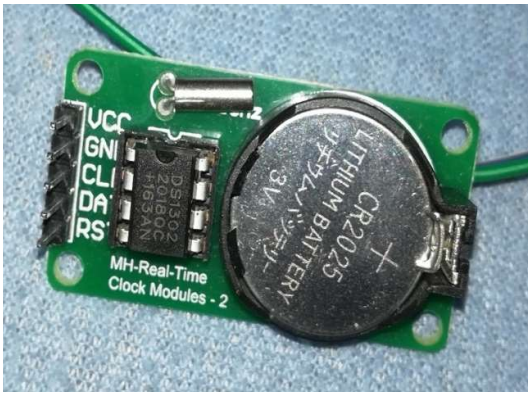

Figure 8: DS1302 RTC Module

RTC (Real Time Clock) modules are simply TIME and DATE remembering systems with a battery setup that keeps the module running in the absence of external power. This keeps the TIME and DATE up-to-date. Therefore, this project used RTC (DS1302) module because it keeps track of the real-time using an internal clock mechanism.

5) *Firebase application*

Firebase is a mobile application development platform from Google with powerful features for developing, handling, and enhancing applications. Firebase has three main services a real-time database, user authentication, and hosting. This project used Firebase Real-time Database and Firebase authentication for Mobile applications. This project involved with Firebase's real-time database to get parking details from the NodeMCU board and store that data in the database. Besides, Firebase sends that parking data to the android mobile application to view parking availability details for users.

6) *Android Studio*

Android Studio is an IDE used for developing android apps, which is officially supported by Google. It is based on IntelliJ IDEA which offers a powerful code editor and developer tools. It is an integrated development environment for Google's Android platform.

Android Studio supports application development within the Android operating system by utilizing a Gradle-based build system, emulator, code

templates, and GitHub integration. Every Android Studio project has one or more modalities with source code and resource files. Library modules,

7) Android mobile application

displays the Admin login and the User login. The owner of the parking may only use Admin login because, it has an authentication process. Admin login allows to view parking availability details, the number of vehicles in the parking area. The Admin can control parking entry and exit gates using this application. User login can access drivers without authentication. The user tab includes parking availability and parked time details. If parking is available, the driver can drive the vehicle to the parking area. This application was developed by using java and XML files. Java language is used to execute the running process, and XML language is used to design the app (Nikolov et al., 2019) (Moroney et al., 2017).

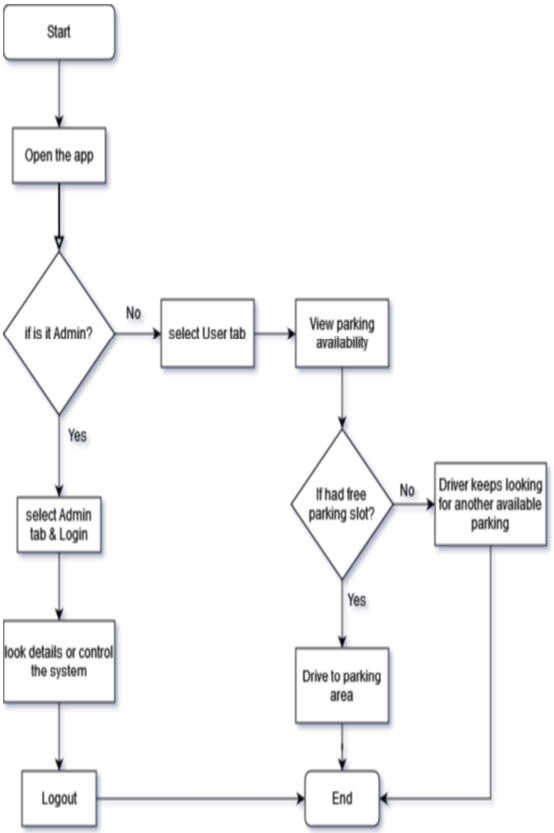

Figure 10:Data flow diagram of Android application

Figure 9 describes the data flow of the Android mobile application. The play store allows installing this application. The application

Figure 10: App Icon

IV. RESULTS AND DISCUSSION

The demand for parking systems is increasing because of the increasing number of vehicles in busy areas. On that design, many parking systems with new technology. This system allows real-time access to parking availability. This smart parking system provides a solution for parking in urban areas. Using this system, people can reduce the time of finding parking slots, reduce fuel consumption in vehicles and reduce traffic on the road.

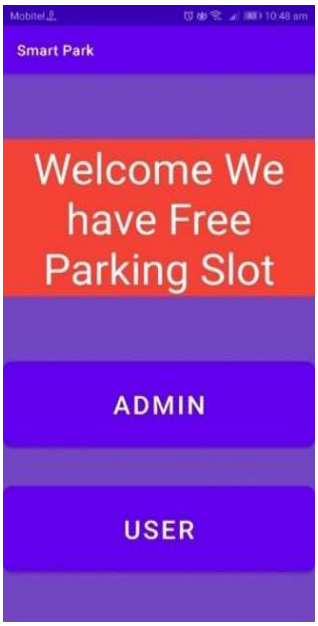

Figure 11: Main User Interface Image

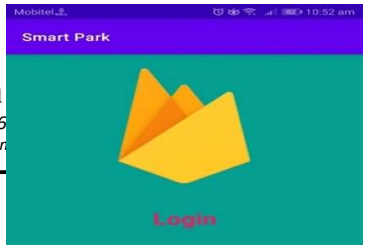

Figure 13: Admin User

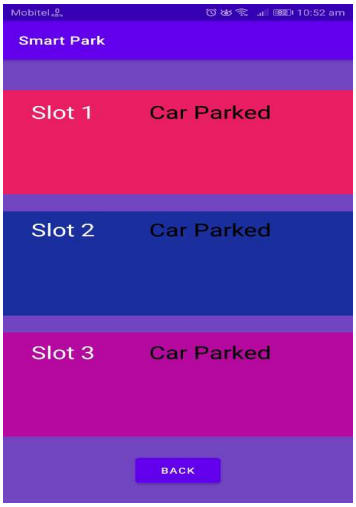

Figure 14: Driver Interface Image

Figure 11 shows the main interface of the system. Admin can login by using the 'ADMIN' button, and it navigates to the login page which is shown in figure 12. Admin needs to login using his username & password. Figure 13 shows the user interface of the admin. This interface displays the number of slots in the parking area as well as the availability of parking slots. And also displays parking entry and exit times. Other than that, the admin can control the open and closed gate using the console button displayed on the penal. Admin can logout using the logout button available at the bottom.

Figure 14 shows the driver's interface. Drivers can access the driver interface using the 'USER' button in the main interface. The driver can notify parking slot availability and available slot numbers and place. For this driver interface no need to login, which means anybody can view the interface. In future, we can build an interface for login, which limit access, and the driver can book prior to parking the vehicle. But, at the movement, this system provides open access for all who can access the parking details if they have only an android app. The parking space owner can control the parking area remotely. Here the sensor modules are used to identify the vehicles. Also, sensors count the number of vehicles in the parking area. Servo motors are used to control the open and closed gates of the parking. Other modules are used to record the entry and exit times of the vehicles. We used this simulation set-up to test our objectives and design and evaluate the number of random test cases. The system shows 90% good results. The results of the project could reduce the fuel consumption of the vehicle which is used for searching for parking and could reduce traffic on the road. Also, could reduce the human time of finding parking slots.

V. CONCLUSION

The concept of a smart city has always been a dream for humans. Over the past few years, the smart city concept has become a reality with great progress. The development of the Internet of Things and cloud technology has provided a new opportunity for designing smart cities.

Various modules are involved in this IoT-based parking system to maintain this system such as NodeMCU board, IR sensors, servo motors, and RTC module. Also included an android app. This system provides real-time processes and information on the parking slot in the android app. This project enhances the performance of saving time and fuel. Also, it resolves the problem of growing traffic congestion.

As for future work, the users can book a parking space from a remote location using their mobile. Also, can send parking fee details for mobile, and users can pay the parking fee online.

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Understanding the Identity of a COVID-19 Suspect or Victim through the use of Google Glass

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Abstract

Coronavirus disease (COVID-19) is a coronavirus-borne ailment that has just been discovered. In most cases, the infection will cause mild to moderate breathing difficulties. As time goes on, the COVID-19 pandemic continues to get stronger. A wide range of disciplines must therefore provide reliable solutions to the problem of risk mitigation. A useful technology is gaining worldwide acceptance because of the rapid growth of Google Glass. An AR-enabled Google Glass is envisioned in this idea, which details the overall design of the device and key components. It was investigated whether a sensor might be used to monitor a person's temperature from afar. Google Glass receives the temperature reading from the sensor. The GPS coordinates of the wearer will be sent to the cloud if the measured value is higher than the national average. There have been a lot of past studies done with Google Glass and other smart glasses for a range of different applications. We think that if the idea is used in real-time, the death rate can be significantly reduced while maintaining social distance, and many infected patients can be found.

Keywords: Google Glass, Coronavirus, Firestore, IR Thermal Sensor, COVID 19

I. INTRODUCTION

Coronavirus disease (COVID-19) (Organization and others, 2020b, 2020a; Singhal, 2020) is a newly found coronavirus-borne infection. Most patients who contract the COVID-19 virus will suffer mild to moderate breathing problems and recover without specific treatment. Aged and adults with underlying medical conditions such as cardiovascular disease, diabetes, chronic lung disease, or cancer are at an increased risk of developing severe medical conditions. The most effective method of preventing and slowing transmission is understanding the COVID-19 virus, its sickness, and how it spreads. Prevent infection in ourselves and others by frequently washing hands or using an alcohol-based rub and refraining from touching the face.

Globally, the COVID-19 pandemic has claimed many lives and posed unexpected threats to public health, food systems, and workplace safety. With the pandemic, tens of millions of people are poor, and the number of undernourished people could rise to 132 million by the end of the year. Nearly half of the world's 3.3 billion workers face unemployment. Informal workers are highly vulnerable, as they lack in social protection, adequate health care, and productive assets. The pandemic has destroyed sources of livelihood for millions. Hunger and malnutrition threaten millions worldwide, especially in low-income nations and among the most marginalized communities such as local producers and native tribes. And yet, millions of agricultural workers – both salaried and self-employed – are routinely exploited, abused, and malnourished while feeding the world. In addition to transportation, work, and living hazards, migrant agricultural workers struggle to access government assistance. This crisis touches on food security, public health, employment and labor issues, particularly worker health and safety (Paul et al., 2021). To address the crisis' human dimension, all industries must adhere to safe and healthy work practices, and labor rights must be protected. Immediate and purposeful action to save lives and livelihoods should include universal health coverage and income support for the poorest. COVID-19's effects are most severe in countries facing humanitarian crises. The rapid pandemic response is critical to getting humanitarian and recovery aid to those in need. Global solidarity and support are urgently required, especially for the most vulnerable in the emerging and developing world. We can only overcome the pandemic's intertwined health, social, and economic consequences by working together, avoiding a prolonged humanitarian and food security catastrophe that could undo previous development gains. We are committed to pooling our expertise and experience to help countries respond to crises and achieve

SDGs. We need long-term, sustainable solutions for the health and agro-food sectors. Achieving universal social protection, safe migration pathways, and formalizing the informal economy should be prioritized over addressing the underlying food security and malnutrition issues.

Many strategies and tactics have been planned, organized, and executed by the globe to avoid and demolish the pandemic. Still, it is a nightmare for to whole scientists and the globe. As modern solutions for the epidemic, a variety of therapies, including vaccinations, are being offered. Nonetheless, those are only temporary fixes, and the world has realized that the Covid19 is a permanent problem. As a result, instead of focusing on a temporary remedy, the world focuses on a long-term solution to prevent the risk. The most valuable therapy for avoiding risk from the virus is perfectly utilizing technologies. The virus has defeated the essential solutions and grows stronger by the day. As a result, trustworthy avoidance solutions are required from a variety of fields.

The famous and highly impactable technologies of current trends are the Internet of Things (IoT), Artificial Intelligence (AI), Image Processing, Cloud Computing, Swarm Intelligence, Wireless Sensor Networks, Robotics, Deep Learning, Data Science and Mobile applications. These cutting-edge technologies are highly classified and deliver timely service. Those technologies are used in various fields, including health, agriculture, transportation, education, and libraries, and they achieve near-perfect accuracy.

In addition to those classified technologies, Google Glass is a growing, unexpected handy technology that most people of the globe like and accept. Nowadays, people do not like carrying an additional device in their hand; instead, they prefer easiness. Of course, google glass eliminates that problem and provides more solutions than a smart mobile device. Current statistics show that more than 21.15 million people have been using google glass since 2018 (Google Glass Usage, 2021). Which indirectly indicates the acceptability of google glass among people. This technology's flag is rising in almost every domain. Education, health, military, and supply chain are a few of those domains.

Though there are countable mechanisms available to identify and protect from covid infection, this paper critically proposes a concept to avoid the infection in advance by reading the temperature of the people coming in front. Google glass is being used for this purpose with significant modifications.

II. LITERATURE REVIEW

The software industry incorporates with the University College Cork (UCC), which developed a Covid-19 Remote Early Warning System (CREW) using digital thermometer sensor to monitor the body temperature of the front-line staff of the hospitals that further can work with wearable and IoT devices via cloud computing (Cusack et al., 2020). Meanwhile, a review article summarized that the drone with the temperature sensors could identify and screen COVID-19 patients in any crowded places (Khan et al., 2021). Likewise, the DOHA international airport developed a Smart Screening Helmet (SSH) for their staff to identify passengers' temperature and COVID-19 affected travellers (Jay Singh, 2020). Similarly, in Malaysia, an intelligent AI helmet was developed using various sensors based on AI to detect human temperature in real-time (Al-Humairi et al., 2020). Likewise, research proposed a system to detect human temperature using a thermal infrared camera and send the details to the relevant authorities via a mobile app if a person's temperature is more than the typical case (Mohammed et al., 2020).

A wearable oura ring device was developed to identify COVID-19 affected people with various sensors build-in, which also used temperature fingerprint sensors to measure the body temperature (Poongodi et al., 2021).

A Japanese older man used a robot to avoid COVID-19 transmission from others that also used to measure the temperature of a human using infrared sensors (COCO LIU and CHAN, 202AD). Comparably, in China, Public Health Clinical Center (SPHCC) used a real-time patient monitoring system that used VivaLNK's temperature sensor to monitor COVID-19 patients (Dean Koh, 2020). Furthermore, China uses infrared temperature sensors installed in drones to monitor human temperature across the country to avoid human interaction in public places (Jaime Perez, 2020). In addition, they have upgraded their facial detection into a contactless temperature detection system to identify fever patients in crowded places (Pratik Jakhar, 2020). Similarly, in the US, dragonfly drones were used to identify COVID-19 affected people using various sensors such as temperature sensors and cough sensors (Cozzens, 2020). Likewise, the Italian government

implemented LoRa temperature detector devices to find the human temperature in real-time (David Maliniak, 2020).

A study proposed a framework to develop a smartphone app based on AI techniques, especially for the healthcare staff to identify COVID-19 symptoms via sensors, which included identifying human temperature (Maghdid et al., 2020). Similarly, research was proposed to reduce the false results in finding COVID-19 patients via temperature sensors using smart devices (Magesh et al., 2020).

A systematic review article mentioned that a biosensor was under the developing stage called 1AX with minimum cost that can help read and store the human temperature in real-time in terms of early detection of COVID-19 symptoms (Javaid et al., 2020)

S.No	Device/ Application	Thermal Detector	Technology used	LR
1	Covid-19 Remote Early Warning System (CREW)	digital thermometer sensor	Internet of Things (IoT), Cloud Computing	(Cusack *et al.*, 2020)
2	Pandemic drone	plasmonic sensor	Drone	(Khan *et al.*, 2021)
3	Smart Screening Helmet	infrared thermal imaging	Artificial Intelligent (AI), Augmented Reality (AR)	(Jay Singh, 2020)
4	Dual-functional plasmonic photothermal	plasmonic sensor	dual-functional plasmonic biosensor	(Qiu *et al.*, 2020)
5	Temi (Home Nursing robot)	Infrared sensor	AI, Google Voice	(COCO LIU and CHAN, 202AD)
6	Smart Helmet	Thermal infrared Camera	IoT, Global Positioning System (GPS), Arduino IDE	(Mohammed *et al.*, 2020)
7	Patient monitoring system	VivaLNK's temperature sensor	IoT, Bluetooth	(Dean Koh, 2020)
8	Smartphone app	Temperature fingerprint sensor	AI	(Maghdid *et al.*, 2020)
9	Biosensor	1AX	Wireless	(Javaid *et al.*, 2020)
10	Dragonfly	Any temperature sensor	Drone, Computer vision	(Cozzens, 2020)
11	Temperature auto-sensing robot	Thermal sensor	IoT, Wireless, AI	(Advantech, 2020)
12	Airborne infrared cameras	Infrared sensor	Drone	(Jaime Perez, 2020)
13	AI-enabled fever detection system	Thermal sensor	AI	(Pratik Jakhar, 2020)
14	LoRa temperature detection device	Infrared sensor	IoT, Wireless	(David Maliniak, 2020)
15	Temperature detection device	Infrared (IR) sensor	AI	(Magesh *et al.*, 2020)
16	Smart AI helmet	Adafruit Thermal (IR) Camera	AI, Raspberry Pi OS, Wireless	(Al-Humairi *et al.*, 2020)
17	OURA ring	Temperature fingerprint sensor	Machine Learning (ML)	(Poongodi *et al.*, 2021)

It was confirmed that the innovative materials with the sensor technologies could identify COVID-19 that can develop at a low cost (Erdem et al., 2021). Similarly, the efficiency and cost-effectiveness of Google glasses help increase their use in the medical sector (Dougherty and Badawy, 2017).

The authors discussed how wearable and robotics technologies could measure human temperature via different thermal sensors (Tavakoli, Carriere and Torabi, 2020). Likewise, another article proposed a system to detect significant symptoms of COVID-19 via sensor-enabled smartphones, including body temperature (Stojanović, Škraba and Lutovac, 2020).

Google Glass is a wearable device working on the Android operating system. It can be worked with the help of AR. It has built-in Wi-Fi, Bluetooth, audio, and video devices. Furthermore, it has a semitransparent screen. Also, it can implement machine learning and computer vision (Steele, 2019). In addition to that, it permits to implementation of sensors within it as it operates (Pennic, 2014).

A Technology expert strongly confirmed that the wearable devices demand increasing during the COVID-19 pandemic, especially Google glasses (Maffei, 2020). Furthermore, the TemPredict study was conducted to prove that the OURA ring with thermal sensors can monitor fever patients (Smarr et al., 2020). Further, A study pointed out that IoT-based smart glasses can be used to identify people with higher temperatures in crowded places (Nasajpour et al., 2020).

A study reported that A Google glass with Biosensors and actuators can be used to measure temperature in real-time via wireless transmission (Zhang et al., 2016). Similarly, China was developed AR glasses to measure human temperature (Emory Craig, 2020). Further, an analysis study supported that Google glass can be used in journalism (Ware, 2018). Likewise, it can be used as a personal assistant to deaf and visually impaired persons (Berger and Maly, 2019). Similarly, Google Glass was used in education and medicine, too (Dafoulas, Maia and Tsiakara, 2018), (Munusamy et al., 2020).

Meanwhile, it can be used during the pandemic as it has a remote access mechanism (Scales, 2020). Similarly, the same feature is available from the smart glass too (Proceedix, 2020); likewise, It was used for virtual ward round using telemedicine during the pandemic crisis (Market Insight, no date), (Martínez-Galdámez et al., 2021). Meanwhile, a study proposed a framework to estimate body temperature via infrared-installed smart glasses (Ruminski et al., 2016).

S.No	Technology used	To/ by	Device	Purpose	LR
1	Text-To-Speech	Blind and Deaf	Google Glass	Watch, Listen	(Berger and Maly, 2019)
2	Remote Access	Onsite Employees	Google glass, Smart Glass	Virtual Access or Monitoring	(Proceedix, 2020; Scales, 2020)
3	Augmented Reality	Doctors	Smart Glass	Virtual Monitoring	(Market Insight, no date),(Martínez-Galdámez *et al.*, 2021)
4	Infrared Sensor	Anyone	Smart Glass	Temperature Measure	(Ruminski *et al.*, 2016)
5	Bio Sensor	Anyone	Google Glass	Temperature Measure	(Zhang *et al.*, 2016)
6	AR, Infrared sensor	Anyone	AR Glass	Temperature measure	(Emory Craig, 2020)

Research work pointed out that the thermal scanner is not recommended to diagnose COVID 19 patients since it can only detect the temperature more than fever temperature, and COVID-19 patients can have less temperature (Madurai and Pugazhendhi, 2020). The previous statement supported by (Surya and Teja, 2020). Furthermore, Google Glass has negative issues such as low battery endurance, data protection issues, and interruption during network problems (Muensterer et al., 2014)

III. METHODOLOGY

This section explains the overview of the system suggested as a concept in this paper and the architecture of Google Glass. The suggested system is based on modular architecture as it includes several modules of programs to handle the different tasks. Section 3.1 describes the architecture and the components of Google Glass, and section 3.2 explain the suggested system overview.

A. Architecture and Components of Google Glass

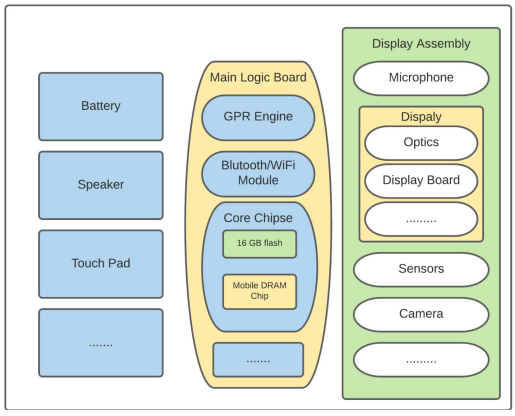

Figure 01(b): The General Architecture of Google Glass

Google Glass is a wearable, voice- and motion-controlled Android device that looks like a pair of eyeglasses and shows information right in front of the user's eyes. The augmented reality experience

offered by Google Glass provides relevant information through visual, audio, and location-based inputs. It is possible to implement, for example, automatically showing the current flight status as a user enters an airport. As it is a very tiny computing device, its architecture and components are a bit complex. Figure 1 (a) and (b) show the internal components of the Google Glass.

not a monolithic system where equally distributed small components are built. We examined Google Glass more closely and discovered that it is made up of many assembles that are loosely dependent on one another. First, we unpack the primary assemblies such as the main logic board, display assembly, battery, speaker, etc. Figure 3.2 shows the general architecture of google glass. Many of

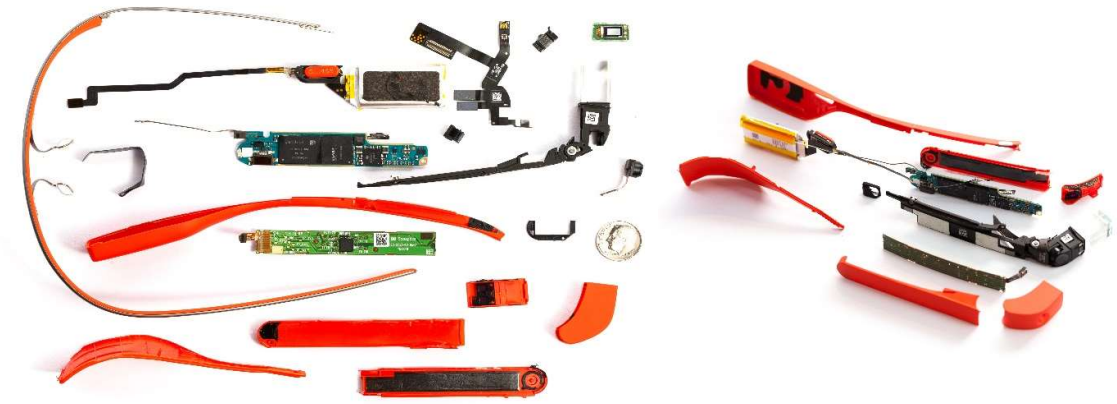

Figure 1(a): All the components of Google Glass. (b) The side opened view of the Google Glass (Google Glass Teardown)

Google Glass consist of several tiny modules in it such as the touchpad, main CPU board, behind-ear module, speaker, display assembly, display, optics, camera, battery, logic board, US dime, built-in Wi-Fi and Bluetooth and some sensors (accelerometer, gravity, gyroscope, light, linear_acceleration, magnetic_field, orientation (deprecated), and rotation_vector)(Interpreting the Evolution of Google Glass).

The intelligent eyewear considers motion and voice recognition, helping the wearer manage his/her day. Another option is the pad that is located on the glasses' rims. To get the information they need, the device sends the information to the wearer using a small package of information which is projected on the wearer's skin using a micro-projector, through a private channel of communication that only the user can access. To see the image in the captured colors, Google Glass uses a field sequential color (FSC) liquid crystal on a silicon (LCOS) system. The term FSC denotes a television system that employs continuous images to carry out color processing and then combines what the viewer sees with his or her natural capabilities to create a color image. LCOS is a method of creating video displays

Any architecture specifies what system modules will be included and what they will be used. It is

the components that Google Glass is made up of are not created solely for Google Glass. Nearly all of them have been with us for quite some time.

B. *Suggested System Overview*

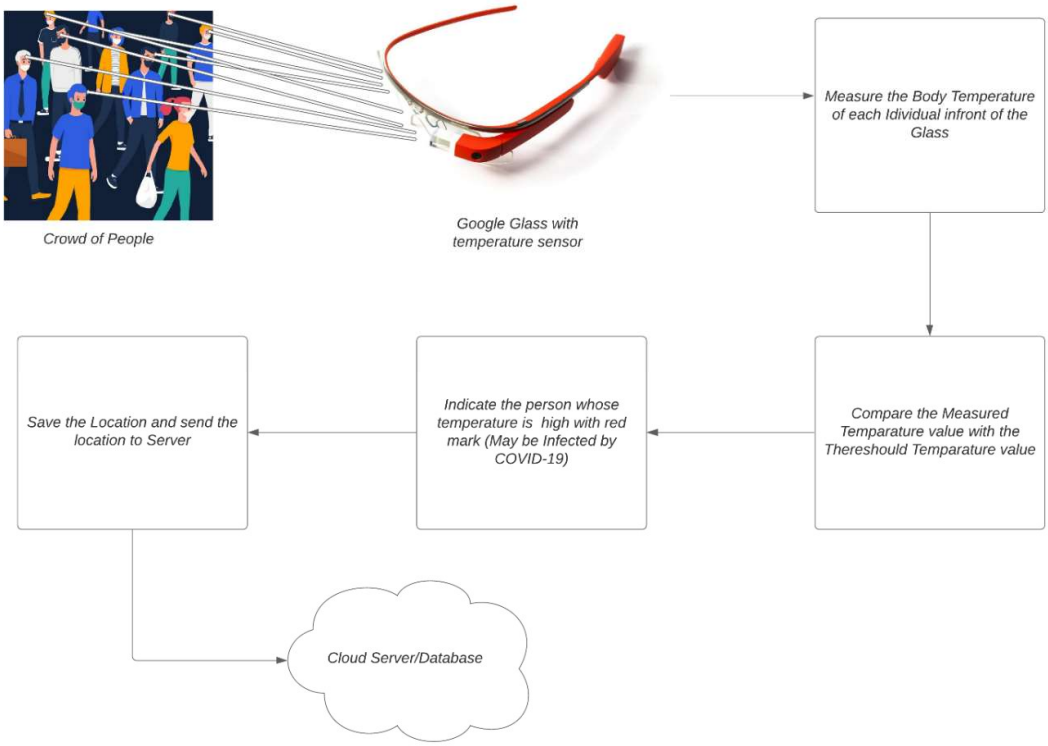

Figure 02. The Suggested System Overview

Figure 0-3 shows the proposed architecture of the potential concept of this study. As shown in the figure, a security guard of the organization wears google glass at the security gate. Whenever crowded people enter the gate, he/she use this glass to measure the body temperature. This study looked at using a sensor to assess body temperature from a distance—the sensor embedded with google glass to do this task. Here the sensor measures the body temperature and passes that value to google glass. Which immediately compared that value with the average human body temperature. If the value is greater than a typical threshold value, the person will be suspected of being Covid-19, and security measures will be taken to avoid entering the building. If not, they can move to the building without any interruption. Also, if the measured value is higher than average, then the locations of the person will be updated to the cloud by google glass to notify the responsible person. Generally, google glasses have multiple features compared with other Virtual reality glasses, and location passing to the cloud easily done by google glass than other devices

IV. RESULT AND DISCUSSION

This section will focus on the necessary sensors and working procedure of the given concept in the methodology part.

A. *Equipment and Working Procedures*

1) *IR thermal sensor*

The sensor is used to gather the body temperature at a distance. Generally, IR thermal sensors can absorb the body temperature of a human or object with radiation. The mechanisms by which heat is transferred from one body to another are conductivity, diffusion, and radiation. Radiation is when a hot object radiates heat energy in electromagnetic waves, which are absorbed by fabulous. Although some of it reaches the visible light spectrum, most of this radiation is in the electromagnetic spectrum's infrared (IR) section (Saha, Dewangan and Dasgupta, 2016).

IR thermal sensor encompasses three components: optical components, IR detector, and electronics. When the item emits infrared energy, optics transmits it to the IR detector, converting it to an electronic signal. The electronic signal is transformed to a temperature after a sequence of electronic procedures (SESOR TIPS, 2021).
When infrared photons collide with the human body or any other object, heat energy is reflected, absorbed, or transmitted. When the reflected heat energy reaches the sensor, it is measured using its three components.

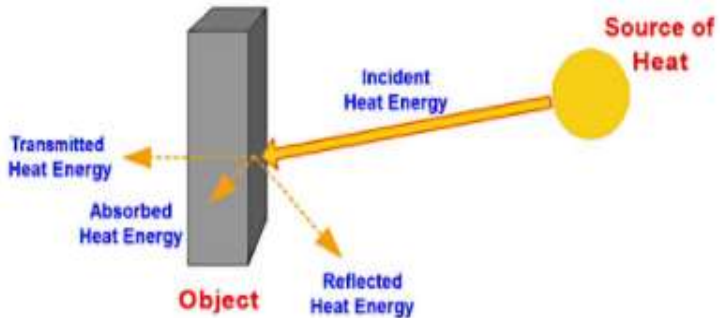

Figure 03: Working mechanism of IR temperature sensor

$$WInc = WRef + WTra + WAbs$$

WInc – Incident energy
WTra – Transmitted Energy
WAbs – Absorbed energy
WRef – Reflected energy

3) Android application for a location transfer

When the temperature coming from the IR sensor needs to be stored in the google glass OS, it needs applications to move on further. Here we suggest some interfaces with the android operating system as below.

When we check Figure 05, we can recognize the two interfaces. In each interface, the longitude, latitude, and average temperature are static. Longitude and latitude are used for getting the location purpose of the covid 19 infected patients. Those will be vary based on the place. The data coming from figure 05 will be passed to this interface as quickly as possible to update the value to the cloud to notify the needy person. Here green circle implies the pass information of the gate

Figure 04: Google glass view with IR thermal sensor

2) Google glass camera view with IR thermal sensor

When the security guard looks at the people by the google glass, they will get Figure 04. When the security guard identifies the blue tag as in the figure, it is normal and has a green signal to enter the gate. If it is red, they will have become a suspect of covid 19

4) Cloud database with location information

Figure 06 merely shows the cloud database and the method of information stored in it. When we look at the figure, it sends the detail with temperature. It will further be shared with the responsible person from this point. The emergency team will reach the spot as soon as they get the message from the database.

V. CONCLUSION

Smart wearable devices play a significant role in the current pandemic situation in monitoring COVID-19 patients in the health sector. Throughout the study, we have proposed a timely remedy for identifying COVID-19-affected humans in crowded places while following social distance measures. Most previous research studies were conducted using Google Glass and Smart glasses for different purposes. However, research studies on these devices for the temperature measurements of moving humans during the pandemic have yet to be completed. However, working with Google Glass has many features compared with the recent VR and AR glass applications. Though the said idea is a potential concept, it has higher robust throughput when it is implemented. Also, in the wearable devices of the Android OS, we can have thermal sensors for measuring the body temperature; hence, this study proposed a possible way to implement the IR sensor with google Glass due to its infrastructure. We strongly believe that the concept implemented in real-time, a high number of infected cases can be found while keeping social distance measures, and death rates can be reduced considerably without any suspects. Furthermore, this study can be extended to find the affected human with the help of the inbuilt camera of Google Glass and notify the relevant authorities about the victim using the image processing technique. It was very tough to find the related studies since the concept is very new, and very few articles were found related to COVID-19 and Wearable devices

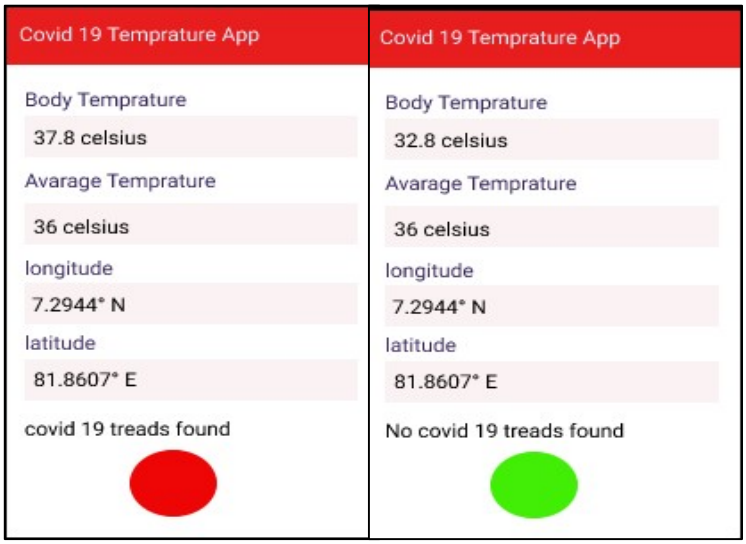

Figure 05: Sample Interface of google glass for Covid 19 detection

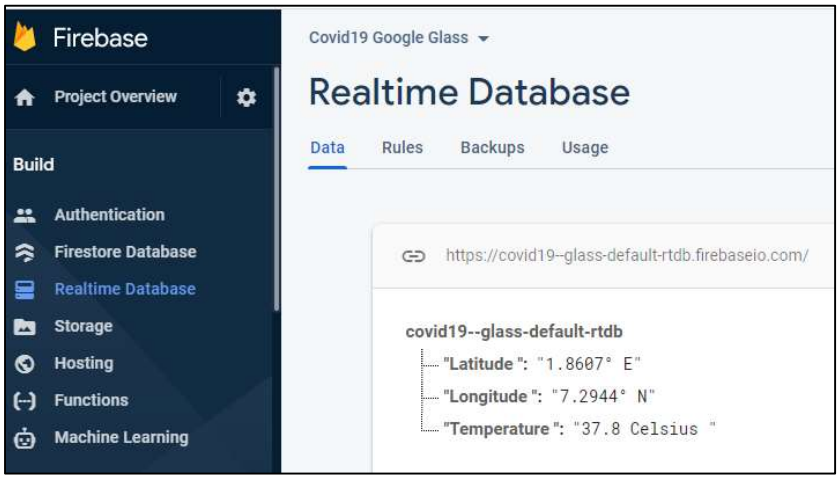

Figure 06: Location shared in the real-time database

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Big Data Application Analysis: A Review

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Abstract

The term "big data" describes datasets that are not only large but also have a high level of diversity and velocity, making it challenging to manage them with conventional tools and methods. Through enhancing decision-making and vision searching, the big data explosion is reshaping lifestyles in terms of working and thinking. This paper conducts an analysis of recent research and studies projects in a variety of sectors that make use of big data. This paper studies 45 previously published articles and conducted a systematic literature review. According to the survey, many fields achieve various benefits, mainly when they apply big data technology. Further, selected algorithms perform better with specific domain data. This paper summarizes the different techniques used in the various domains and their benefits. Also, the article discusses the limitations in this study and limitations in big data applications.

Keywords: Big data analysis, Big data applications, Big data technologies

I. INTRODUCTION

Big Data is becoming a global trend. Although it does not yet have a widely accepted academic or scientific definition, it continues increased commercial expansion for its surrounding industries and related study fields (Hernández-Leal, Duque-Méndez and Moreno-Cadavid, 2017) (Soomro et al., 2019). Big data analytics is seeing patterns, trends, and correlations in massive amounts of unprocessed data in order to make data-driven choices. These processes use well-known statistical analysis techniques, such as clustering and regression, to bigger datasets utilizing contemporary technologies. NASA scientists invented the phrase Big Data in 1997 to characterize the challenge of presenting data sets that are too huge to fit in a computer's main memory, restricting analysis of the data set as a whole (Austin and Kusumoto, 2016). It is particularly formidable when managing large amounts of data and has had much more success in various fields (Li *et al.,* 2019).

The word "big data" refers to data sources that are too large or complicated, and conventional data processing methods are insufficient to process them. It is crucial to consider the data's size, complexity, and velocity in big data. The big data set is expanding in size at an exponential rate. This data is too big, too unstructured, or too "raw" compared to traditional data. In relational databases, processing methods employed still do not worry about the amount of data but are rather concerned the quality of the data (Gorodov and Gubarev, 2013) (Huda et al., 2016). The amount of data in one big data collection currently ranges from a few dozen terabytes (TB) to many petabytes (PB). Because of this, gathering, storing, searching, sharing, analyzing, and displaying massive data can be challenging. Enterprises are currently examining vast amounts of highly detailed data in order to learn something they did not know previously (Du et al., 2021). A Variety of data is generated from multiple sources such as social media, machine logs, sensors, transactional data, etc.

The demand for big data processing technology has increased in the age of big data. Big data brings a quick and significant rise in data resources and a greater difficulty in extracting useful information that customers require (Tulasi, 2013). Processing data is becoming increasingly more complicated. Traditional data analysis techniques have glaring flaws, which raises new demands on big data-based resource services for digital libraries (Li *et al.,* 2019) (Ying, Chan and Qi, 2020).

This paper aims to give an analysis of the big data analytics research that is currently accessible. Some of the numerous big data tools, approaches, and technologies and their potential in various decision fields are examined. In this review, the authors discussed what big data is, what the field big data is used for, how to analyze big data applications, and what obstacles big data faces.

II. LITERATURE REVIEW

Willis et al. discuss the ethics and analytics of big data in higher education (Willis, Campbell and Pistilli, 2013). This paper discusses ethical questions such as the "role of big data in higher education", 'role of big data in student experience", "application of big data in student retention" and "what is the impact on successful outcomes". Authors conclude that the actual issue in higher education when applying big data is that statistical likelihood within an academic prediction matrix has significant ramifications for both organizations and specific students. (Kamilaris, Kartakoullis and Prenafeta-Boldú, 2017) discuss big data in agriculture and smart farming using big data.

Using new healthcare-specific big data technologies, data from numerous sources studies to understand the industry best practices and give high-quality insights. Most countries, especially the United States, use big data to enhance their medical facilities (Batarseh and Latif, 2016). Wang et al. (Wang et al., 2018) discuss big data analytics in healthcare. This paper demonstrates a link between big data analytics capabilities, IT-enabled transformation practices, benefit dimensions, and business values through a big data analytics-enabled transformation model constructed from a practice-based approach. The growing requirement for healthcare management to handle the influx of clinical data supporting evidence-based medical practice is recognized as a potential solution in big data analytics (Wang et al., 2018).

Big data is a term used to represent the increasing expansion and accessibility of organized and unorganized data. It may be just as significant to industry and society as the World wide web has been (Singh Jain et al., 2017). Big data analytics using Deep learning performs exceptionally well nowadays using huge data and the introduction of potent computer hardware like the GPU. It can fully use enormous volumes of unprocessed data and fully automatically find abstract knowledge. Voice recognition, picture categorization, and other industries have effectively used great learning capacity (Peng et al., 2017).

Govindan et al. (Govindan *et al*., 2018) discuss big data in logistic and supply chain frameworks by applying the capability maturity model. Researchers used Twitter data to analyze the food supply chain management problems. Further, they used a text analytics method that uses clustering techniques, support vector machines, and multiscale bootstrap resampling to analyze the content of the Twitter data. The paper suggests that a big cluster of phrases can help decision-makers learn how to improve different parts of the logistics and food distribution chain (Govindan et al., 2018).

Data is regarded as a competitive resource and a new way to provide value for organizations, and the notion of big data is receiving a lot of attention in both the industry and the scholarly literature (Müller and Jensen, 2017). The quantity of data that can now be collected and used is increasing in today's smart cities. The ability to quickly collect, analyze, and store large amounts of data from various types of quantitative and qualitative domain-specific information sources has been made possible by recent advancements in hardware and software components, including social media, the IoT, monitoring devices, mobile technologies, data storage, and cloud computing (Iqbal et al., 2020).

Big data applications enable knowledge service providers to imbibe, procedure, analyze, and distribute content, transforming enormous amounts of data into insightful and compelling understandings. However, it is important to note that big data poses challenges to the methods and means of handling and analyzing data (Maqsood Ahmad Sandhu, Ahm Shamsuzzoha, 2018). Big data are data that, due to their size, complexity, and difficulty, demand novel management strategies, processing methods, algorithms, and analyses. Data collection, processing, storage, analysis, and visualization problems that were initially quantitative problems with data become qualitative problems as the scale of the data exceeds a certain threshold (Lee and Yoon, 2017).

III. METHODOLOGY

This study was conducted using a qualitative approach known as systematic literature review, based on earlier research and review papers over the last five years. The collected data were analyzed qualitatively to examine Big data's Fields, Technologies, and Purpose.

Table 01: Summary of big data application fields and techniques

References	Application Domain	Tools/Techniques and Data used	Purpose/Benefits
(Kamilaris, Kartakoullis and Prenafeta-Boldú, 2017), (Guo and Wang, 2019),(Horita *et al.*, 2017)	Agricultural	Big Data sources - Weather stations, Remote sensing (satellites, synthetic aperture radar, airplanes), geospatial data, historical datasets (land characterization and crop phenology, rainfall and temperature, Ground sensors (salinity, electrical conductivity, moisture), cameras (optical) **Techniques for big data analysis** - Machine learning (scalable vector machines, K-means clustering, random forests, extremely randomized trees), statistical analysis, modelling, cloud platforms, MapReduce analytics, GIS geospatial analysis, NDVI vegetation indices	Improve the accuracy of analyzing and forecasting disaster management, improve farmers productivity, weather forecasting
(Lee and Yoon, 2017),(Stieb, Boot and Turner, 2017),(Bofill-De Ros *et al.*, 2019), (Luo *et al.*, 2016),(Alyass, Turcotte and Meyre, 2015),(Tetko *et al.*, 2016)	Medical	Big Data sources – clinical data, sensors data, wearable medical devices data, DNA/RNA sequence data, biological image data **Techniques for big data analysis –** Machine learning (Decision trees, logistic regression, naive Bayesian approaches, Bayesian networks), Data mining, Neural network, Pattern Recognition, Natural Language Processing	personalized medicine. early detection of diseases(heart disease, cancer), identification of chronic diseases,
(Yan *et al.*, 2018),(Zeng, 2015),(Xie, Zhou and Li, 2016)	Transport	Big Data sources – IoT sensors data, Automatic data(automated passenger counts (APCs), camera video, automated vehicle location (AVL)), Global Positioning System (GPS) **Techniques for big data analysis –** machine learning, data mining, crowdsourcing	Traffic analysis to identify roads with a high risk of accident, transport route optimization
(Bajpai and Mani, 2017),(Willis, Campbell and Pistilli, 2013),(Kim and Ahn, 2016),(Zhu *et al.*, 2019)	Education	Big Data sources - social networking sites (like Facebook, Twitter, Blogs) Course Management systems (CMS), Learning Management System (LMS) and physical world data like library usage **Techniques for big data analysis –** machine learning, data mining, crowdsourcing	Prediction of performance of students, improve the resource management, providing feedback, course recommendation, and students behavior analyze.
(Muliawaty *et al.*, 2019),(Yu and Zhou, 2019),(Jordan, 2014)	Bureaucracy	Big Data sources – social media(Twitter, Facebook, blog and news website) **Techniques for big data analysis-** classification technique for sentiment analysis (Naive Bayes algorithm, Decision Tree, Artificial Neural Network)	Big data can used by local government agencies to enhance administrative and public services by knowing the public opinions.
(Padma and Ahn, 2020)	Tourism	Big Data sources - Satellite images, Geo-tagged images, conventional map, Google Analytics **Techniques for big data analysis –**data mining, crowdsourcing, Statistical and spatial analysis, Regression analysis, Sentiment analysis, Content analysis	Forecast tourist's arrival and predict the tourist volume, identify the potential area of tourism, identify which places are popular among different nationalities
(Du, Liu and Lu, 2021),(Ouyang, Wu and Huang, 2018),(Ishika and Mittal, 2021)	Security	Big Data sources – IoT devices data, sensor data **Techniques for big data analysis –** machine learning, data mining, crowdsourcing	Used to enhance the neural network's performance in order to increase the precision of early warning and Internet credit prevention
(Zhang, Zhan and Yu, 2017)	Business	Big Data sources – Sensor data (detect location in store), transaction logs **Techniques for big data analysis –** machine learning, data mining, crowdsourcing	Big data minimize resource waste and the inventory of the automotive industry. Reduce inventory and operational cost

A keyword-based search for articles and conference papers was conducted in the first stage using the databases IEEE, Emerald, Sage, and ScienceDirect and works indexed in Google Scholar.

The keywords "Big data Application" and "Big data technologies analytics" from scholarly publications from journals and conference proceedings were found using Google Scholar. The possessed publications included qualitative investigations, and the search period was set from 2017 to 2022.

A. Criteria for selecting and excluding articles

A first assessment of the recovered records was carried out by one of the writers. After analyzing individual titles and abstracts, duplicate articles were deleted, and more records were discarded. The included studies were then examined by a second author, who assessed the full-text papers or eligibility.

The authors selected 45 research articles from 75 based on the following criteria and all papers published in conferences or journals. The authors believed these two venues were more likely to contain current and relevant scientific papers related to this study.

- Majority of the Published papers between 2017 and 2022
- Only full papers
- Peer-reviewed papers
- Articles were an open access

B. Research Question

The following are the research questions (RQ) used in this study to collect data analysis.

- Which fields are most frequently utilized in big data applications?
- What emerging techniques support big data technologies across various domains?

IV. RESULTS AND DISCUSSION

Big data has a wide range of possible effects across many disciplines. This study aimed to understand the Techniques and the purposes for implementing Big data technology.

In the agriculture domain, there are some opportunities and berries to apply big data. For example, the lack of expert human resources and reliable infrastructures to collect data are some barriers. Further, there is a huge gap in structure and governance related to agricultural big data. Big data can be used to recommend guidance to farmers based on their crop conditions, weather and responsiveness to fertilizers. Moreover, by integrating agricultural data with the supply chain framework farmers can gain more from planned harvesting.

Nowadays, big data play a crucial role in biomedical and healthcare. By combining data from many sources, practitioners can present a new perspective on patient care that takes a patient's entire health status from DNA to behaviors. Also, the accessibility of cutting-edge mobile health devices enables more accurate real-time data collection and saves many lives by early detection of the seriousness of diseases.

Today businesses use big data for multiple purposes. Researchers conclude that having a positive review on social media for a product effect on the market of the product. Further big data can use to identify market trends, customer satisfaction, develop personal recommendation systems and etc.

Big data applications impact the field of transportation in numerous ways. Understanding passenger behaviors helps in decision making. Further, statistical methods such as Multiple linear regression, factorial analysis of variance (ANOVA) and etc. are used to analyze the tourism data. In all references include various fields and the benefits of big data technology for these studies. Finally, to obtain the best possible outcome from our study, authors may propose big data technology applications uses various fields of applications.

Only 45 articles, 2% of the Google Scholar results for the phrases "Big data Applications" and "Big data Technology Analytics" were examined. Another limitation of this assessment is that articles written outside of English were not taken into consideration. Because only Google Scholar was searched, academic databases and journal articles were also excluded from the search. Data collection from online websites only has possible drawbacks. It was unable to adopt data from a variety of sources, including first-hand information obtained from interviews and questionnaires (Ying, Chan and Qi, 2020).

There are still several issues with deploying big data approaches in real-world applications,

including a lack of pertinent supporting policies and an absence of uniformity of standards and norms (Li *et al*., 2019).

V. CONCLUSION

Big data analysis was reviewed in this article. This paper examines the applications of big data in different fields and the most current uses of big data technologies in various areas. Big data applications are used in agricultural, medical, transport, education, bureaucracy, tourism, security and business domains. Further to analyses the big data nowadays, mainly machine learning techniques are used. Additionally, some algorithms perform far better in some specific fields. For example, decision trees, logistic regression, naive Bayesian approaches, Bayesian networks, neural networks, etc., perform better in medical applications. Big data applications in all industries have a bright future since they develop new data values. Pertinent research and technology, the collaboration between research institutions and businesses, and strong government encouragement help further bring considerable data value.

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Artificial Intelligence Applications for Distributed Energy Resources: A Survey

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Abstract

Distributed Energy Resources (DER) is a concept that is still being worked on in the power grid of today. It makes it possible for electricity and data to move back and forth between adjacent power sources in the networks and clusters of the electricity system. Smart Grid is meant to replace the old grid with a network of Distributed Energy Resources. It combines many new and old technologies, such as information and digital communication technologies, to do a lot of different things. With this, the New System would be ready to identify, respond, and act to changes in utilization and cope with a variety of issues while making sure the power system runs on time. Distributed energy resources are a big part of artificial intelligence (AI). In the past few years, these promising technologies have changed quickly and been used in a growing number of ways. This study focusses on analyzing the applications of AI on DER in the different areas of DER, such as renewable energy, grid control, energy management, and AI in virtual power plants.

Keywords: Distributed Energy Resources, Smart Grid, Artificial Intelligence, Renewable Energy, Energy Management

I. INTRODUCTION

Devices for power generation, transmission, and distribution that are connected to the electric grid are referred to as distributed energy resources. They are typically situated in close proximity to load centres, and they individually or as a collection provide services to the electric grid (Worighi et al., 2019). DERs can be made up of a diverse range of generation, transmission and distribution assets. There are virtual assets that can contribute to the performance of DER electric system.

Physical DERs include things like power plants, battery banks, and solar panels that have a capacity of 10 MW or less. The utility company, a private company, independent power producers operate these facilities. Similarly, to how it supervises the functioning of large central power plants, the utility requests start and stops from these smaller facilities. Like with physical power plants, digital twins can be used to analyze the efficiency of a virtual power plant before it is added to the grid.

The need for energy is going through a significant transformation. Some of the older concepts are becoming obsolete, and it is necessary to develop new ones in order to address the issues posed by climate change and the scarcity of resources. The demand for electricity is skyrocketing at a pace that no one has ever witnessed before. The new cities and their infrastructure need to lessen their impact on the environment caused by carbon emissions. Getting there will be heavily dependent on the proportion of renewable energy sources that are incorporated into DERs (Facchini, 2017).

The emerging model of distributed generation is getting more and more attention, mostly because infrastructures are becoming more and more digitalized. This makes data more accessible and gives users more control over the stability of the network than ever before, even when there are occasional problems and interactions with customers.

Using PV, a wind turbine, fuel cells, and other DERs to make electricity on-site is a faster and less expensive option. Central power plants have larger installed peak capacities, but they also take longer to build than onsite distributed energy resources (DER) power plants. It also takes more time to put up high-voltage transmission lines (Notton et al., 2018).

Consumers benefit from increased service reliability, increased performance delivery, and energy security when they use an electrical network that is based on distributed energy resources (DER). When distributed energy resources (DER) make use of a renewable technology, they provide a significant contribution to the overall mix of power generation and are a component of the environmentally friendly approach for a cleaner planet.

The paper initially discusses about the AI for power system applications. It discusses the context on renewable energy, grid management, grid control, predictive maintenance and autonomous learning. Further, it is discussed about the use of AI Energy Management, AI for Virtual Distributed Energy Resources. There are edge IoT devices which facilitate the use of AI on the edge. Similar systems are discussed on the paper.

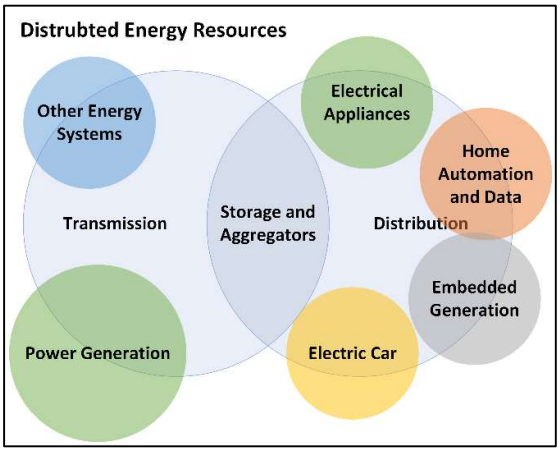

Figure 01: Distributed Energy Resources

II. DISCUSSION

A. *ARTIFICIAL INTELLIGENCE FOR POWER SYSTEM APPLICATIONS*

The growth of analytical models has made it possible to utilize various different tactics from the field of machine learning across a variety of industries, including the field of electricity generation and distribution. (Hossain et al., 2019). At the moment, most researchers are focusing on Machine Learning (ML) and Deep Learning (DL). People have thought of the Deep Learning (DL) as a new area for extracting features and dealing with a lot of data when ML methods fail. AI as a whole includes many subfields, such as machine learning, deep learning, big data, computer vision, neural networks, natural language processing, and many more. (Hossain et al., 2019). DL uses huge computational models like neural network algorithms with many levels of processing units to increase computational power and improve training methods. These networks are used to learn different trends from huge datasets. AI can help make systems in the power industry that are smarter and more reliable.

There are several Deep Learning Algorithms, particularly used in the Distributed Energy Resources. Some of the relevant algorithms are given here in Figure 02(China Electric Power Research Institute et al., 2018; Hafeez et al., 2020; He et al., 2017).

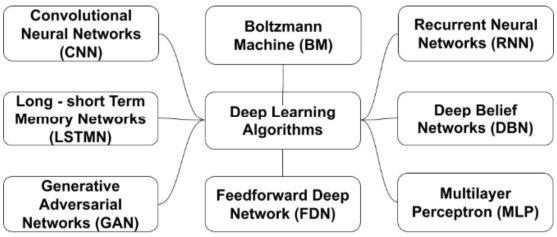

Figure 02: Deep Learning Algorithms

1) *Renewable Energy*

AI has the potential to revolutionize the renewable energy market. Using AI, electricity firms can improve their forecasting, grid management, and maintenance scheduling. Undoubtedly, renewable energy is the future, but its unpredictability poses a significant obstacle. Renewable energy relies on resources such as sunshine, airflow, and water. All of these resources are dependent on the weather, which is uncontrollable by people. Artificial intelligence has helped overcome this obstacle because it is a dependable tool for weather forecasting. It uses machine learning to analyze current and historical meteorological data in order to give reliable forecasts. These forecast data are utilized by the energy corporations to manage the energy systems. If the outlook is favourable, the corporations create and store renewable energy. If the prediction is poor, power firms adjust their load management accordingly. They anticipate the problem and utilize fossil fuels to maintain a continuous power supply.

The good forecast of production can be done by aggregating the forecast that is achieved through traditional method of power curves and the

forecast using Artificial Neural Networks. The method is explained using the Figure 04.

2) *Grid Management*

Grid management is another essential part of a DER system. Likewise, artificial intelligence and machine learning play a crucial role in this field. These systems utilize data analytics to anticipate residential energy consumption. The forecast is based on a certain portion of the year and data from prior years. This helps power companies predict how much energy will be needed over the next few days. Consequently, they can control their grids without interruption. If consumption is expected to be high, energy production can be increased. Alternately, during periods of the year when energy use is low, production might be reduced to prevent waste.

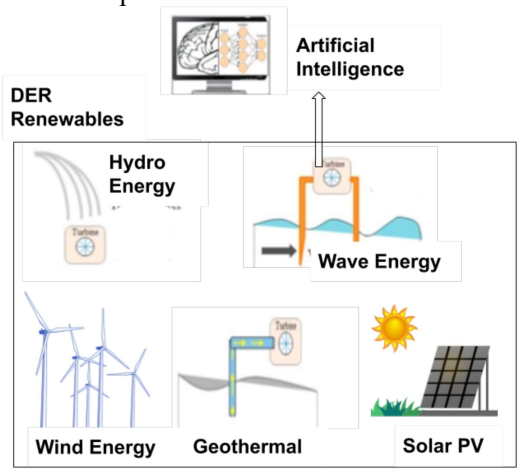

Figure 03: Renewables Associated with AI Forecasting

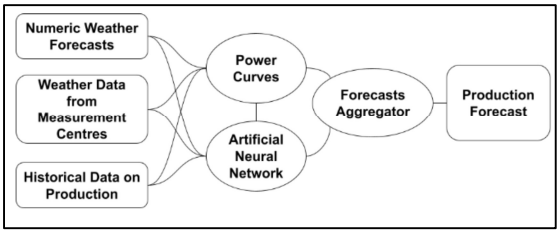

Figure 04: Renewable Forecasting using Artificial Neural Networks and Power Curves.

Advanced Metering Infrastructure (AMI), Distributed Automation (DA), Distributed Generation (DG), Distributed Storage, Home Energy Management Systems (HEMS), and Demand Response are examples of SG applications for monitoring and grid management (DR)(China Electric Power Research Institute et al., 2018). Smart Grids are one of the greatest possible IoT network deployments, with smart meters, wireless smart sensors, and smart appliances communicating to ensure reliable and effective power generation and distribution. Utility companies have to submit AMI end-user sensor, monitoring system, and smart meter data for billing, grid management, and forecasting. Sensor network data and SG interactions(Kimani et al., 2019).

3) *Predictive Maintenance*

There are times when electrical networks require repair, regardless of how effectively they are managed. It is essential that the entire system operates efficiently. By utilizing the power of AI and machine learning, it is simple to predict which system component will require repair(Shin et al., 2021). When power companies are made aware of imminent grid repair, they are able to inform customers. Scheduled maintenance allows users to anticipate upcoming power outages. Currently, we are experiencing power outages with no prior notification.

Predictive maintenance can be done via signaling systems through mobile alerts. They also can be alerted with Dashboard warnings. Here the previous historic data in Distributed Energy Resources are stored in the cloud. The data is then fed to an AI system which works as a decision-making system. These decisions are then given to the user in order to achieve predictive maintenance. This is shown in Figure 05.

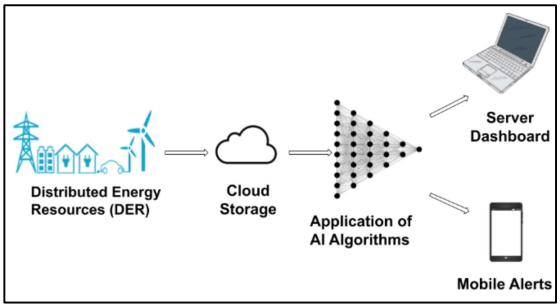

Figure 05: Usage of Artificial Intelligence for Predictive Maintenance

4) *Grid Control*

In power systems, new AI models in power systems are constructed using recursive neural networks. Transient stability of the electrical grid has been identified and its defining properties retrieved using data mining technologies(Rafik et

al., 2020). This has resulted in answers for problems like assessing the current state of the system's operations, optimizing its controls, and coordinating their actions. The findings were used in load forecasting and standby dispatching systems, allowing for more informed choices in power grid monitoring, network analysis, index management, and index control(Ali and Choi, 2020).

5) Autonomous machine learning drives smart grid autonomy.

Using machine learning, DER - smart grid autonomous management can improve the intelligence of its planning, decision-making, and system comprehension(Jiao, 2020). In the field of smart grid applications, researchers frequently run into issues including adaptability in relay protection, assessing grid equipment defects, assessing grid parameters, and identifying stealthy faults. The smart grid's ability to learn on its own will be bolstered by the cumulative effects of autonomous machine learning, which will also raise the smart grid's level of learning in terms of perception, cognition, and behaviour(Azad et al., 2019).

6) Knowledge Information System

The expert system was the first and most important use of artificial intelligence. It was closely related to knowledge engineering. At the moment, experts' experience and knowledge are also needed to solve many issues in smart grid DERs. With an insight knowledge information system (KIS), specialists can learn more about a certain field and gain more knowledge and experience in it. The KIS's inference engine can be used to simulate how experts make decisions on the job. Setting up power grid knowledge data about fault diagnosis, intelligent control, fault localization and analysis, energy router self-determination, and other things will be a big step in the right direction for smart grid knowledge engineering (Kabalci and Kabalci, 2019; Li et al., 2018).

B. AI IN ENERGY MANAGEMENT

The world of energy has always faced problems with sustainability. By using energy at its best level, any industry can help save energy and use it efficiently without wasting it. As we've already talked about, AI is giving different services and industries new ways to use unmapped data and link it to decentralized energy resources(Lee et al., 2022). So, industries can use AI to optimize how energy is used in different sectors. This gives us real chances to solve the problems facing the environment. When AI, machine learning, and deep learning algorithms are used with an organization's core energy system, it's easy to get insights into how the energy operations work. Then, it breaks down the data and suggests an actionable way to manage energy while helping you save money on energy you don't need. It is a real-time way to cut down on energy waste and find new ways to save energy by using untapped data to optimize how much energy each industry uses.

A successful AI Energy Management system can be taken into action by considering the following factors.

- Always keeping an eye on the Al control system to make sure it doesn't go against safety rules (Khargonekar and Dahleh, 2018).
- If the Al control system does break the safety rules, the system will automatically switch to a neutral state (Khargonekar and Dahleh, 2018).
- Maintain a smooth transfer during failovers to prevent the system from going through any abrupt changes (Urlini et al., n.d.).
- Verification of the acts taken by Al on two different levels before implementation (Schneier, 2005).
- Communication that takes place continuously between the cloud-based AI and the physical Infrastructure (Kumari et al., 2020).
- Estimation of the degree of uncertainty in order to guarantee that we will only carry out actions with a high level of confidence (Kläs and Vollmer, 2018).
- Human override is always an option and will take precedence over any actions taken by the AI algorithm (Hendrycks et al., 2021).

C. AI FOR VIRTUAL DER

To begin, a digital twin model is produced that is a reflection of the real environment. This model includes each item and the location at which it is located. Utility companies are gaining more insight into their power grids and DERs with the use of digital twin models, which is increasing their level of safety and productivity while

simultaneously cutting down on equipment downtime (Steindl et al., 2020). After the data has been incorporated with digital twin, the AI equipped simulations, analyze performance, and identify potential areas for improvement in order to maximise the intended level of performance (Novais et al., 2021). To achieve strategic and compliance objectives, different rules can be implemented, and the insights acquired can then be dynamically transferred back onto the original power system by means of AI-based asset controllers. A virtual environment is developed when more assets are added, and inside this environment, numerous different simulations may be run, problems can be investigated, and feedback can be sent to the DERs and smart grid. The AI models will continue to learn with the real-time data as they learn continuously through continuous learning in order to maximize long-term performance (Nikam and Kalkhambkar, 2021). This continuous influx of data and knowledge in real-time enables the models to become more intelligent over time and benefit from the decisions they have made in the past. An all-encompassing AI strategy may also actively synchronise and optimize traditional and newer DER with one another and with the electricity network. This opens the door for machine-to-machine interaction and decision-making. Because all of the assets are being controlled by AI, this active synchronisation capability ensures that they are all working together to achieve both individual & combined goals of the devices and systems in the grid.

D. EDGE AI FOR DER

The use of machine learning and deep learning algorithms make the edge IoT smart system intelligent and powerful (Loven et al., n.d.). Therefore, the following systems can be made smarter with the use of AI.

1) Advanced Measurement and Sensors

Smart metering, which customers and utilities can use to find out how much and when they use electricity, is part of the AI powered smart grid. This checks the safety of the system, the integrity of the grid, and helps with highly developed protective relays (Kabalci et al., 2019). This gives customers more options and lets them meet demand. It also makes the grid less crowded. Evaluation and monitoring carried out in advance make the grid more stable by finding problems early and isolating them so that power outages don't happen. The sensors collect data which is very helpful for forecast, analysis and predictive maintenance works.

2) Automatic Monitoring and Control

Smart Grid DER offers direct tracking and presentation of the statuses and efficiency of energy system devices over vast geographies, allowing device controllers and users to recognize this information and optimize electric grid components, activities, and output (Hancke et al., 2012; Meral and Çelík, 2019).Monitor and control technology from SG assist inform decisions, minimize wide-area problems, and enhance distribution reliability and capacity.

III. CONCLUSION

The use of the most recent AI technology is anticipated to be inevitable for the high performance of the newer DER system. Integrating Artificial Intelligence with Distributed Energy Resources (DERs) is a critical component for the successful operation of smart grid. Throughout the course of our study, we investigated the potential applications of AI in areas such as renewable energy, grid control, energy management, virtual power plants, and Edge AI devices. The DERs powered with AI will be able to provide many smart features thereby giving us reliable, less energy consuming electrical systems.

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