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Propeller Display Based on Persistence of Vision Using RF Transceivers

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Abstract

In current era, energy is the main factor in designing all the applications, maximum and efficient use of the energy is very important. Conventional methods of displaying images and text in public are using LCD display and dot-matrix LED board. Propeller LED display is a device that project an image or text with least number of LED's that appear as if they are floating in the air. The floating image is received because of human eye limitation, i.e. because of an illusionary principle persistence of vision (POV), actually the floating images emerge by synchronizing LED'S blink to form an image at particular time and rate. The implementation for the display is done with an advanced RISC based Harvard microcontroller. This platform brings a newer coding and a different understanding of peripherals. The project also aims to build the newer display to work with modern forms of interfaces. The project can be also be implemented with help of any Android Smartphone/tablet running with higher Android versions as the extension of the current work.

Keywords: *Persistence of Vision (POV), Propeller, Space Multiplexing, AT89C52, Radio Frequency Transceiver (RF Transceiver)*

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I. INTRODUCTION

The core phenomenon on which the entire project is based is the Persistence of vision. Persistence of vision is the phenomenon pertaining to the human eye by which an afterimage is thought to persist for approximately one twenty-fifth of a second on the retina. The way this phenomenon of persistence of vision works is based on the belief that human perception of motion (brain centred) is the result of persistence of vision (eye centred). Any motion that we see around us is the direct implication of persistence of vision phenomenon at work. The belief was debunked in 1912 by Wertheimer [1] but persists in many citations in many classic and modern film-theory texts. [2][3][4][5]. Persistence of vision is still the accepted term for this phenomenon in the realm of cinema history and theory. Blinking POV [10] is a reprogrammable LED kit that uses persistence of vision to create the illusion of text or a small picture floating in the air. In the past, it was scientifically proven that a frame rate of less than 16 frames per second caused the mind to see flashing images. People still identify motion at rates as low as ten frames per second or slower (as in a flipbook). The flicker caused by the shutter of a film projector is distracting below the 16-frame threshold. In drawn animation, moving characters are often shot "on twos", that is to say, one drawing is shown for every two frames of film (which usually runs at 24 frames per second), meaning there are only 12 drawings per second. Even though the image update rate is low, the fluidity is satisfactory.

However, when a character is required to perform a quick movement, it is usually necessary to revert to animating "on ones", as "twos" are too slow to convey the motion adequately.[5]

The phenomenon of POV is evident in a number of events like for e.g.: When we rotate a fire cracker stick at high speed, we observe a continuous circle being formed as shown in fig.[1.1]. [6]



Fig. 1.1 Demonstration of POV effect

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A two dimensional POV display is often accomplished by means of rapidly moving a single row of LEDs along a linear or circular path. The effect is that the image is perceived as a whole by the viewer as long as the entire path is completed during the visual persistence time of the human eye as shown in fig. [1.2]. A further effect is often to give the illusion of the image floating in mid-air.

A 3 dimensional POV display is often constructed using a 2D grid of LEDs which is swept or rotated through a volume. POV display devices can be used in combination with long camera exposures to produce light. [5]. This propeller clock is mechanically scanned and displays in digital format. Made from scrap it can be used anywhere and everywhere and the interesting fact is that its crystal clear display.

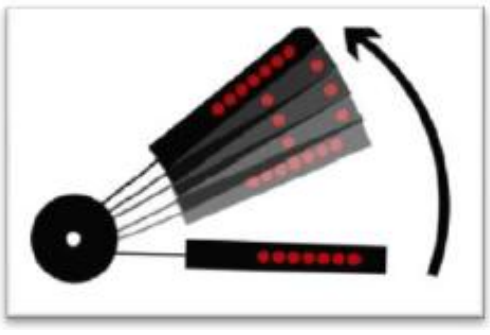


Fig 2 POV effect demonstrations

II.METHODOLOGY

The project methodology is carried out as shown in the flow diagram; all activities had been planned as shown in the activity flow chart with the intention that everything is completed step by step.

This project was started with a simple principle which is frequently encountered in our everyday life, which is Persistence of Vision. This phenomenon makes one feel fast moving/changing objects to appear continuous. A television is a common example; in which image is re-scanned every 25 times, thus making it continuous.

Further, a glowing objects if rotated in a circle at fast speed, it shows a continuous circle. By modifying this basic idea, 7 LEDs can be rotated in a circle, showing 7 concentric circles. But if these LEDs are switched at precise intervals, a steady display pattern can be shown.

Existing systems do employ POV principle, but for displaying each pixel, individual LED is used. This results in a huge number of LEDs even for small sized displays. By using a propeller type display, LED count can be kept to a bare minimum. Even 7 LEDs can perform a task of over 525 LEDs. Applications can find their way into cost

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effective solutions for large public displays, information systems. It can directly replace railway station information displays, bus stands and many more places.

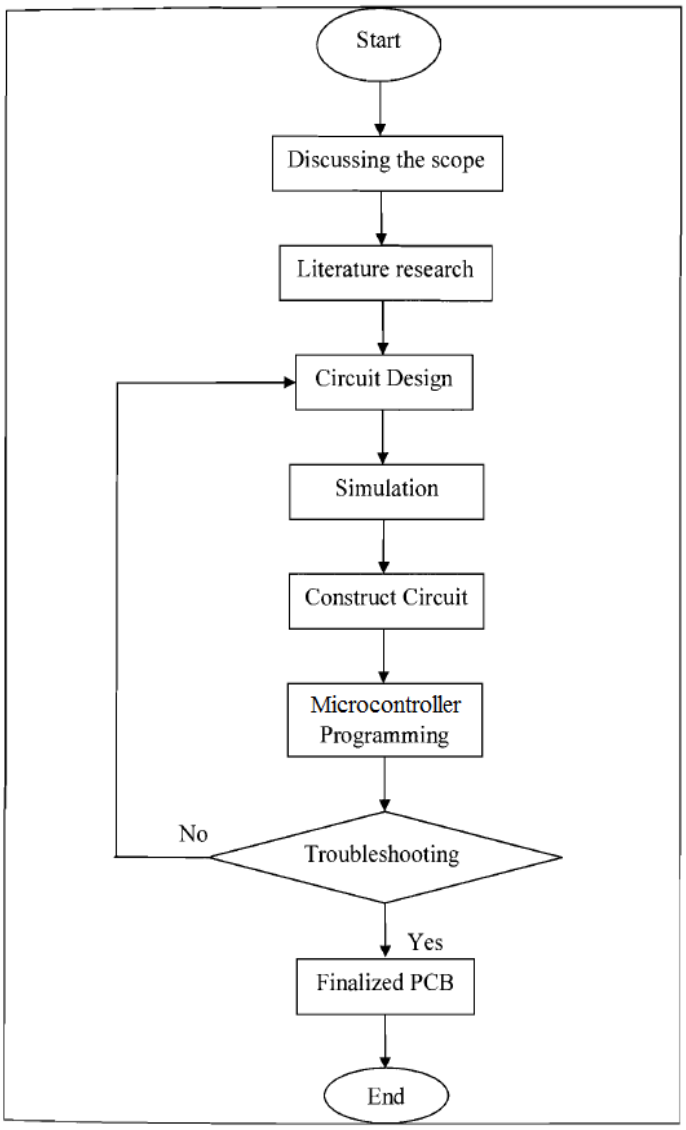


Figure 3 Project Activities Flow Chart

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III.LITERATURE SURVEY

The design and construction of a low cost propeller LED display by Sheik Rafik Manihar, Komal Prasad Dewangan, and Ajay Kumar Dansena used principle of space multiplexing and the propeller display is mechanically scanned and displays the characters in digital format, propeller display based on persistence of vision using RF transceivers uses a wireless transmission technology and is a real time project.

Wireless dual purpose propeller clock display by Nayab Suhail Hamirani, Asad Ali Shaik, Peer Mohammad Memom and Yasir Ali Khatri used a infrared remote control for time selecting like switching from analog to digital mode, propeller display based on persistence of vision using RF transceivers uses a wireless transmission technology and is a real time project.

Design and implementation of microcontroller based propeller clock by George John P, Togis Thomas, Vishnu Balakrishnam, and Vishnu N Nair used principal of persistence of vision and was implemented using a microcontroller. propeller display based on persistence of vision using RF transceivers uses a wireless transmission technology and is a real time project.

IV.EXISTING ALGORITHM

Existing systems do employ POV principle, but for displaying each pixel, individual LED is used. This results in a huge number of LEDs even for small sized displays. By using a propeller type display, LED count can be kept to a bare minimum.

The propeller display is a POV display based on 8051 microcontroller. The display used an 8051 based AT89C2051 microcontroller chip that was used to control the switching of red colored LED'S.

The display consisted of the following components:

1. Microcontroller - AT89C2051: Central controller for switching the LEDs at appropriate time.

2. IR sensor – MOC 7811: Used to provide Interrupt to the microcontroller whenever it reached home position [starting position] so that it can start the display routine again.

3. DC motor – 12 V: Used to rotate the assembly at high speed to induce the persistence of vision effect.

4. LED display – 8 general purpose LEDs strip: Used as display agents.

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5. Power supply 12 V DC for motor and +5 V DC for microcontroller.

There was a huge scope of enhancement in the design of the display. The shortcomings of the display were:

(1) The microcontroller AT89C2051 used was a low speed microcontroller and a basic one [11]. Operation at high speed was not satisfactory as very often lines in the display were missed due to the slow switching speed of the controller. The entire aesthetics of the display lies in the speed at which a controller can switch the LEDs.

(2) The LEDs used were simple single colored LEDs. Nowadays a wide variety of LEDs are available which can enhance the color displaying capacity of the display.

(3) One more shortcoming of using a primitive controller was that to change the display pattern, we needed to stop the display, unmount the chip, burn a new code in it and again remount it. This shortcoming can be seen to by using some way to upload a message onto the controller directly without needing to unmount it.

(4) The mechanical assembly of the display especially the motor was a bit unstable and over long duration of operation, the vibrations caused the display to go out of sync.

Due to such shortcomings, we decided to implement the same display atop a new and advanced microprocessor base and decided to change some elements that caused undesired operation.

V.PROPOSED ALGORITHM

In this project a wireless communication technology where RF transmitter and receivers used to successfully communicate to a spinning onboard microcontroller to update the display, the display can be controlled by PC GUI, the PC is loaded with a message to display and when no message is received, a real time clock is displayed. By using a propeller type display, LED count can be kept to a bare minimum

A user interface (UI) is a graphical display in one or more windows containing controls, called components, that enable a user to perform interactive tasks. The user does not have to create a script or type commands at the command line to accomplish the tasks. Unlike coding programs to accomplish tasks, the user does not need to understand the details of how the tasks are performed.

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Fig 5.1: GUI window

Typically, UIs wait for a user to manipulate a control, and then respond to each user action in turn. Each control, and the UI itself, has one or more callbacks, named for the fact that they "call back" to MATLAB to ask it to do things. A particular user action, such as pressing a screen button, or passing the cursor over a component, triggers the execution of each callback.

The UI then responds to these events. You, as the UI creator, write callbacks that define what the components do to handle events. This kind of programming is often referred to as event-driven programming. In event driven programming, callback execution is asynchronous, that is, events external to the software trigger callback execution.

VI.IMPLEMENTATION

Implementing the project hardware requires construction of different modules that will then be put together to create the final outcome. The project hardware is divided into 3 main modules:

(i) LED module

(ii) The GUI

(iii) Motor mechanical assembly

In this section we will emphasize on a detailed overview of each of the block shown in above block diagram. In every description of the block respective schematics and working is explained.

The propeller clock consists of following blocks, as shown in the block diagram.

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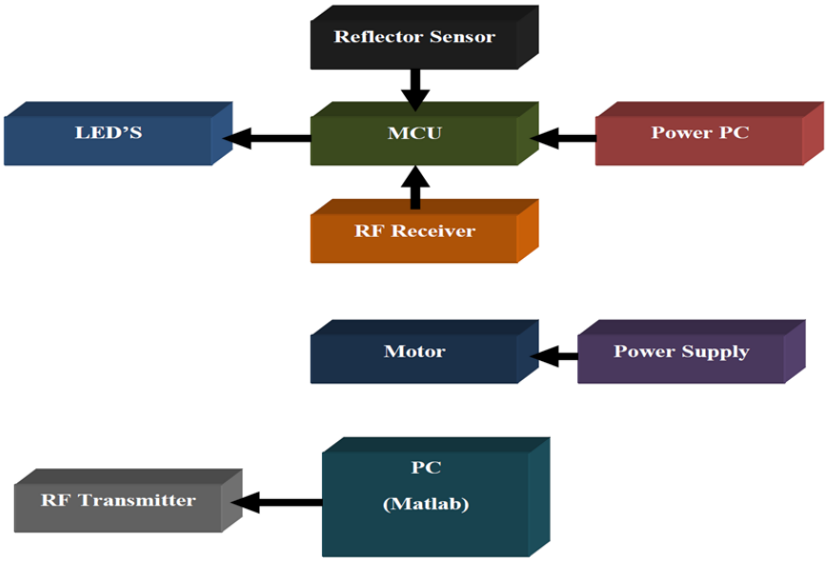


Fig6.1: General block diagram

6.1. Microcontroller AT89C52

The AT89C52 is a low-power, high-performance CMOS 8-bit microcontroller with 8Kbytes of Flash programmable and erasable read only memory. The device is high-density non volatile memory technology and is compatible with the industry- Standard 8051 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in system or by a conventional non volatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel ATmega328 is a powerful microcontroller which provides a highly flexible and cost effective solution to many embedded control applications.

The AT89C52 provides the following standard features : 8K bytes of flash, 256 bytes of RAM, 32 I/O lines, the AT89C52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. It also has programmable watch dog timer with internal oscillator, three 16-bit timer/counters, on-chip oscillator, and clock circuitry.

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6.2. LED Module

LED module consisting of 7bright LED is fixed in another side of the arm of our project. These LEDs are connected with each of the port pin of microcontroller, with a series current limiting resistorof470 ohm.

6.3. DC Motor

Repeated scanning of the display is must for continuous vision. This task is achieved using circular rotation of the whole circuit assembly. So, we used a DC motor as the prime mover.

6.4. Interrupter Module

Interrupter module is the sensor module, consisting of the IR interrupt sensor. This sensor was selected from a variety of other alternatives, because of its small size, precise interrupt sensing, and study casing. One great advantage of using this module is, interfacing it with the microcontroller is just a matter of two resistors and a general purpose transistor.

Following is the complete circuit diagram of our interrupter module.MOC7811 is the sensing part of the interrupter module, while rest of the circuitry works as signal conditioning circuit. 3 wires emerge out from the module, respectively Vcc, Signal and Ground. Output of the module is LOW, if interrupt occurs, otherwise it remains HIGH. It consists of IR LED and Photodiode mounted facing each other enclosed in plastic body.

When light emitted by the IR LED is blocked because of some completely opaque object, logic level of the photodiode changes. This change in the logic level can be sensed by the microcontroller or by discrete hardware.

6.5. Mechanical Assembly

Mechanical assembly plays a vital role in proper functioning of this project. The display is scanned each time, by rotating the whole assembly in a circular path. Here, one major challenge was how to bring +5V supply to the spinning circuit.

We tried the same by adopting two three different methods, but finally concluded on the method, as shown in the figure. As seen in the diagram, one supply connection (GND) is provided through the motor's shaft. Other terminal (Vcc) is connected, by arranging a friction disc brush arrangement. The brush keeps its contact with the disc, so that current can be supplied.

Most critical objective was to achieve pristine balance and overall good

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mechanical strength. For weight adjustment, we have provided one long screw, and weight can be attached or removed by adding / removing metallic bolts. If the assembly is balanced perfect, then it can achieve stability, and rotate at high RPMs too. This will improve the overall efficiency of the display. **See Figure 6.2**

6.6. DC Power Supply

A fixed voltage power supply producing constant +5V consists of a bridge rectifier, filter capacitors and 3 terminal regulators IC LM7805. The 12v ac is obtained from the output of an step down transformer. This power supply is capable of supplying +5v and load current up to 500mA. Input capacitor is used to improve transient response of the regulator IC, i.e. response of regulator to sudden changes in load.

It is also helpful in reducing the noise present in the output. Dropout voltage (Vin-Vout) needs to be at least 2V under all operating conditions for proper operation of regulator. For microcontroller and led we are giving the supply by connecting the output of ICLM7805 which is inputted by the 12v battery (which is placed on the pcb).

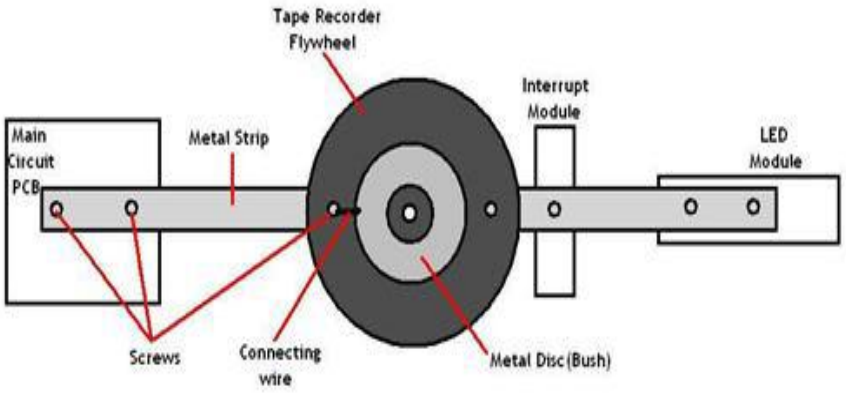


Fig6.2: Bottom view of rotating assembly

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6.7. Simulation Software and Tools

Few softwares and Simulators are used like, Edsim Simulator, Multisim 11 and Microvision Keil. Edsim Simulator is used to perform simulation of Assembly code, so first we checked our program in Edsim and checked all the values of registers like Accumulator and so on. In Multism11 we designed the schematic of the project. Microvision Keil software was used to convert the Assembly code to HEX file and for uploading the program from the computer to programmer. We have used ATMEL series programmer in which we can program various ATMELs ICs and AVR too.

VII. TEST AND TROUBLESHOOTING

7.1 Interrupt Module Testing

This Interrupter module testing is required for detecting exact position of wheel on which whole circuit assembly is mounted.

7.2 DC Motor RPM Testing

DC Motor used in this project is 12 V dc motor which is tested by using digital contact-less tachometer. Arrangement was made so that the sensing circuit gives high to low pulse for each completion of revolution. By measuring the time difference between two successive pulses RPS can be calculated which further provide RPM value, as shown below:

Power supply given to DC Motor = 9V

Time interval between two successive pulses as seen on

CRO = 30.4ms

RPS = 1 / (30.4ms)

=32.89

RPS = 33

RPM= 33x60=1980

7.3 Power Supply Module Testing

Power supply module was designed to provide 5V DC power supply necessary to drive both motor and circuit. AC input is given from 9V 750mA transformer. Results are as follows.

Input voltage, Vs=9V AC.

Output voltage observed, Vo = 4.92V DC

7.4 Testing the Motor Speed and Synchronization

Now we are ready to rotate the display. But before we start the motor, make sure that no wires are tangles to any of the parts that will rotate when we turn on the motor. This can

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cause extensive hardware damage! Now put the toggle switch in the motor controller module to ON position. Initially keep the potentiometer at slowest speed and check that no part is hanging out that may cause the assembly to dug or to get tangled during operation. Finally when everything is checked out, slowly start increasing the speed by rotating the potentiometer until a satisfied resolution is obtained. If still the display doesn‘t work properly, try to remove excess weight from the mounting assembly which may cause the motor to operate at low RPMs.

7.5 Testing the Motor Speed Controller

It might happen that the controller might not be supplying sufficient power to the motor to operate to its full capability. To ensure that the module is working at its full potential, check voltage levels at the module output using a DMM.

VIII. RESULTS AND DISCUSSIONS

A. Speed of the LED's (Frame rate)

The rotational speed of the LED's affects directly how many pictures can be displayed in a Second. This corresponds to the frame rate. On a modern TV, the frame rate is 100Hz. More the frame rate, the less flickering of the picture. Because on the Propeller Display the picture is scanned mechanically, it is not easy to achieve high frame rates. The propeller has to be very well balanced to keep vibrations as low as possible and keep the speed of the rotating LED's as high as possible.

Let’s see how fast the LED's rotated when a picture is displayed with a frame rate of 25Hz. Speed is represented by v

Here is the Calculation.

Acceptance: f = 25Hz (Frame rate)

r = 0.2 m

(Radius from centre of rotation to the LED's)

$v = f (2 \pi r) 3600$

$(2 \pi r) = 2 * 0.2 * 3.141$

$= 1.256$

$v = 25 (1.256) 3600$

= 113040 meter/ hour

We see that already a slow frame rate of 25Hz generates very high speeds on the LED's. The bigger the radius of the display, the bigger is the speed and more vibrations occur.

The sequence of execution is as shown in the flowchart (Fig 8.1).To enter a text, the rotation switch can be rotated until the

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cursor on the LCD-Display is over the desired character on the alphabet.

Now, a push to the rotation switch selects the character and adds it to the string.

In the fig 8.1, time has been displayed; where as other characters can also be obtained. As the whole alphabet can't be shown at a time, it scrolls when the start or end of the display is reached by the cursor. If the entered text is complete, we select the arrow from the alphabet showed on the last line of the display and then the text will be transferred to the Propeller Display.



Fig 8.1: Display generated pattern

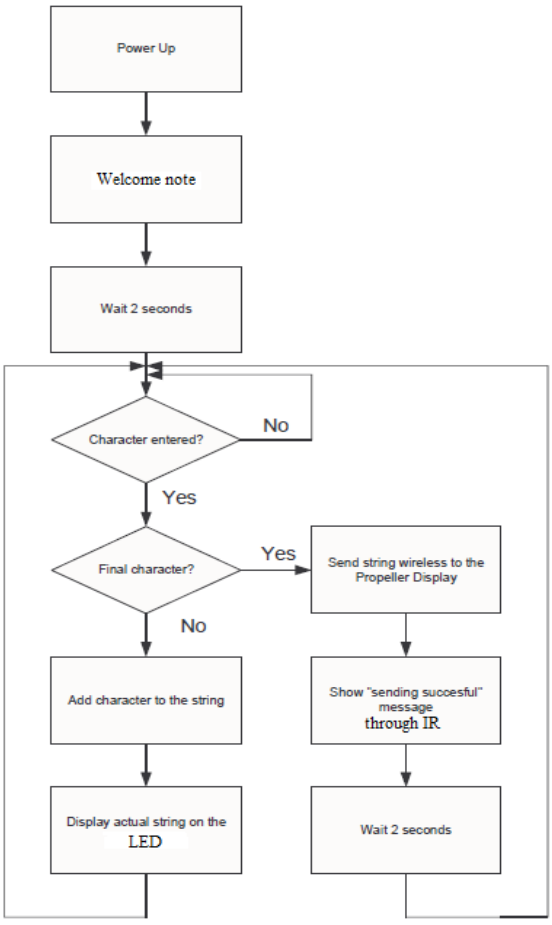


Fig 8.2: Sequence of Execution

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CONCLUSION

The conventional LED displays use an individual matrix of LEDs for each character. For example in a display using 8*4 Led matrixes for a single character, 10*8*4 LEDs would be required to display a word consisting of 10 characters, increasing the circuit complexity. Our circuit uses a low power microcontroller board, with 7 LEDs and a low power motor. This technology saves power monumentally. The display is configurable to show any character sent in any direction from a controlling system in this case it is a laptop that transmits text wirelessly and the generated pattern is as shown in fig 8.1, whereas the configured character display can be designed sent from any android

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