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Digital Real Time Clock

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ABSTRACT: Nowadays, we can see various ways of visual information everywhere. One of the most common sights that we can see today is the LED matrix display. Nowadays, these are popularly being used in the street sides, shopping-malls, buildings, parks and other public outings. Led matrix displays have become a basic way of conveying visual information or data since they are cheaper and more reliable than LCD displays and other expensive display devices.

Now, considering the growing popularity of the LED matrix display, we decided to construct a small home based PC controlled LED matrix real time clock cum smart notice board so that it could be used for both indoor uses like small household purposes as well as for various outdoor uses.

The project Digital Real Time Clock is concerned with making use of a two dimensional arrangement of LEDS in a rectangular arrangement for the purpose of displaying time, date, day of the week along with features like atmospheric temperature, humidity and some daily dose of quotes. The characters to be displayed are obtained from sensors like RTC module, temperature sensors while it is to be displayed on the LED matrix. So the sensors acts input devices and the led matrix works as an output device. We thank our project guide **Prof. Sathish Kumar K**, Associate Professor, Department of Electronics and Communication Engineering who has guided us and has been a source of inspiration. He has been enthusiastic in giving his opinions and critical reviews.

The selection of this project work as well as the timely completion is mainly due to the persuasion and interest of our project co-ordinator **Prof. Sathish Kumar K**, Associate Professor, Department of Electronics and Communication Engineering; we will always remember his generous contribution.

We sincerely thank **Dr. Soorya Krishna K**, Head of the Department, Electronics and Communication Engineering, who has been a constant driving force behind the completion of the project.

We thank our beloved principal **Dr. Shrinivasa Mayya D**, for his constant help and providing an environment which helped us in completing our project.

Finally, we thank all the teaching and non-teaching staff of Electronics and Communication Engineering Department for the help rendered.

I. CHAPTER 1 INTRODUCTION

In optoelectronics, the use of light emitting diodes (LEDs) has been of great importance. These are universally used in our daily activities; as an indicator light in power supply devices; for information and image display in super-markets, school campuses, recreational centers, alongside roads and highways, in offices, residential buildings, in vehicles, in aircrafts, and what not. These devices that make use of LEDs are mostly microcontroller based systems. They appear very beautiful to the eyes. The vibrant light may be compared to her jewels, dotted on her dress.

Nowadays, we can see various ways of visual information like LED, LCD ,etc,. While there are competents in the field in the form of LCDs and seven segment displays, LEDs are generally preferred over their counter-parts due to their reliability and low cost comparatively. What is more is that, it is a high brightness, long life, no pollution, pure color LED display module which can be used safely in harsh environmental terrains.

Generally we make use of normal static LED display screen to convey a message. Prior to this, if we wish to project large chunk of information, we used to alter the data for every few instances. Now scrolling displays are way more popular than its counterpart. Scrolling LED displays can be made by pre programming the controllers. This 32 x 16 scrolling LED matrix display system is a microcontroller based system.

From the name or title given to this project, it can be explained that the project entails firstly about the real time displays. Secondly, the dimension, 32 x 16 can be simply said as 32 columns and 16 rows arrangement. Thirdly, scrolling is the movement of text or graphics up and down or across a display screen as if unrolling a scroll.

Matrix, here, can be referred to as a rectangular arrangement of circuit elements for performing a function. Display can be an eye-catching arrangement by which something is exhibited.

The LED matrix has a total of 512 LEDs which are arranged in a rectangular form. Each of the above said LED can be independently controlled and addressed. The LED matrix can be used singularly or can be cascaded to form a long chain of LEDs which are used to display visual data.

II. CHAPTER 2 PRIOR ART SEARCH

We have gone through quite a lot of information available online. Some of them are being presented as a matter of reference below;
https://youtu.be/AKjup-IX2iI
https://www.youtube.com/watch?v=OmVoR3mTP00&t=217s
https://arduino-projects-free.blogspot.com/2018/09/rgb-led-matrix-clock-with-arduino.html
https://www.brainy-bits.com/dht11-tutorial
https://arduinobymanmohan.blogspot.com/p/ds1307-rtc-i2c-module-how-to-set-date.html

Each of these above contains various informations which are not integrated. For example, the first link redirects us to YouTube, where the user makes us learn about how to interface the RTC module with the LED matrix display and arduino in order to obtain the time. The other link tells us about interfacing the DHT-11 sensor with LED matrix display and Arduino.

Since our project mainly deals with interfacing different components with one another to obtain a common goal, we have referred all the above links and interfaced the above told and made it as a single product which otherwise will be available as individual and independent products.

III. CHAPTER 3 SYSTEM REQUIREMENTS

3.1 Hardware requirements

1. Arduino Atmega 2560.
2. DHT- 11 sensor.
3. DS 1307 I2C RTC module.
4. 32x16 LED matrix.

3.2 Software requirements

1. Arduino IDE

3.3 Hardware related theory

3.3.1Arduino Atmega 2560

Figure 3.3.1 Arduino Atmega 2560

The Arduino Atmega 2560 board comes equipped with as many as 54 digital pins, 16 analog pins with memory storage in order to store the program code. This board is comparatively larger to various other boards already available outside. It has a length of 4 inch and a width of 2.1 inch. The board has a flexibility to regulate voltage as needed with 2 powerful voltage regulators provided on board i.e. 5V as well as 3.3V in comparison with Arduino Pro Mini with a single regulator. Amongst 54 digital input/output pins, 15 of them are PWM (Pulse Width Modulation). This also consists of crystal oscillator of frequency 16MHz. A DC jack is provided to supply power to the board, although not every version of the board comes equipped it.

The In-Circuit Searial Programming header which is being made use of in order to program the Arduino and to upload the code is a remarkable addition for Arduino Atmega. There isn’t much to differentiate amongst Arduino UNO and Arduino Atmega barring that Arduino Atmega arrives with a larger memory, size and quite more input/output pins. Arduino IDE is a tool used in-order to program the board commonly used in every Arduino family boards. Arduino Atmega is specifically created for ideas that demands sophiscated circuits and a larger chunk of memory. That being told, certain projects like 3D printing and controlling of multiple motors are to be made by Atmega itself due to the reason being its ability to contain more detailed instructions and having more input/output pins. In-order to safeguard the computer’s USB port from overheat effect, it comes with a defaultable poly-fuse. The inclusion of fuse gives the computer a subsidiary layer of protection. This board can be used as a main board for executing projects, or can team up with other boards of Arduino family.

3.3.1(a) Pin configuration of Arduino Atmega 2560

No.	Pin number	Pin description
1		54 digital I/O pins
2	A0-A15	16 analog I/O pins
3	D2-D13	12 PWM (Pulse Width Modulation) pins
4	Pin #0(RX) and pin #1(TX); Pin #19 (RX) and pin #18 (TX); Pin #17 (RX) and pin #16 (TX); Pin #15 (RX) and pin #14 (TX).	4 serial communication ports, 8 pins
5	Pin #50 (MISO) Pin #51(MOSI) Pin #52 (SCK) Pin #53 (SS)	SPI communication pins
6	Pin #20 (SDA) Pin #21 (SCL)	I2C communication pins
7	Pin #13	Built in LED for testing

Table 3.3.1(a) Pin Configuration of Arduino Atmega 2560

The pinMode(), digitalWrite(), digitalRead() functions enables us to make use of each and every digital pins as either input pin or output pins. Operating voltage is 5V.

5V & 3.3V: Upto 5V of power can be regulated. It can be obtained from Vin of the board or USB cable or another regulated 5V voltage supply. While another voltage regulation is provided by 3.3V pin. Max drawable power is 50 milli ampere. Voltage according to our convenience can be set.

GND: This board comes with as many as 5 GND pins, which comes handy when the situation demands multiple ground connections to be done.

Reset: Setting the pin to LOW will surely prompt the board to get reset into factory configuration.

Vin: The voltage supplied as input ranges between 7 - 20V.

Serial communication: Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the ATmega16U2 USB-to-TTL Serial chip.

Serial 0: 0(RX) and 1 (TX);

Serial 1: 19 (RX) and 18 (TX);

Serial 2: 17 (RX) and 16 (TX);

Serial 3: 15 (RX) and 14 (TX).

PWM: PWM pins are from 2 to 13 and 44 to 46. They give an 8-bit PWM output with the analogWrite() function.

SPI: Pin #50 (MISO), pin #51 (MOSI), pin #52 (SCK), pin #53 (SS).

LED: Pin #13 is for the Led. Pin 13 has an in-built LED connected to it. LED turns ON when the pin is HIGH and vice versa.

TWI: Pin #20 (SDA) and pin #21 (SCL).

This is not it. There are quite a lot of pins like;

Reset: Making it LOW will force the micro-controller to factory reset.

Analog Pins: There are as many as 16 analog pins printed on the board labelled from A0 to A15. Note that all of these pins could be made use of as digital input/output pins. There is a 10 bit of resolution for each of the analog pins.

I^2C: Pin #20 and pin #21 does support I^2C communication wherein pin #20 denotes SDA (Serial Data) and pin #21 denotes SCL(Serial Clock).

3.3.2 DHT 11 humidity and temperature sensor

Figure 3.3.2. DHT 11 humidity and temperature sensor

The DHT 11 is one of a low cost digital humidity and temperature sensing module. The DHT 11 is normally used as humidity as well as temperature sensor**.** This sensor comes with a microcontroller of 8 bit which displays the atmospheric temperature and humidity as serial data**.** The digital output is due to the thermistor which measures the outer air. It is clearly easy to use and needs careful timing to collect data. It must be noted that it produces output for every 2 secs. It comes with a resistor of 4700 ohm or a 10000

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ohm.
It uses a maximum current of about 2.5milli ampere while conversation (requesting of data), which is decent for 20% - 80% of humidity readings with an accuracy of 5% and is good for temperature readings of 0-50 degree Celsius with a accuracy of ±2 degree Celsius. The sensor comes with sampling rate of not more than 1 Hz (for every one second). It is built with a size of 15.5mm x 12mm x 5.5mm pins with a 0.1 spacing. This sensor can track temperature ranging from 0°C to 50°C , 20% to 90% of humidity range and comes with a tolerance of ±1 unit.

3.3.2(a) Pin configuration of DHT 11 humidity and temperature sensor

Pin	Pin description
VCC	VCC
Data	Serial data
GND	Ground

Table 3.3.2(a) Pin configuration of DHT 11 humidity and temperature sensor

VCC: Supplies power ranging from 3.3V to 5.5V

Data: Gives the outputs of both humidity and temperature via serial data.

GND: Is connected to the circuit ground.

3.3.2 DS 1307 I2C RTC module

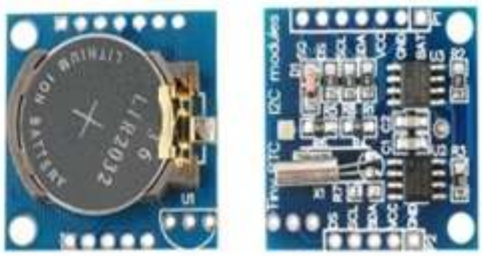

Figure 3.3.3 DS 1307 I2C RTC module

The DS-1307 RTC module is an 8 pin module using an I2C interface. This low power clock or calendar comes packed with an SRAM of 56B. The data provided will be in the format<seconds- minutes- hours- day- date- month- year>. For any of the months with less than 31 days, it's ending date is automatically set .

These are readily available as ICs and they work just like a clock or a calendar for that matter. These modules works even when there is a power shutdown, thanks to CR2032 cell which acts as backup. In case of power failure, the in-built power sense circuit directly opts for the backup power. The output pin is of 1 hertz. It is obtainable in 8-pin DIP as well as SOIC. This module comes pre-assembled with pre programmed and defaulted time.

3.3.3(a) Pin diagram and Pin description

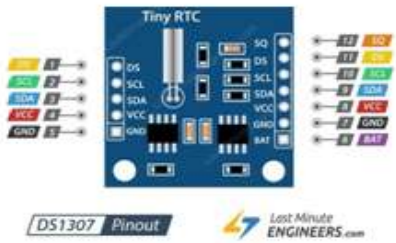

Figure 3.3.3(a) Pin Diagram of DS 1307 I2C RTC module

Pin description

SQW: Output of the pin is one of the four frequencies, 1kHz, 4kHz, 8kHz or 32kHz and can be enabled programmatically.
DS: Output of pin is for temperature readings if your module has a DS18B20 temperature sensor installed right next to the battery holder (labelled as U1).
SCL: Is the clock inputs for the I2C interface and is used to synchronize data movement on the serial interface.
SDA: Is the data input/output for the I2C serial interface.
VCC: Pin supplies power for the module. It can be anywhere between 3.3V to 5.5V
GND: Is a ground pin
BAT: Is a backup supply input for any standard 3V lithium cell or other energy source to maintain accurate timekeeping when main power to the device is interrupted.

3.3.3(b) Working of DS1307

The crystal oscillator which is also a chip source has 2 inputs called X1, X2 . V_{BAT} is connected to 3V of battery. VCC takes a voltage of 5V with the help of micro-controllers. The read and write are acquired if the VCC is not granted. Whenever the device wishes to start a communication with another device in the IIC (I^2C) network, START and STOP conditions are a must.

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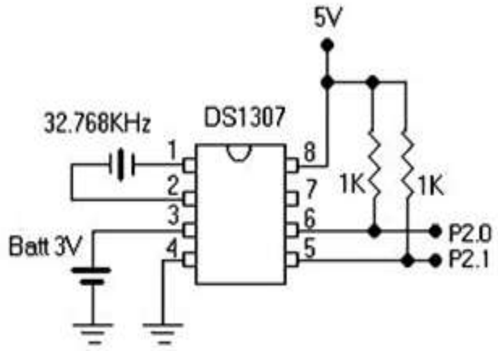
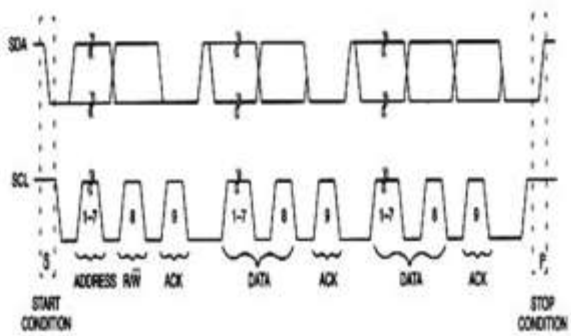


In order to have access to the device, the START condition has to be given a code for identification of the device. Until the STOP condition is implemented the registers can be accessed in serial order.

When DS-1307 I^2C communicates with the micro-controller the START condition and STOP condition is as given in the below timing diagram:



3.3.2 32x16 LED matrix

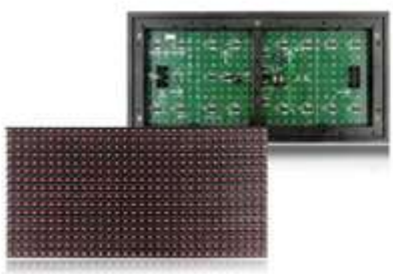


Figure 3.3.4 32x16 LED matrix

This bright, large 32*16 LED matrix panel has an on-board controller circuitry and is created to being used right out of your board. All kinds of eye-catchy display projects such as Clocks, message displays, graphical posters are easier to be created using this display module. This 32x16 high brightness LEDs consists of a total of 512 LEDs on a 10mm pitch and readable from a distance of 12 meters. It comes with a toughened plastic build. The Controller ICs are mounted on the board and the interface is simple clocked data interface. The dimensions are as follows: 320(W) x 160(H) x 14(D)mm (30mm(D) including rear connectors). 12 or 13 digital I/O pins (i.e., 6 bit data and 6-7 bit control) are required for the panel to work along with a power supply of a good 5V and a minimum of a couple of amps per panel display. A 2A or greater regulated 5V adapters is recommended to be used along with a terminal block DC jack, or a DC extension cable jack would also work fine. It is to be noted that these panels are usually created to be driven by the high speed processors such as FPGAs; These don't come with PWM control of any type inbuilt. You are supposed to re-sketch the screen again and again to manually PWM the entire thing, instead. We succeeded to produce a 12 bit color from the LED module using a 16MHz Arduino Uno. However , if it was run by other high speed multi-processor controllers such as CPLD, XMOS or FPGA, it would have truly stood out.

3.4 Software related theory

3.4.1Arduino IDE

The **Arduino Integrated Development Environment (IDE)**, is a platform application for Windows, Linux, Mac OS which is written in functions from C and C++. The Arduino IDE is also used in writing and uploading of programs in some compatible Arduino boards and also with some 3rd party cores and some other vendor development boards.

It uses some special rules for structuring of code which assists languages like C and C++. It provides a particular software library, which supplies many input and output procedures from the Wiring project. If the user writes the code, it requires only basic functions, starting from the sketch to the main program loop, which are compiled and linked to a program stub main() with GNU tool-chain into an executable cyclic program, which also includes the IDE distribution. The Arduino IDE utilizes the program to convert it into a text file from executable code in hexa-decimal encoding.

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IV. CHAPTER 4 PROJECT IMPLEMENTATION

4.1 Block diagram and flowchart

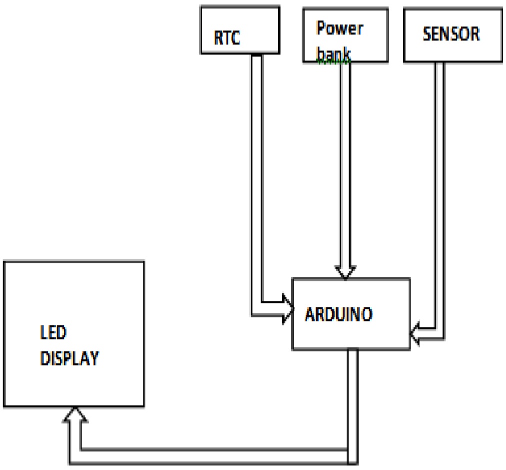

Fig 4.1 (a) . Block diagram of hardware implementation

The above figure shows the block diagram representation of different hardware components to be implemented. The output of both RTC and the DHT sensor serves as an input for the arduino and the power required for arduino is given through power bank or more simply a battery. The output of arduino is in turn serves as input for the LED module.

The complete working of the project is best explained with the help of a flow-chart as shown below in fig 4.1(b).

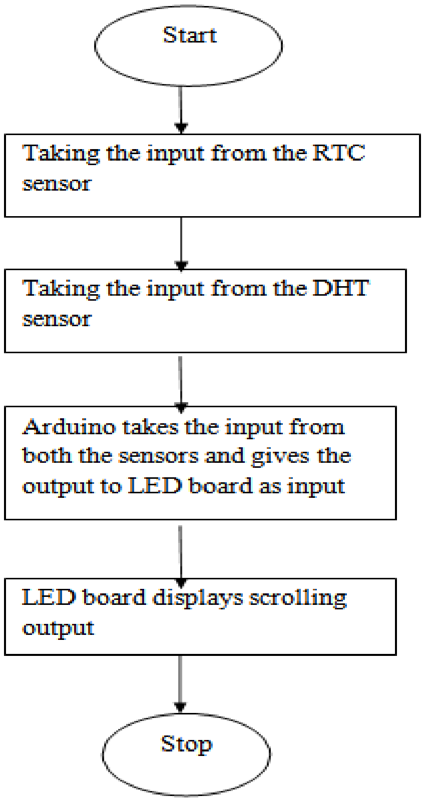

Figure 4.1 (b): Flowchart

4.1 Interfacing of DHT 11 sensor with Arduino UNO

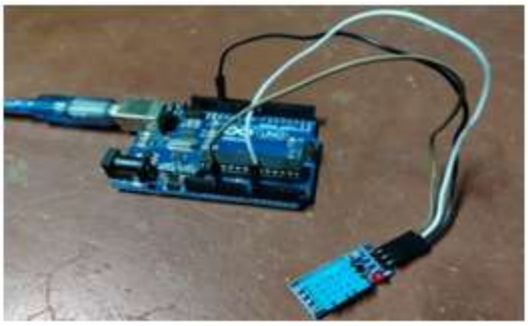

Figure 4.2: Interface of DHT 11 sensor with Arduino Uno

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4.2.1 Circuit of DHT 11 with Arduino Uno

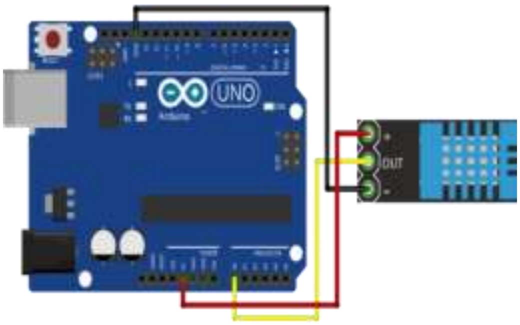

Figure 4.2.1: Circuit connection of DHT 11 sensor with Arduino Uno

The terminals of the DHT 11 temperature and humidity sensor are connected to Arduino UNO and its code is implemented according to the connection. The 5V pin of the Arduino Uno is connected to the VCC pin of the DHT 11 sensor module. The A0 pin from the Arduino Uno board is connected to the data pin, which is the OUT pin on the DHT 11 sensor module and the GND of the Arduino Uno board is connected to the GND pin of the DHT 11 sensor module.

4.2.2 Arduino Code

figure 4.2.2: Code for the Interface of DHT-11 sensor module and Arduino Uno

4.2.3 Output

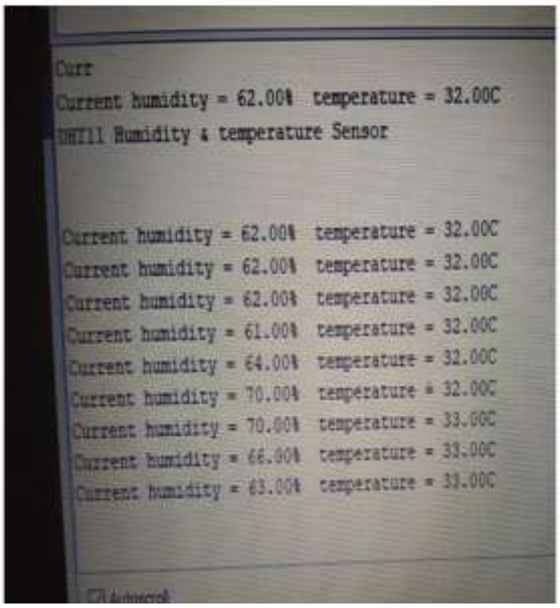

Figure 4.2.3 Output of Interface of DHT-11 sensor module and Arduino Uno

4.3 Interfacing DS 1307 I2C RTC module with Arduino UNO

4.3. Interface of RTC and Arduino Uno

4.3.1 Circuit connection of DS-1307 RTC module and Arduino Uno

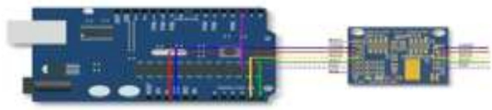

Figure 4.3.1 Circuit connection of DS-1307 RTC module and Arduino Uno

The four terminals of the RTC module are plugged to the four pins of the Arduino Uno board and the code is implemented according to its connection. The 5V pin from the Arduino Uno board is plugged to the VCC pin of the RTC module and the GND pin from the Arduino Uno board is plugged to the GND of RTC module. The serial data (SDA) pin from the RTC module is connected to the A4 pin of the Arduino Uno board and the serial clock (SCL) pin from the RTC module is plugged to the A5 pin of the Arduino Uno.

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4.3.2 Arduino Code

Figure 4.3.2 (a). Arduino code for Interfacing RTC with Ard ino Uno

Figure 4.3.2 (b)

Arduino code for Interfacing RTC with ArduinoUno

4.3.3 Output

4.3.3. Output of Interface of RTC and Arduino Uno

V. CHAPTER – 5 CONCLUSION AND FUTURE WORK

In this particular project, we have created a DIGITAL REAL TIME CLOCK which not only displays the correct time 24 hours a day and 7 days a week, it also measures the atmospheric temperature and humidity using a sensor and displays on the LED board.

This project serves as a replacement for any analog physical clock in offices and integrates the temperature sensor module along the clock module. Once the correct time has been manually set, there is no stopping unless the power supply is cut for longer durations.

There is still a scope for improvement by turning it into a digital notice board/ digital advertisement hoarder. This can be done by using Bluetooth module and developing a mobile application in order to control it from any smart phone device.

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