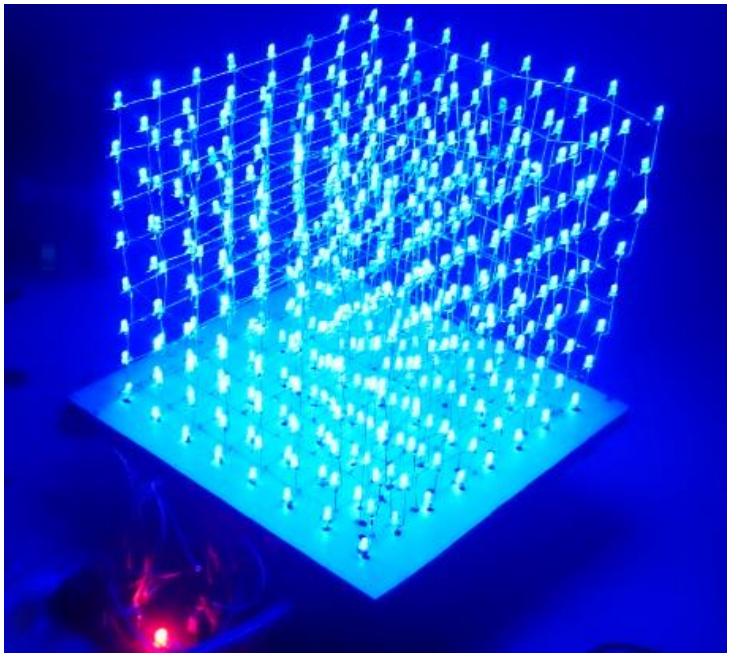
LED CUBE

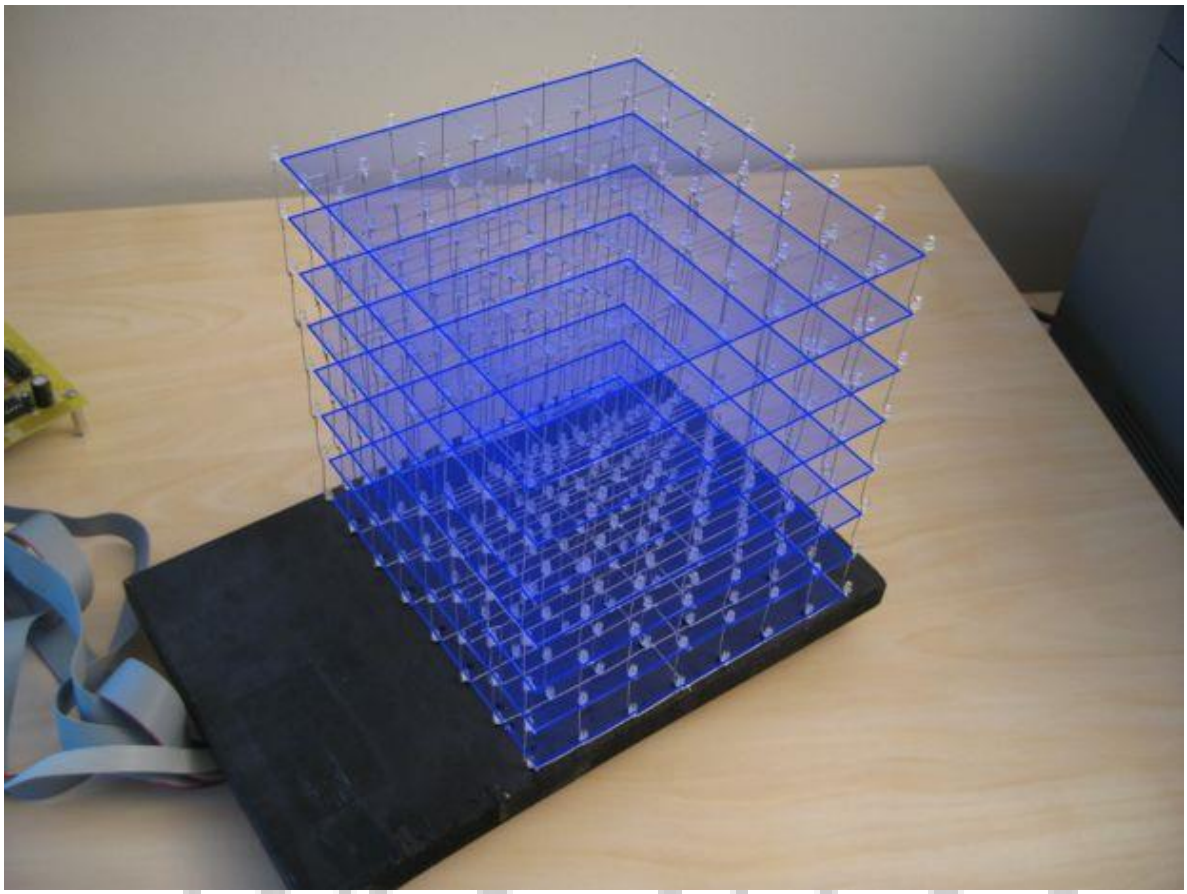
❖ www.KartikNighania.com

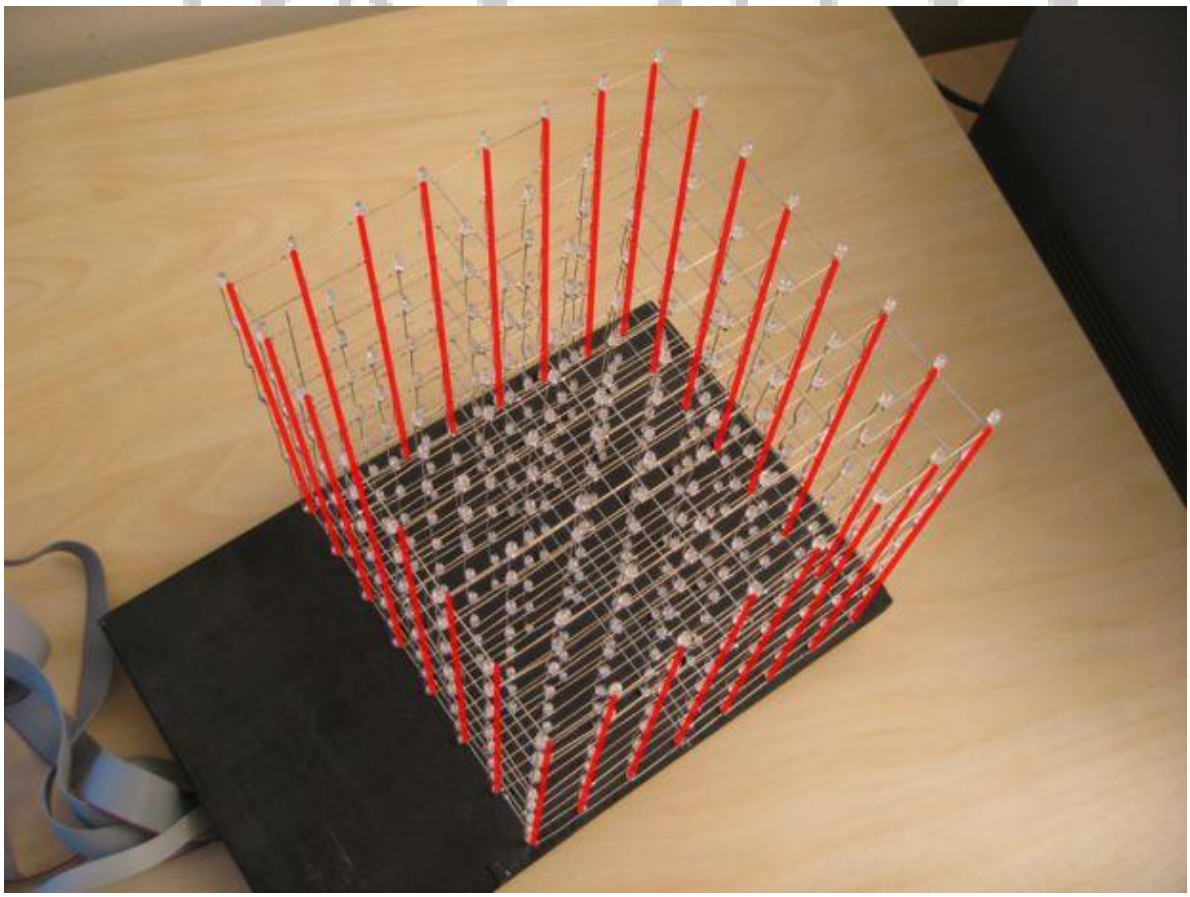


❖ Here is what you need to make a LED cube:

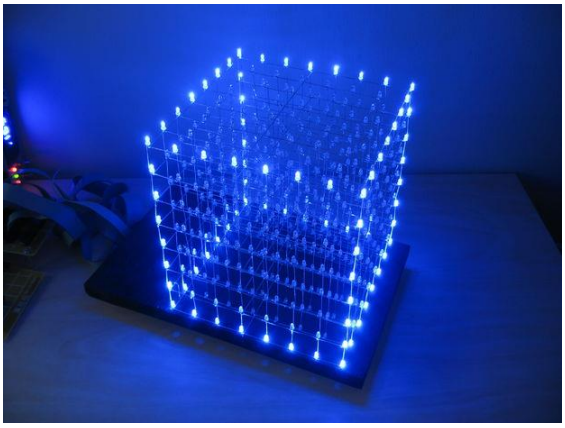
- 512x LEDs (I ended up using 580 LEDs. The rest got burned :p)
- 64x resistors 220 ohm
- 1 large prototype GCBs.
- 1x ATmega32 microcontroller (you can use other AVR with 20 GPIO pins)
- 8x 74HC574 ICs
- 2x ULN2003 ICs
- 1x 74HC138 IC
- 1x 1000uF electrolytic capacitor
- 1x 10uF electrolytic capacitor
- 1x 100uF electrolytic capacitors
- 8x 20 pin IC sockets
- 1x 40 pin IC socket
- 2x 14 pin IC socket
- 2x 16 pin IC socket
- 1x 2-pin screw terminal
- 9x 8-pin terminal pins.
- 1x 10-pin FRC cable connector.
- 1x FRC cable
- 8x Ribbon cable
- 1x pushbuttons.
- 18x 8-pin female header plugs.
- Piece of wood for template and base.
- Soldering iron with wire

THE ANATOMY OF AN LED CUBE-





THEORY OF LED CUBE



WE ARE GOING TO BE TALKING ABOUT ANODES, CATHODES, COLUMNS AND LAYERS, SO LETS TAKE A MOMENT TO GET FAMILIAR WITH THE ANATOMY OF A LED CUBE.

AN LED HAS TWO LEGS. ONE POSITIVE (THE ANODE) AND ONE NEGATIVE (CATHODE). IN ORDER TO LIGHT UP AN LED, YOU HAVE TO RUN CURRENT FROM THE POSITIVE TO THE NEGATIVE LEG. (IF I REMEMBER CORRECTLY THE ACTUAL FLOW OF ELECTRONS IS THE OTHER WAY AROUND. BUT LET'S STICK TO THE FLOW OF CURRENT WHICH IS FROM POSITIVE TO NEGATIVE FOR NOW).

THE LED CUBE IS MADE UP OF COLUMNS AND LAYERS. THE CATHODE LEGS OF EVERY LED IN A LAYER ARE SOLDERED TOGETHER. ALL THE ANODE LEGS IN ONE COLUMN ARE SOLDERED TOGETHER.

EACH OF THE 64 COLUMNS ARE CONNECTED TO THE CONTROLLER BOARD WITH A SEPARATE WIRE. EACH COLUMN CAN BE CONTROLLED INDIVIDUALLY.

EACH OF THE 8 LAYERS ALSO HAVE A SEPARATE WIRE GOING TO THE CONTROLLER BOARD.

EACH OF THE LAYERS ARE CONNECTED TO A ULN2003 THAT ENABLES THE CUBE TO TURN ON AND OFF THE FLOW OF CURRENT THROUGH EACH LAYER.

BY ONLY TURNING ON THE ULN2003 FOR ONE LAYER, CURRENT FROM THE ANODE COLUMNS CAN ONLY FLOW THROUGH THAT LAYER. THE ULN2003S FOR THE OTHER LAYERS ARE OFF, AND THE IMAGE OUTPUTTED ON THE 64 ANODE WIRES ARE ONLY SHOWN ON THE SELECTED LAYER.

TO DISPLAY THE NEXT LAYER, SIMPLY TURN OFF THE ULN2003 FOR THE CURRENT LAYER, CHANGE THE IMAGE ON THE 64 ANODE WIRES TO THE IMAGE FOR THE NEXT LAYER. THEN TURN ON THE ULN2003 FOR THE NEXT LAYER. RINSE AND REPEAT VERY FAST.

THE LAYERS WILL BE REFERRED TO AS LAYERS, CATHODE LAYERS OR GROUND LAYERS.

THE COLUMNS WILL BE REFERRED TO AS COLUMNS, ANODE COLUMNS OR ANODES.

ELECTRONIC CIRCUIT DIAGRAM

We ended up having below pins to make our LED cube glow–

2 BEING VCC & GND OF COURSE FOR OUR LED CUBE.
8 FOR THE 8 LAYERS IN CUBE –ULN2003
8 FOR LATCH INPUT – 74HC574
3 FOR ADDRESS BIT IN DECODER IC – 74HC138
0 OUTPUT ENABLE IS SHORTED WITH VCC TO KEEP
\+ IC ALWAYS ENABLED

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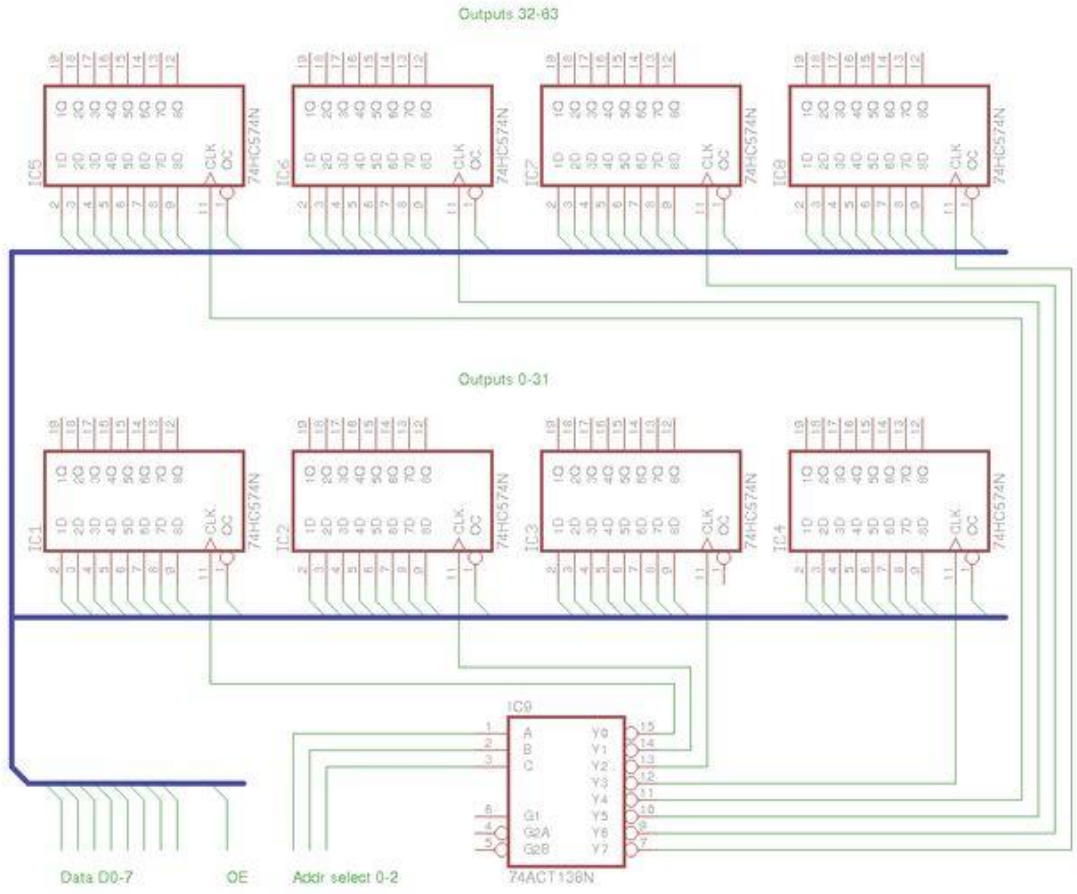
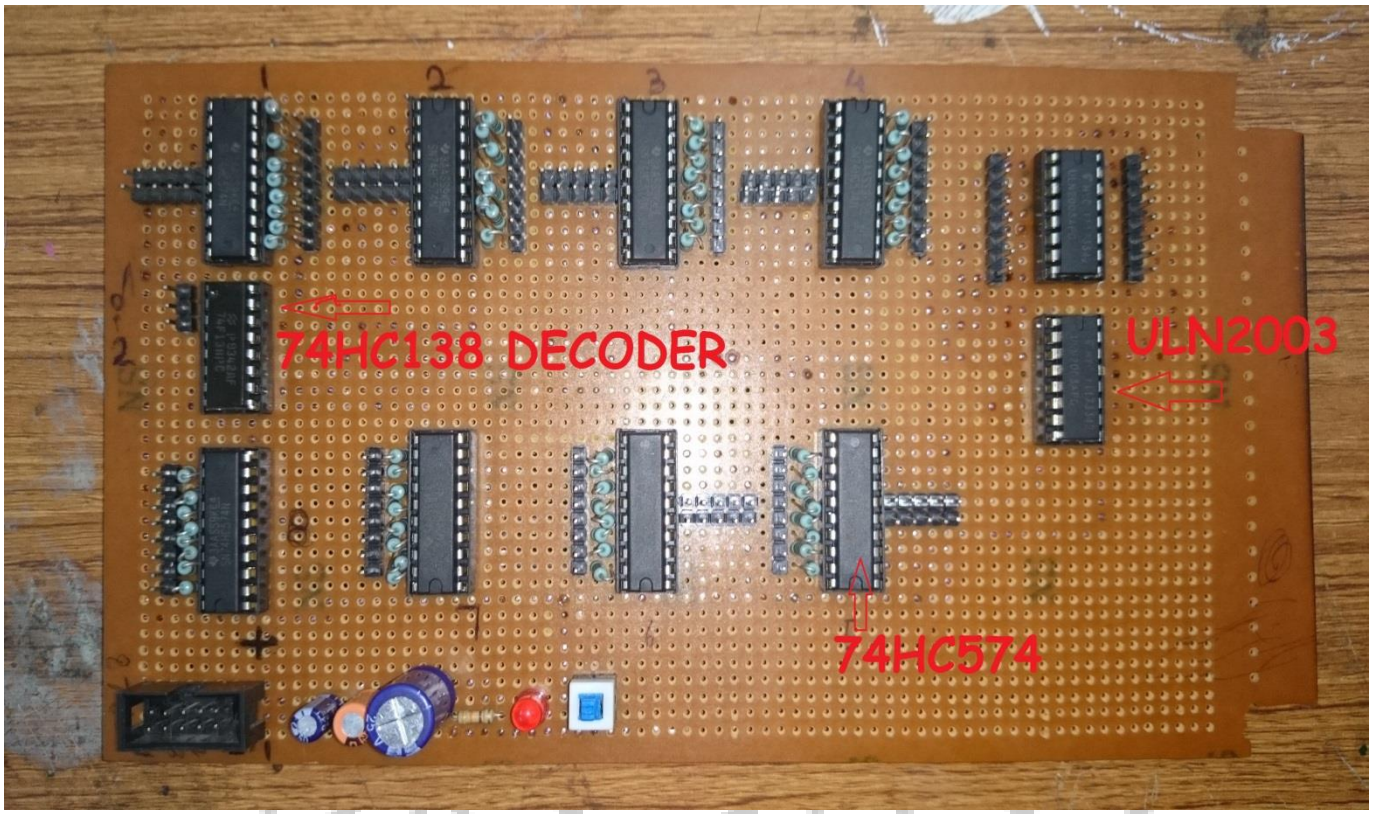
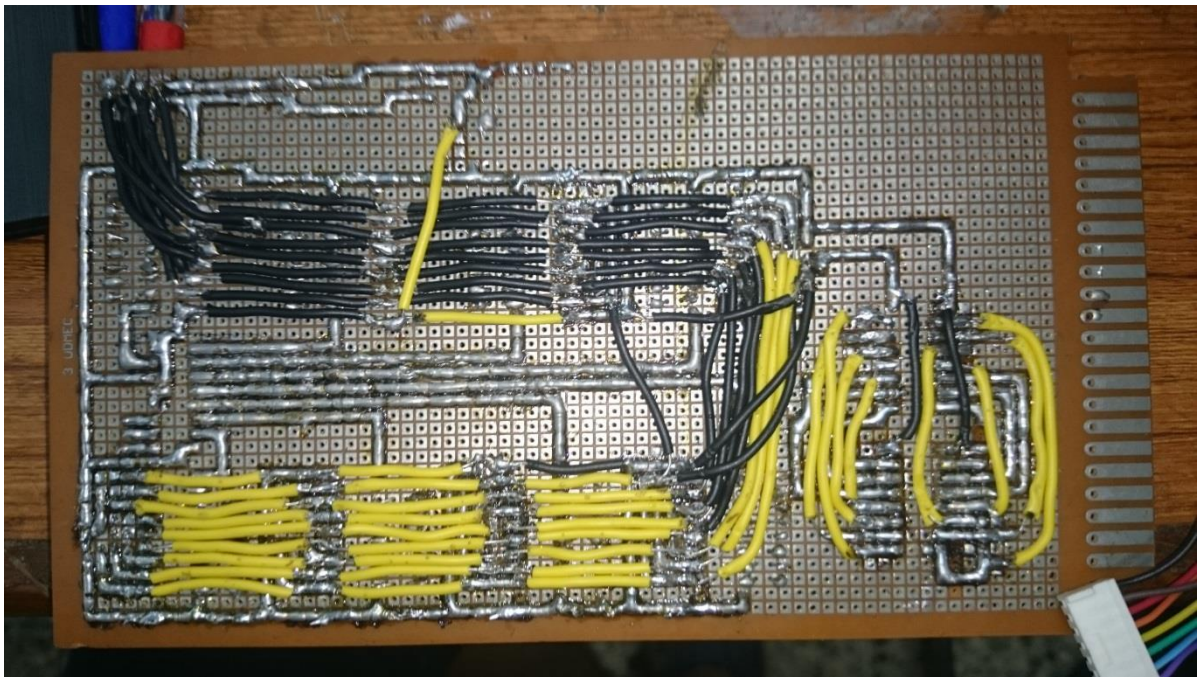
21 GENERAL PURPOSE INPUT OUTPUT PINS



FRONT



BACK



THEORY OF CIRCUIT

AN 8X8X8 LED CUBE REQUIRES 64+8 IO LINES TO OPERATE. NO AVR MICRO CONTROLLER WITH A DIP PACKAGE (THE KIND OF THROUGH HOLE CHIP YOU CAN EASILY SOLDER OR USE IN A BREADBOARD, DUAL INLINE PACKAGE) HAVE THAT MANY IO LINES AVAILABLE.

TO GET THE REQUIRED 64 OUTPUT LINES NEEDED FOR THE LED ANODES, WE WILL CREATE A SIMPLE MULTIPLEXER CIRCUIT. THIS CIRCUIT WILL MULTIPLEX 11 IO LINES INTO 64 OUTPUT LINES.

THE MULTIPLEXER IS BUILT BY USING A COMPONENT CALLED A LATCH OR A FLIP-FLOP. WE WILL CALL THEM LATCHES FROM HERE ON.

THIS MULTIPLEXER USES AN 8 BIT LATCH IC CALLED 74HC574. THIS CHIP HAS THE FOLLOWING PINS:

- 8 INPUTS (D0-7)
- 8 OUTPUTS (Q0-7)
- 1 "LATCH" PIN (CP)
- 1 OUTPUT ENABLE PIN (OE)

THE JOB OF THE LATCH IS TO SERVE AS A KIND OF SIMPLE MEMORY. THE LATCH CAN HOLD 8 BITS OF INFORMATION, AND THESE 8 BITS ARE REPRESENTED ON THE OUTPUT PINS. CONSIDER A LATCH WITH AN LED CONNECTED TO OUTPUT Q0. TO TURN THIS LED ON, APPLY V+ (1) TO INPUT D0, THEN PULL THE CP PIN LOW (GND), THEN HIGH (V+).

WHEN THE CP PIN CHANGES FROM LOW TO HIGH, THE STATE OF THE INPUT D0 IS "LATCHED" ONTO THE OUTPUT Q0, AND THIS OUTPUT STAYS IN THAT STATE REGARDLESS OF FUTURE CHANGES IN THE STATUS OF INPUT D0, UNTIL NEW DATA IS LOADED BY PULLING THE CP PIN LOW AND HIGH AGAIN.
TO MAKE A LATCH ARRAY THAT CAN REMEMBER THE ON/OFF STATE OF 64 LEDS WE NEED 8 OF THESE LATCHES. THE INPUTS D0-7 OF ALL THE LATCHES ARE CONNECTED TOGETHER IN AN 8 BIT BUS.

TO LOAD THE ON/OFF STATES OF ALL THE 64 LEDS WE SIMPLY DO THIS: LOAD THE DATA OF THE FIRST LATCH ONTO THE BUS. PULL THE CP PIN OF THE FIRST LATCH LOW THEN HIGH. LOAD THE DATA OF THE SECOND LATCH ONTO THE BUS. PULL THE CP

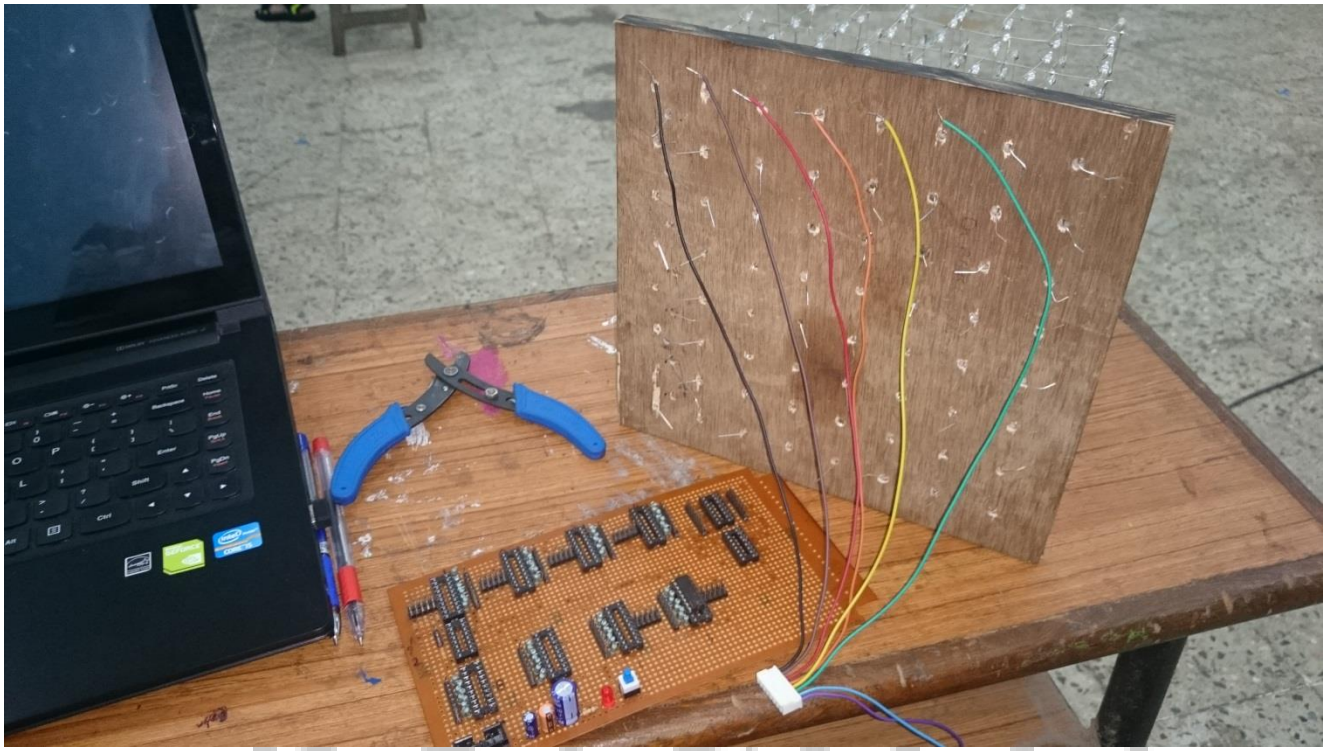
PIN OF THE SECOND LATCH LOW THEN HIGH. LOAD THE DATA OF THE THIRD LATCH ONTO THE BUS. PULL THE CP PIN OF THE THIRD LATCH LOW THEN HIGH. RINSE AND REPEAT.

THE ONLY PROBLEM WITH THIS SETUP IS THAT WE NEED 8 IO LINES TO CONTROL THE CP LINE FOR EACH LATCH. THE SOLUTION IS TO USE A 74HC138. THIS IC HAS 3 INPUT LINES AND 8 OUTPUTS. THE INPUT LINES ARE USED TO CONTROL WHICH OF THE 8 OUTPUT LINES THAT WILL BE PULLED LOW AT ANY TIME. THE REST WILL BE HIGH. EACH OUT THE OUTPUTS ON THE 74HC138 IS CONNECTED TO THE CP PIN ON ONE OF THE LATCHES.

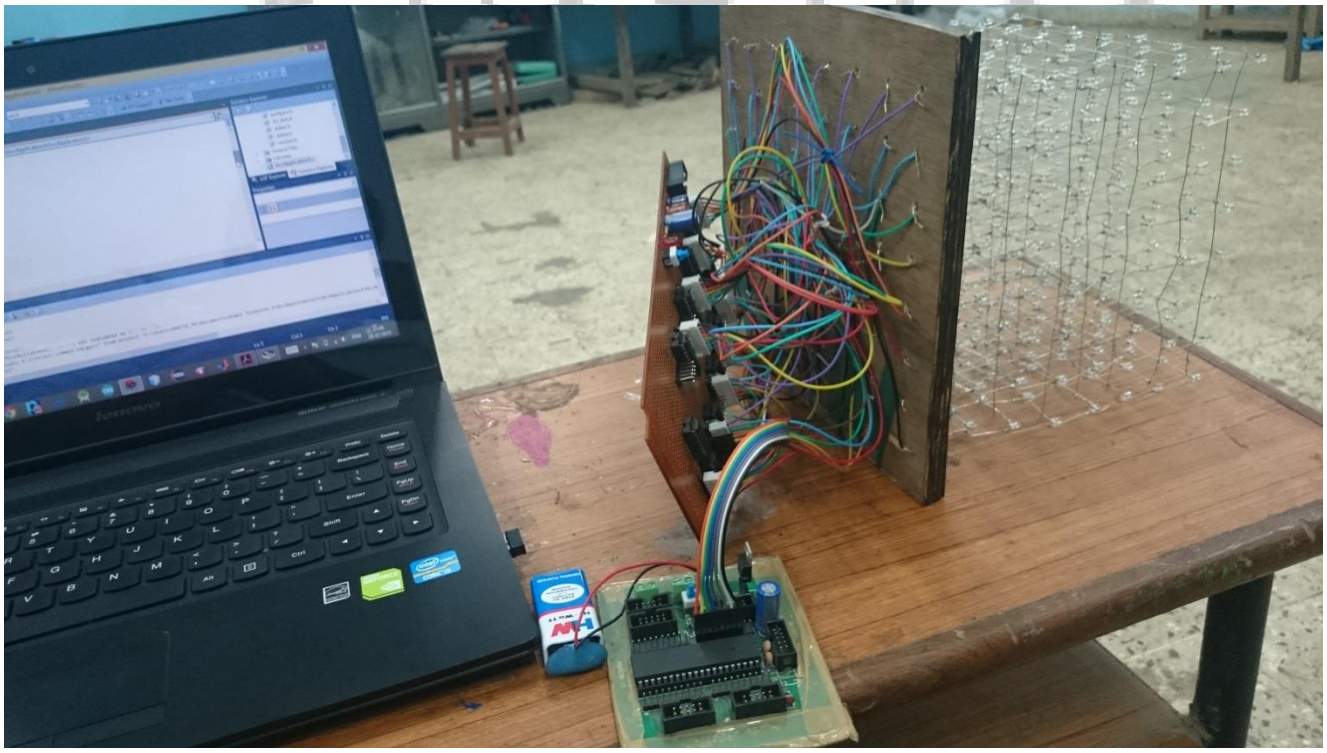
then the AVR CHIP is programmed by code

PROBLEMS FACED:

- TAKE CARE THAT LEDS DON'T BURN DUE TO EXCESSIVE HEATING
- CHECK THE CIRCUIT PROPERLY FOR ERRORS BY A DMM
- USE PULL-UP RESISTORS TO AVOID GHOSTING OF LEDS
- U CAN USE A BOARD HAVING HOLES IN IT FOR MAKING LAYERS AND THEN JOINING EACH FLOOR ONE ABOVE THE OTHER LAYERS

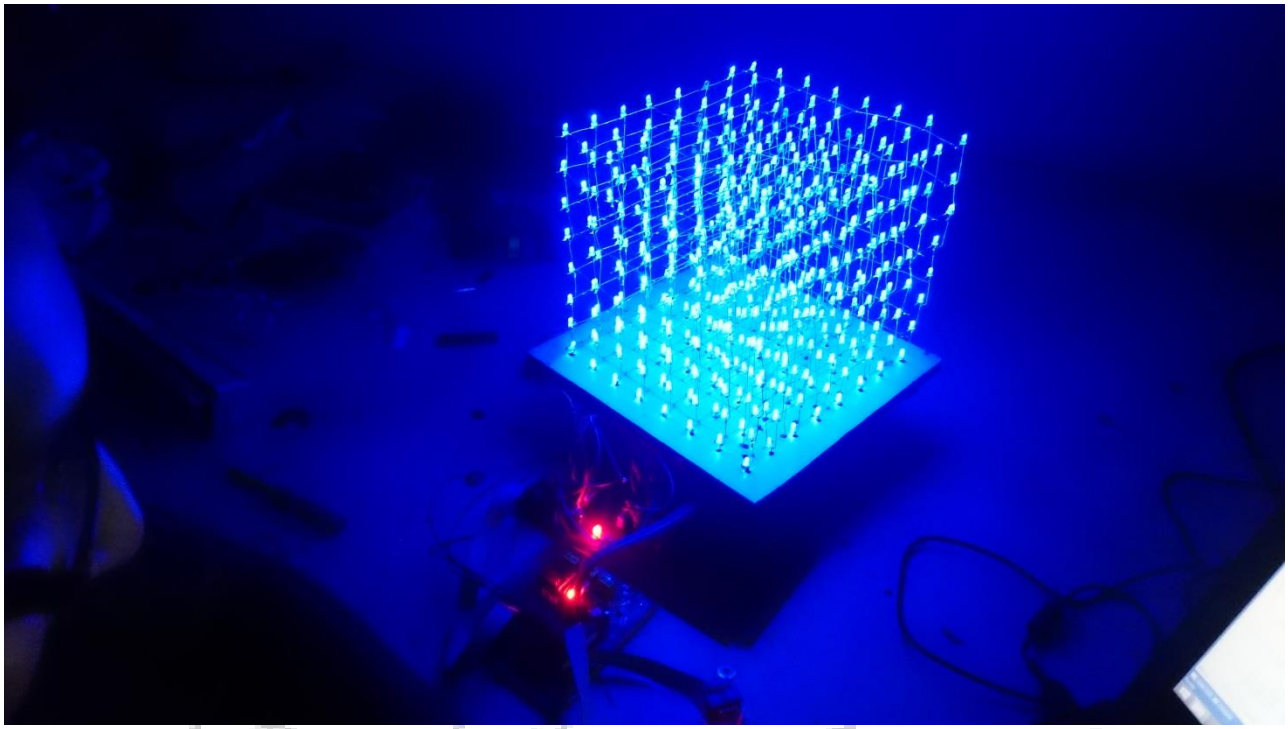


FINAL SETUP



FINAL RESULTS

LED CUBE WAS ABLE TO DISPLAY 16 AMAZING DIFFERENT PATTERNS!!



THE WHOLE PROJECT WAS COMPLETED IN 2.5 WEEKS. WHICH INCLUDED:-

- ✓ *Making of led cube*
- ✓ *Circuit board*
- ✓ *Coding of microcontroller*
  - ➢ *With a budget of ₹2000*

*A project of DRISHTI GROUP, SVNIT, SURAT-395007
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Size of model- 35x35x35 cm

Future Scope-

Can be used in railway stations to show train timings and other details. Due to its 3D design, it can be viewed from any angle making it capable to deliver information to large gathering if placed at the centre.

As a real time clock.

If 16x16x16 or 32x32x32 LED cube made then can show graphs in 3D for better understanding and deeper evaluation.

Lastly for lighting purposes in occasions with its amazing POV (persistence of vision) display patterns that helps it to run just with 640 mA current consumption.