NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ARDUINO CONTROLLED 8X8 LED MATRIX

BY

1. NIKHIL MATHUR   164242

2. N. KUSUMA PRIYA   164243

3. SURYA PRAKASH   164258

CERTIFICATE

This is to certify that Nikhil Mathur (164242), N. Kusuma Priya (164243) and Surya Prakash (164258) B. Tech. 3/4 have duly completed the experiments enlisted in the following index and have fulfilled all the requirements of the course Micro Processors and Micro Controllers Lab to my satisfaction in the Academic year 2018-2019.

Signature of faculty

Date: 27/4/2019

Table of Contents:

ARDUINO CONTROLLED 8X8 LED MATRIX

Introduction:

In this project, we control an 8×8 LED Matrix through an Android Interface with the help of the Arduino microcontroller. We first interface the Arduino and the 8X8 LED Matrix to display information (even scrolling information and images can be displayed) and later control it through an Android device.

An LED matrix is a two dimensional array of LEDs that can be used to display symbols, characters or even images. Based on the orientation of the LEDs in the matrix, there can be two types of LED matrices.They are Common Row Anode and Common Row Cathode.

LED matrix modules are one of the commonly used display devices and are used in major applications like electronic display panels and notification systems.

Circuit diagram:
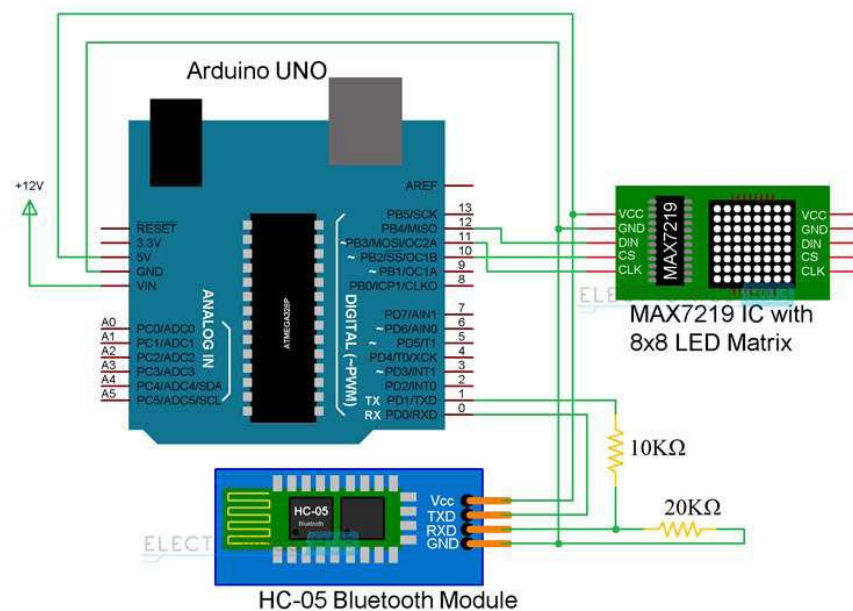
List of Components:

S. No	Component	Number
1	Arduino Uno Board	1
2	MAX7219 IC Board	1
3	8x8 LED Matrix	1
4	HC05 Bluetooth Module	1
5	20k ohm Resistor	1
6	10k ohm Resistor	1
7	Breadboard	1
8	Connecting wires	As per requirement

Component description:

Arduino Uno(Microcontroller)

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. The ATmega328 on the Arduino Uno comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol.

Technical Specifications:

Microcontroller: Microchip ATmega328P

Operating Voltage: 5 Volts

Input Voltage: 7 to 20 Volts

Digital I/O Pins: 14 (of which 6 provide PWM output)

Analog Input Pins: 6

DC Current per I/O Pin: 20 mA

DC Current for 3.3V Pin: 50 mA

Flash Memory: 32 KB of which 0.5 KB used by bootloader

SRAM: 2 KB

EEPROM: 1 KB

Clock Speed: 16 MHz

Length: 68.6 mm

Width: 53.4 mm

Weight: 25 g

Pins :

LED: There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

VIN: The input voltage to the Arduino/Genuino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.

3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50mA.

GND: Ground pins.

IOREF: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.

Reset: Typically used to add a reset button to shields which block the one on the board.
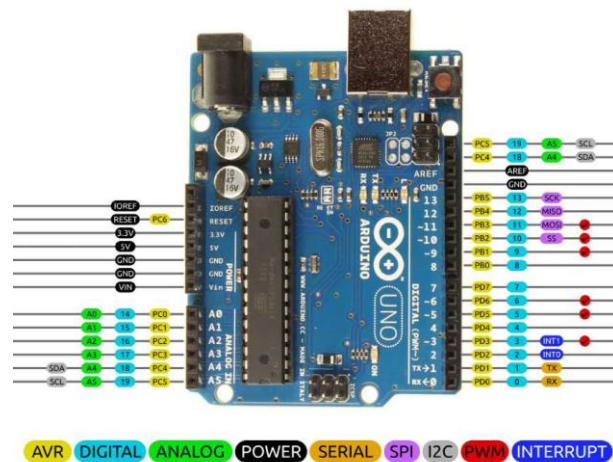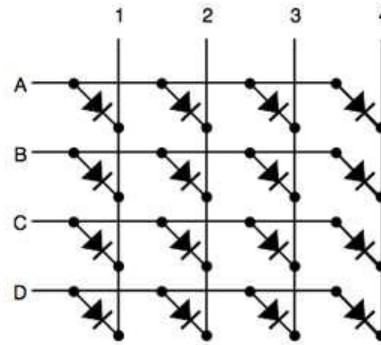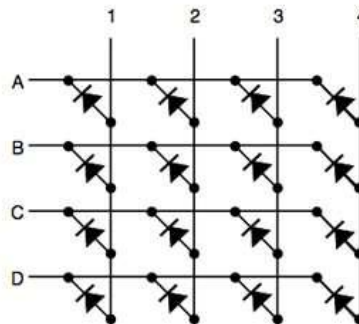

8x8 LED Matrix

An 8 x 8 LED matrix display is used in this project to display the information. LED matrices are available in different styles like single color, dual color, multi-color or RGB LED matrix.

They are also available in different dimensions like 5 x 7, 8 x 8, 16 x 16, 32 x 32 etc. Based on the arrangement of the LEDs in the matrix, an LED matrix can be either common row anode or common row cathode.

In case of common row anode type LED matrix, the current sources (high or positive voltage) are given to the rows A-D and the current sinks (low or negative voltage or ground) are given to the columns 1-4.

In case of common row cathode type LED matrix, the current sources (high or positive voltage) are given to the columns 1-4 and the current sinks (low or negative voltage or ground) are given to the rows A-D.

The LED matrix used in this project is a common row cathode type LED matrix. While developing the project, the type of LED matrix must be known and the program must be written accordingly.

IC MAX7219

The LED matrix can be driven in two ways. They are parallel (where each row or column are sent with parallel data) and serial (where the data is sent serially and an IC is used to convert this serial data into parallel data).

MAX 7219 is a common cathode display driver with serial input and parallel output. It is used to interface microprocessors and microcontrollers with 64 individual LEDs (8 x 8 LED matrix for example has 64 LEDs), seven segment LED displays up to 8 digits or bar graph displays.

The 8 x 8 LED matrix is connected to the MAX 7219 as shown in the circuit diagram and the data input is received from the Arduino board to the MAX 7219.

A Pre-wired MAX 7219 and 8 x 8 LED matrix module has been used in this project for convenience.
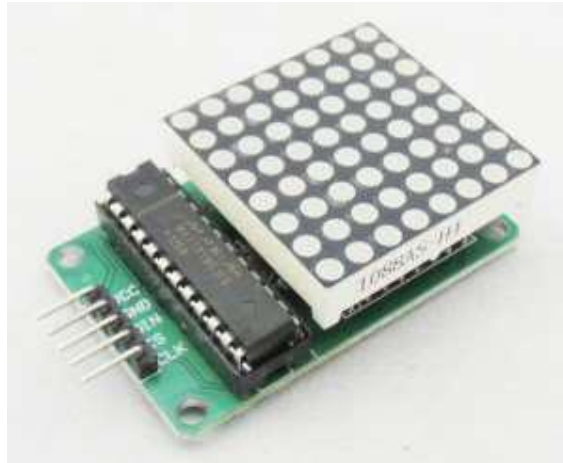
HC05 Bluetooth Module:

HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration.

Bluetooth serial modules allow all serial enabled devices to communicate with each other using Bluetooth. It has 6 pins,

1. Key/EN: It is used to bring Bluetooth module in AT commands mode. If Key/EN pin is set to high, then this module will work in command mode. Otherwise by default it is in data mode. The default baud rate of HC-05 in command mode is 38400bps and 9600 in data mode. HC-05 module has two modes,

a. Data mode: Exchange of data between devices.

b. Command mode: It uses AT commands which are used to change setting of HC-05. To send these commands to module serial (USART) port is used.
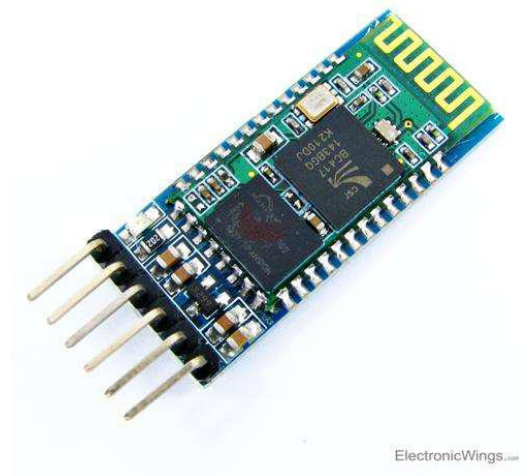
2. VCC: Connect 5 V or 3.3 V to this Pin.

3. GND: Ground Pin of module.

4. TXD: Transmit Serial data (wirelessly received data by Bluetooth module transmitted out serially on TXD pin)

5. RXD: Receive data serially (received data will be transmitted wirelessly by Bluetooth module).

6. State: It tells whether module is connected or not.

HC-05 has red LED which indicates connection status, whether the Bluetooth is connected or not. Before connecting to HC-05 module this red LED blinks continuously in a periodic manner. When it gets connected to any other Bluetooth device, its blinking slows down to two seconds. This module works on 3.3 V. We can connect 5V supply voltage as well since the module has on board 5 to 3.3 V regulator. As HC-05 Bluetooth module has 3.3 V level for RX/TX and microcontroller can detect 3.3 V level, so, no need to shift transmit level of HC-05 module. But we need to shift the transmit voltage level from microcontroller to RX of HC-05 module.

Circuit Design:

Since the communication between Arduino and MAX7219 is based on SPI Communication Protocol, all we need is three pins from Arduino (Data, Clock and Chip Select). The CS, CLK and DIN pins of the MAX7219 IC Board are connected to pins 10, 11 and 12 of the Arduino. As we are using the Bluetooth connection between Arduino and Android device, the RX and TX pins of the HC-05 Bluetooth Module are connected to TX and RX pins of the Arduino (Pins 1 and 0).

Working:

The aim of the project is to interface an Arduino Uno board with an 8 x 8 LED matrix to display information.

Even though a single 8 x 8 LED matrix with corresponding MAX 7219 IC is used in this project, multiple LED matrices can be connected in series for long scrolling display. Connect the components as shown in the circuit diagram. The working of the system is as follows.

3 of the 14 available digital input / output pins are used to control the display driver IC MAX 7219. The 3 pins on the MAX7219 IC are clock, data in and load (or cs in case of MAX 7221 IC). A maximum clock frequency of 10MHz can be applied. DIN (Data in) accepts the serial data from the microcontroller or Arduino board.

It is 16 bit long where the first 8 bits (D0 – D7) are for driving the columns (SEG A-G and DP of the MAX 7219 IC) of the LED matrix and the next 8 bits (D8 – D15) are for driving the (DIG 0-7 of the MAX 7219 IC) rows of the LED matrix.

The load pin (or CS or chip select pin in case of Max 7221 IC) latches the serial input data on its rising edge.

Another important pin on MAX 7219 is the ISET, which sets the peak current to the segment to drive all the LEDs. It is connected via a resistor (R1), which is called RSET. The capacitors filters out any noise in the supply.

When the serial data in is sent using the Arduino (through the program), the serial data is converted into segments and digits to drive columns and rows of the LED matrix. According to the data sent, the corresponding LEDs on the matrix light up and display the message.

The program written here is for scrolling text display. It might be difficult to view long scrolling data on a single 8 x 8 LED matrix. Hence, multiple LED matrices can be chained to form a long matrix.

The no. of MAX 7219 ICs are equal to the no. of 8 x 8 LED matrices. In order to extend the display to multiple LED matrices, the Data OUT (DOUT) pin of the first MAX 7219 must be connected to the Data IN (DIN) pin of the second MAX 7219 IC. This process must be continued for multiple LED matrices.

(The positioning of the LED Matrix in the chain is important. The first LED matrix must be placed at the right of the chain.)

Controlling the LED Matrix through an Android App:

A dedicated app for Android based devices is designed for this project. The layout of the app which is already installed on a mobile phone is shown in the following image.
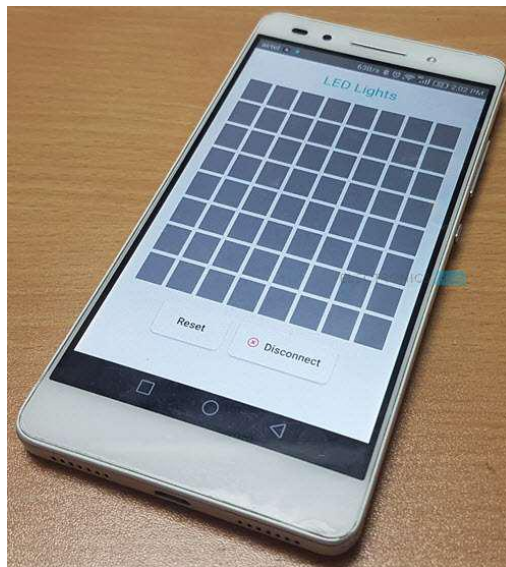
The app has 8×8 squares (each corresponding to one LED on the 8×8 LED Matrix), a Reset button and a Disconnect button. Touching a particular square will turn ON the particular LED in the 8×8 LED Matrix.

The color of the square will turn Red, as an indication that the LED is turned ON. Touching the square once again will turn OFF the corresponding LED and the color of the square will revert back to grey.

A Reset button is given at the bottom, using which you can reset the 8×8 LED Matrix i.e. all the LEDs will be turned OFF. The disconnect button will get disconnected from the Bluetooth.

The app utilizes the Bluetooth feature of the phone. Hence, necessary permissions must be given. Also, the HC-05 Bluetooth Module must be paired with the device (Phone).

Arduino Code:

```
#include<LedControl.h>

int DIN = 12;

int CS = 10;

int CLK =  11;

int row=0;

int col=0;

int temp=0;

int data=0;

LedControl lc=LedControl(DIN,CLK,CS,1);

void setup()

{

 lc.shutdown(0,false);

 lc.setIntensity(0,5);

 lc.clearDisplay(0);

 Serial.begin(9600);

}

void loop()

{

  if(Serial.available() > 0)

  {

    data = Serial.read();// it returns ascii value if we send one in the phone

    if(data < 96)

    {

     if(temp==0)

     {

      row=data-48;
```

```
      temp=1;
    }
    else
    col=data-48;
  }

  else if(data=='n')
  {
    lc.setLed(0,row,col,true);
   Serial.println('n');
  Serial.println(row);
  Serial.println(col);
   temp=0;
  }
  else if(data=='f')
  {
    lc.setLed(0,row,col,false);
   Serial.println('f');
   Serial.println(row);
   Serial.println(col);
   temp=0;
  }
  else if(data=='r')
  lc.clearDisplay(0);
}


}
```

Applications:

- Arduino based 8 x 8 LED matrix display uses only 3 pins of the Microcontroller. Hence, it can be used in applications where displaying information is a part of the system in which other pins of the microcontroller can be used for other peripherals.
- LED Matrix is a basic form of display device that is used for displaying information at public places like bus or train stations.
- Multiple LED matrices can be combined to form large displays and can be used to display images with multi colors.

Conclusion:

The code was uploaded to the microcontroller and was executed successfully. The Bluetooth Module has limited range which limits its possibility.