

# Smartphone, Voice, and Infra-Red Remote Controlled Learning kit with Feedback Voice

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**Abstract-** This paper presents a new tool for teaching the alphabets and numbers of different languages to children. This device is made with a large 32X32 Matrix Display, with the ability to show alphabets of different languages and numbers with feedback sounds, it can be controlled using voice commands, TV remote control, and an android application in a smartphone. Moreover, the device is designed in such a manner, to display a real-time clock at the first run. To obtain data such as time and calendar, an RTC (Real-Time Clock) module is interfaced with Arduino Mega 2560. To display each character on 32X32 Matrix display, the monochrome bitmap format of each character was taken and converted into the required format using the software called "LED Matrix Studio". Based on the UART communication protocol, mobile and voice command controls are executed through HC 05 Bluetooth Module. Further, the TV remote sends a code to the IR receiver in NEC format for each button that is pressed. Since the power consumption of the device is quite low, it can be used in places where the famine of electricity has empowered. The device can be added with some additional features, such as music, animation, mathematical search. A noisy environment will affect the operation of the device for voice commands. Although, the device will make learning procedures easy for children and teaching procedures easy for teachers.

**Keywords:** Arduino Mega 2560, UART, NEC, Matrix Display, Voice Command, HC-05 Bluetooth, Android Application, Feedback sounds, Real-Time Clock, monochrome bitmap, LED Matrix Studio

## I. INTRODUCTION

Nowadays, kids are highly attracted by technological advancement and engaged themselves more often with entertainment, social media, games, etc and hence they have driven away from education. Hence, it is crucial to make a technological device that will attract kids for the

studies i.e., which will teach them. Moreover, the prices of the product need to be in the range of the poor and may also use this technology.

This paper presents a device of 32X32 matrix display by cascading four 16X8 LED matrix displays and each display is driven by the driver chip MAX7219 that displays the alphabets of three different languages, such as English, Tamil, and Bangla, and numbers from 0 to 9. Furthermore, a feedback sound has been added for each character and the sound will be produced to display the respective character. The device can be controlled, or the alphabet or numbers can be changed using smartphones through the Bluetooth and even by TV Remote. The device can be controlled by giving voice commands such as "next" for the next letter or number and "previous" for the previous letter or number, and "menu" to move to the menu. In addition, the display of respective alphabet or number will also provide feedback voice, which will provide fun for children and those with eye problems can also use this device for learning. This can be used as a digital watch that displays the day, date, month and year. Therefore, it will serve as both a learning device and a clock. In addition to the fact that the device is light and small, it can be carried anywhere and even while traveling. Only 12V DC battery is enough to power the display.

## II. LITERATURE REVIEW

Perhaps An intelligent LED display technology using a single-chip microprocessor and a programmable logic device (CPLD) was introduced by Xiao Chen and Tang (Chen and Tang, 2009). For the work, a single-chip AT89S52 microprocessor was used to control the data and establish the external connection for this particular system. In the presence of a single-chip microprocessor, the Altera CPLD EPM7128 chip was used as a display hardware controller to display information as desired. Instead of using CPLD to drive the LED display, a MAX 7219 driver IC can be used, so the control circuit will be

much simpler. Moreover, by using the DS3231 real time clock module, better time accuracy will be achieved. A field programmable Gate Array (FPGA) based on Verilog for displaying data on two-color 8X8 LED dot-matrix displays was introduced by Wan-Fu Huang (Huang, 2013a), (Huang, 2013b). To carry out the work, a Spartan-3 FPGA was used and the circuit design was Verilog. The display unit is designed to display characters for four-direction rotation along with two-speed modes i.e., normal speed mode with 0.2 seconds and fast speed mode with 0.1 seconds for a step movement of one row or column.

Tonmoy et al., introduced a digital LED matrix-based educational display for children with wireless control (Tonmoy, Hossain and Hasan, 2019). The device has a 16X16 matrix display to show the letters of the alphabet. A 16X16 display is connected by cascading of four 8x8 displays. Each 8X8 display is driven by the MAX7219 display driver. MAX7219 display drivers send alphabetic data serially from the microcontroller for display. To control the display there are several options. The user can change the display contents by voice commands or using the TV remote control or sending commands from the smartphone or drawing a gesture into the smartphone. As suggested for kids, the screen could be designed more and a sound system also added so that it would be easier for kids to learn alone.

Suman Poudyal presented a paper, Wi-Fi based Scrollable Digital Display with RTC using Arduino (Poudyal *et al.*, 2019). Here hardware and software design to display messages in a LED matrix with the ability to display fixed or scrollable text and adjustable scrolling speed. The author suggested work to deal with a superior notice board. The scroll view feature is mainly developed with the aim of schools and colleges to display daily data continuously. The system was built using a Wi-Fi module to send data from a mobile phone. Moreover, a real time clock module is also included with the system to keep track of the time on the screen. The author did not specify which Wi-Fi module was used. If it is necessary to connect the system via the Internet, the Wi-Fi module will be accurate. But the RF module is also a Wi-Fi module and it is used to transfer data from mobile phones when the internet is not needed. The display can be designed bigger so that the time and notification can be displayed simultaneously.

### III. METHODOLOGY

#### A. System Overview

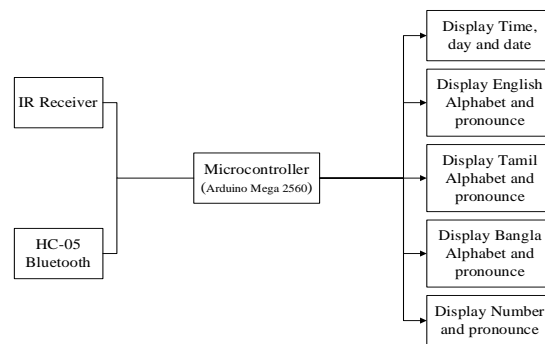


Figure 01: Block Diagram of the system

The block diagram in Fig. 1 shows that the commands are fed to the microcontroller via a Bluetooth module and an IR Receiver and the respective operations. Using TV Remote 32-bit NFC format (Diarah, Egbune and Aaron, 2014) code will be sent to TSOP1738 IR receiver and using UART communication protocol android devices will send the signal at baud rate 9600 bps to HC-05 Bluetooth Module. From these input receivers, the signal will be sent to the microcontroller. According to that the respective letter or number and feedback sound will be the output. The sound will be stored in a microSD in the format of .mp3 and from DF Mini Player the respective sound will be sent to the LM306P audio amplifier for amplification and output sound from the speaker.

#### B. System Design

##### 1) Receiving data from IR remote:



Figure 02: Codes generated for different buttons

The TV remote transmits 32-bit code for a single button. It follows the NEC data for sending code

(Kader et al., 2003). The codes transmitted for different buttons are shown in Fig.2.

2) *Display letters on dot matrix display:* To display anything in an 8X8 dot matrix display, the microcontroller must send 64-bit or 8-byte data to the display. In this device, four 8×32 (32×32) dot matrix display segments are used. At the end, there are sixteen 8X8 dot matrix display displays. Hence, to display a character in this display, the microcontroller must send 128 bytes (16 x 64 bits) data (Kapoor et al., 2016). Fig 3, shows a simplified circuit diagram showing the connection of an 8X32 dot matrix display pin with a microcontroller.

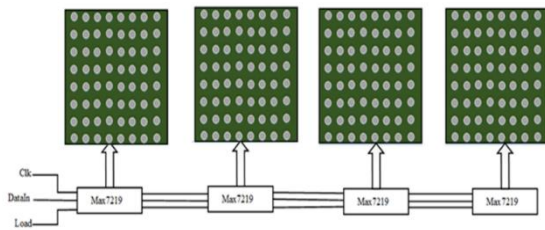


Figure 03: Codes generated for different buttons

To display a character in a 32×32 display, first, a monochrome bitmap format was captured for the respective characters which would be converted into a byte array by the software (Bouazza et al., 2016). Each of the respective characters are placed in a software called "LED Matrix Studio (LED Matrix Studio download | SourceForge.net, no date) to obtain a bit format. A sample design and bit format from the software is shown in Fig 4. After bringing the bits from LED Matrix Studio to the main code, the format of the bits is arranged according to the dot matrix display arrangement of the device.

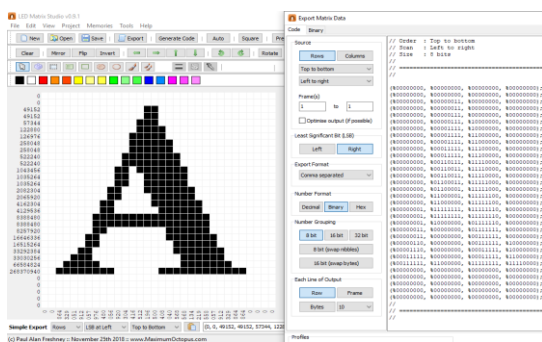


Figure 04: Letter design and respective bit format in LED Matrix Studio

3) *Receiving data from Bluetooth via smartphone:* The interface of an android application is shown in Fig 5. While pressing each button, it sends a unique ASCII code via the Bluetooth in a baud of 9600 bps to the Bluetooth module using the UART

communication protocol (Nanda and Pattnaik, 2016).

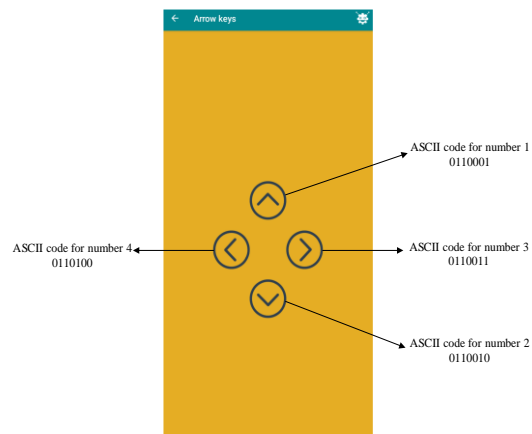


Figure 05: Interface of an android application for arrow key control to share data via Bluetooth

In the same manner, a bluetooth device is used to send voice commands (Alam et al., 2019) too. While a voice command is given, it generates a string and sends the respective ASCII code via Bluetooth. The Interface of an android application is shown in Fig 6. The interface of a bluetooth module with the microcontroller is shown in Fig 7. Here, the RX pin is 10, and the TX pin is 11. Because, if RX and TX pins of the Bluetooth module are connected to the default RX and TX pins of the microcontroller, every time while loading the code to the microcontroller the TX and RX pins must be disconnected from the microcontroller to avoid any interruption while loading code. Therefore, pin 10 and pin 11 were defined as the external RX and TX respectively.

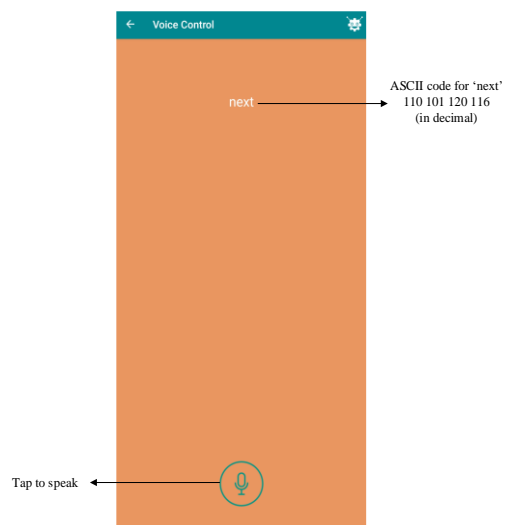


Figure 06: Interface of an android application for voice command control

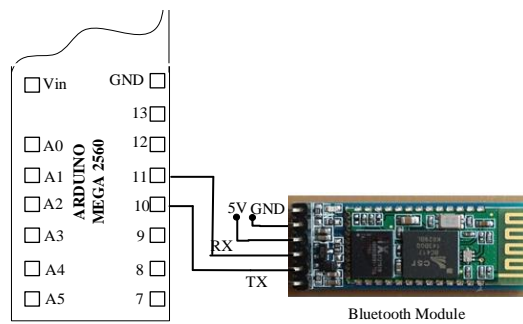


Figure 07: Interface HC05 Bluetooth Module with Arduino

4) *Interfacing RTC module with Arduino:* DS1307 RTC module uses an I2C communication protocol (RezaKhan, Kabir and Ara Hossain, 2012) to transfer data with the microcontroller. Arduino always acts as Master so that is responsible for the clock signal (Interfacing DS1307 RTC Module with Arduino & Make a Reminder - Arduino Project Hub, no date) and, hence DS1307 is the slave. DS1307 RTC module has a total of 12 pins on both sides and pins SCL and SDA are those two pins for I2C communication. And Arduino Mega 2560 has in-built SCL and SDA pins.

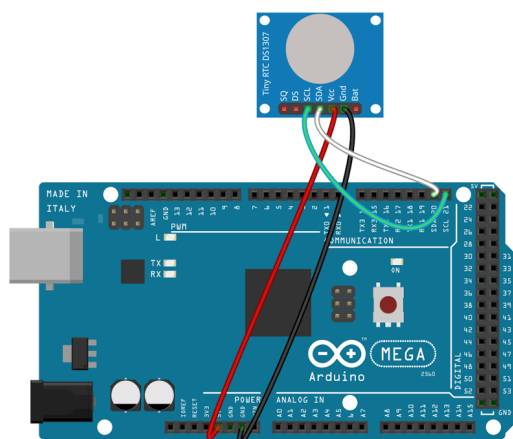


Figure 08: DS1307 RTC Module interfaced with Arduino Mega 2560

To read the data and utilize it, Arduino provides a special library called the “RTClib” library and since the communication between Arduino and RTC module is an I2C communication a library called “Wire.h” also included. Which will allow communication with I2C devices.

5) *Interfacing DF Mini-Player module with Arduino:* The module has a total of 16 pins, and among them, VCC, RX, TX, and GND pins are necessary for Arduino interfacing (Dada et al., 2018).

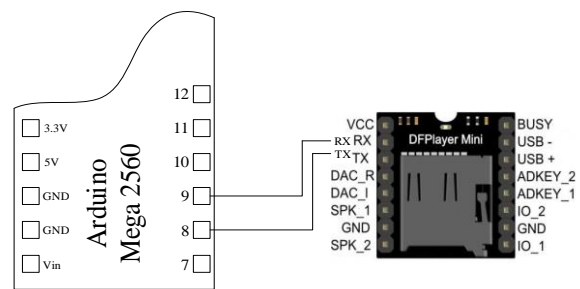


Figure 09: Interfacing DF Player Mini with Arduino

As shown in the above figure 9, the RX and TX pins are connected to Arduino pins 9 and 8 respectively. In the Arduino, pin 8 and pin 9 are allotted as RX and TX respectively as same as done for the Bluetooth module to avoid any communication interferences. Then to play the respective audio, the file is created and stored on the SD card in .mp3 format by naming each file with a four-digit number such as “0001.mp3”, “0002.mp3”, “0003.mp3” and placed inside the “mp3” folder.

SPK\_1 and SPK\_2 pins of DF Mini Player are connected to the speaker so that we can hear the feedback voice.

6) *Circuit Diagram:*

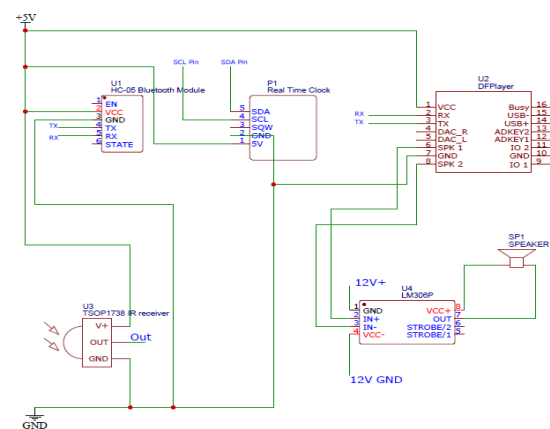


Figure 10: Circuit Diagram

IV. RESULTS AND DISCUSSION

A. Programming

HC-05 Bluetooth module and IR Receivers are transmitting data to the microcontroller. Hence, at first, the UART and IR Receivers have to be enabled or initialized. Since an LED dot matrix display is used here, and alphabets of three different languages and numbers from 0 to 9 are to be displayed, has to be designed so that, there will be character patterns. Furthermore, all the

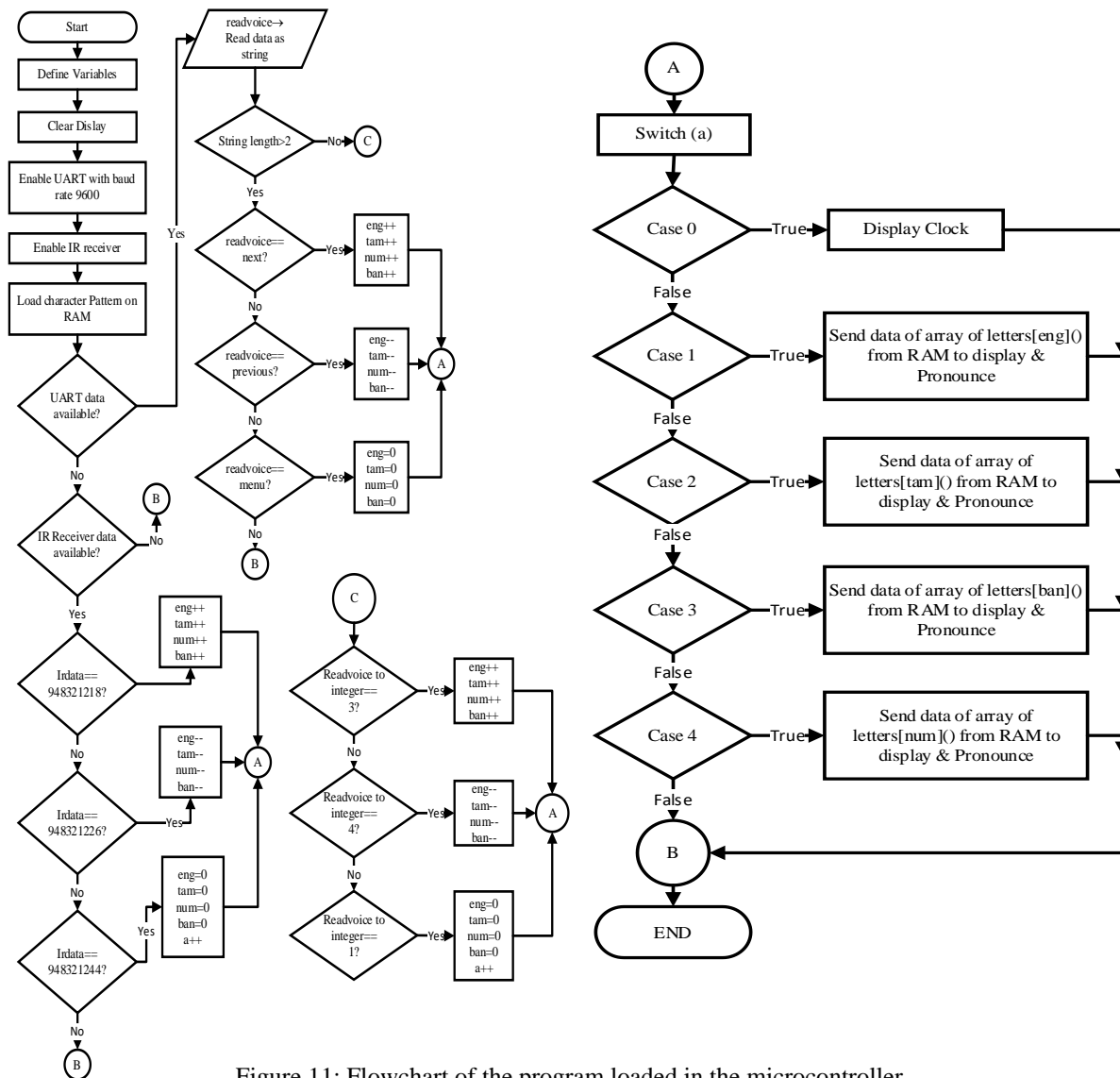


Figure 11: Flowchart of the program loaded in the microcontroller

necessary characters to display the real-time clock were designed separately. All of these patterns have to be loaded to the RAM of the Arduino. Then the microcontroller has to check for the data from the Bluetooth or IR Receiver. If there is any command via Bluetooth module, UART has to be checked, and if not the IR Receiver. If there is any command via Bluetooth, then the given command will be analyzed based on its length. According to the program written here, if the length of the given command is more than two, it will be categorized as voice command and if not, the command is from the smartphone. If there is no data in the UART, then the IR Receiver will be checked. According to the button pressed from the remote, a unique code will be sent to the IR Receiver. The flowchart for this program is given below in figure 11.

B. Result

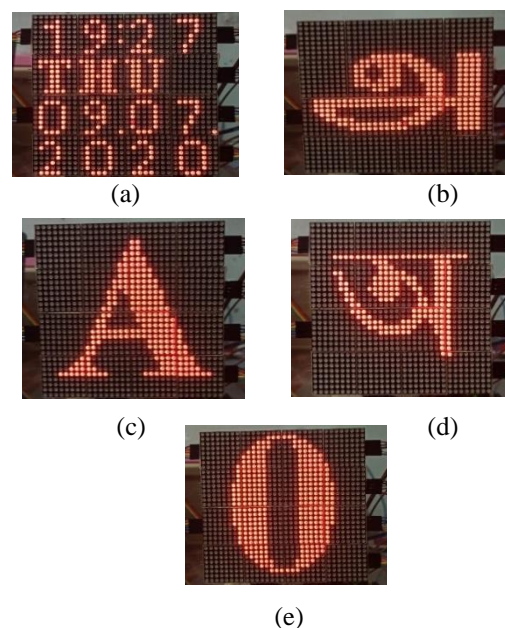


Figure 12: Result of implemented system

The system by default set to show time, day and, date once the device is turned on. Other functions described above are obtained through the implementation of the device and some results are shown in figure 12. In figure 12(a) the clock is shown. In there the time is shown in 24 hours format. It is displayed as an hour and minute respectively. Then the day of the week is displayed. After that, the date, month, and year are displayed respectively. Figures 12(b), 12(c) and, 12(d) are showing the displays of letters, and figure 12(e) is showing the display of a number. Along with these displays, the respective feedback sound is also produced.

## V. CONCLUSION

The century in which humans live is fully interfering with modern technology and smart technology. Therefore, there is a necessity for this device that will attract kids and at the same time will teach kids. Further, technologically, it can be controlled via TV remote control and smartphone and also using voice commands. It can be used in homes and even in schools for engaging learning so that there are opportunities for teachers to be loved by students. As it shows the alphabets of three different languages like English, Tamil and Bengali, it simultaneously gives the pronunciation of the respective letters as feedback. In addition to that, it has another additional feature of a real-time clock, which displays the current time, day, date, month and year as well. When the respective next button from the TV remote control or smartphone or the "Next" voice command is received by the microcontroller, it will display the next following letter one by one and the respective pronunciation will also be produced by the DF mini-player, in which there is a microSD card consist of all mp3 files of each character, it will be sent to the filter circuit along with the noise. The filter circuit will significantly reduce noise and feed the speaker connected to it. When it receives the respective previous button from either IR remote control or smartphone or the "previous" voice command, it displays the previous letter one by one along with its pronunciation. When the menu button either from IR remote or the smartphone or the voice command "menu" is received, the next category from which the device currently belongs will be displayed in the order of the real time clock, the alphabets in the order of English, Tamil, Bengali and Numbers.

The feedback sounds produced contain some noise which cannot be filtered by the designed filter circuit. Hence, controlling the device via voice

commands is not accurate in a noisy environment. However, it can still be used in homes, classrooms, schools, and offices as a digital clock. While the device is in clock mode, the brightness of the LED display can be adjusted and even can be turned off by the remote control and the smartphone. Because it is made of microcontroller, the power consumption is very low. Therefore, it can be used in territories where famine has enabled electricity, using 12V battery, the cost is also low. We can make teaching more successful by incorporating some additional features, such as music, animation, and mathematical search. It has some limitations like the voice command is not effective in a noisy environment and the voice command must be given in English. In the future, voice commands in other languages but English can be added.

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