

The assignment is to design a circuit that takes in audio input ,detects its level and displays with three LEDs. I attempted two realizations, one using CMOS components and one with Arduino.

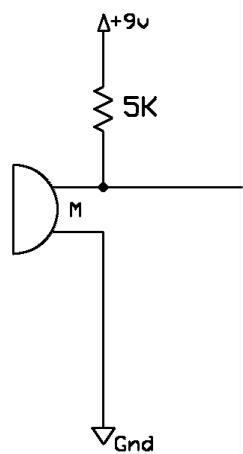
## THE FIRST REALIZATION

### RESOURCES USED:

electret microphone J 60 x1  
 LM324N Quad Op Amp x2  
 CD4051BE 8-Channel Demultiplexer x1  
 CD4035BE PIPO shift register x1  
 red, yellow, green LEDs x~  
 capacitors and resistors x~

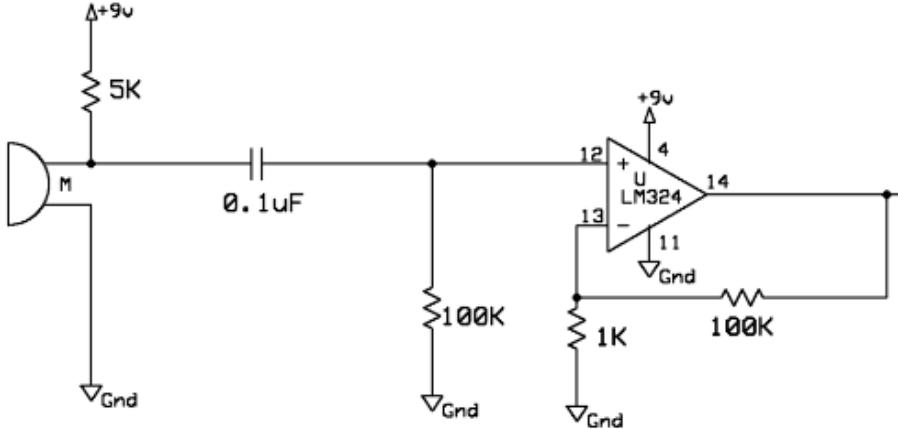
### DESIGN PROCESS:

- According to the requirement, I choose the input from a electret microphone. The primitive idea is to use three comparators to realize the project and show different level of volume.
- After simply connected the microphone with power , resistor and ground, I found the output of microphone range to 0-100mV under the approximate test range. (using oscilloscope)



• Thus, to compare with voltage that can be divided from the power supply , 9V, the microphone needs to be amplified about 100 rate to 0- 10 V ( but due to the supply voltage limit, the real output will be 0-9 V )

• Thereafter a simple amplifying circuit. Firstly I used a high pass filter to remove the constant noise and ambient sound, and then simply connect the output to an amplifier with amplifying close enough to 100.



- The amplifying rate can be found by equation use two resistors connected:

$$\text{Gain} = 1 + (100k/1k) = 101$$

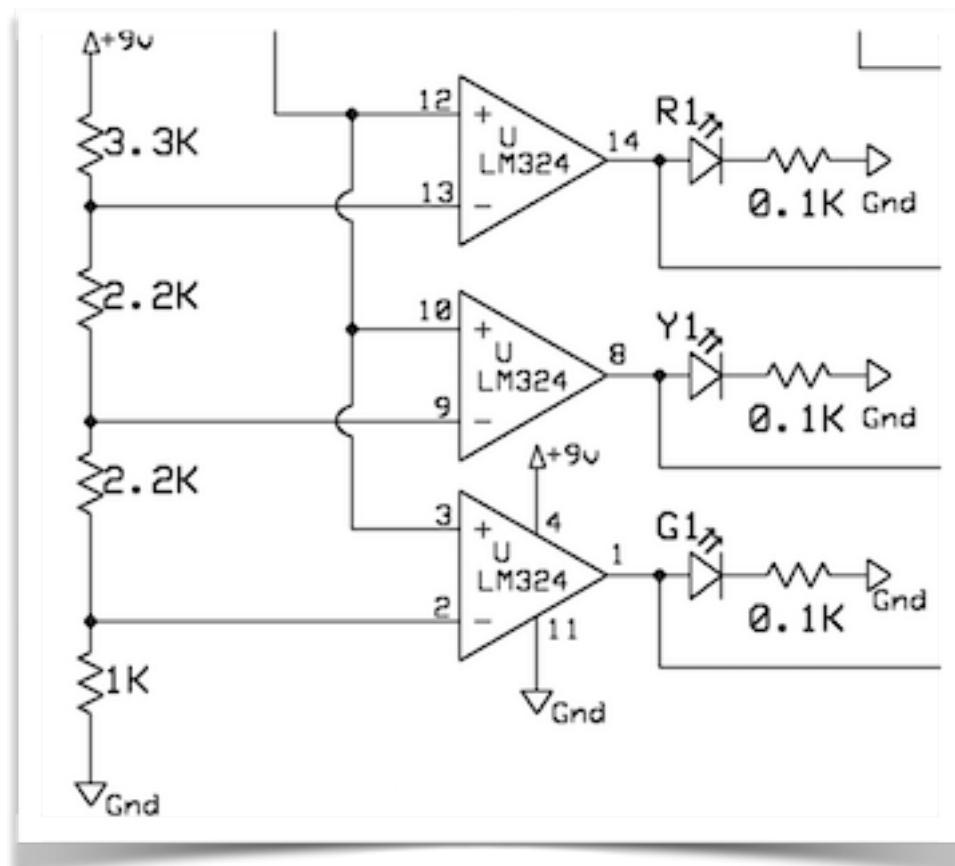
And this step is verified on the oscilloscope.

- Next step is to compare the input voltage with several constant voltages which can be generated from voltage supply by a voltage tree.

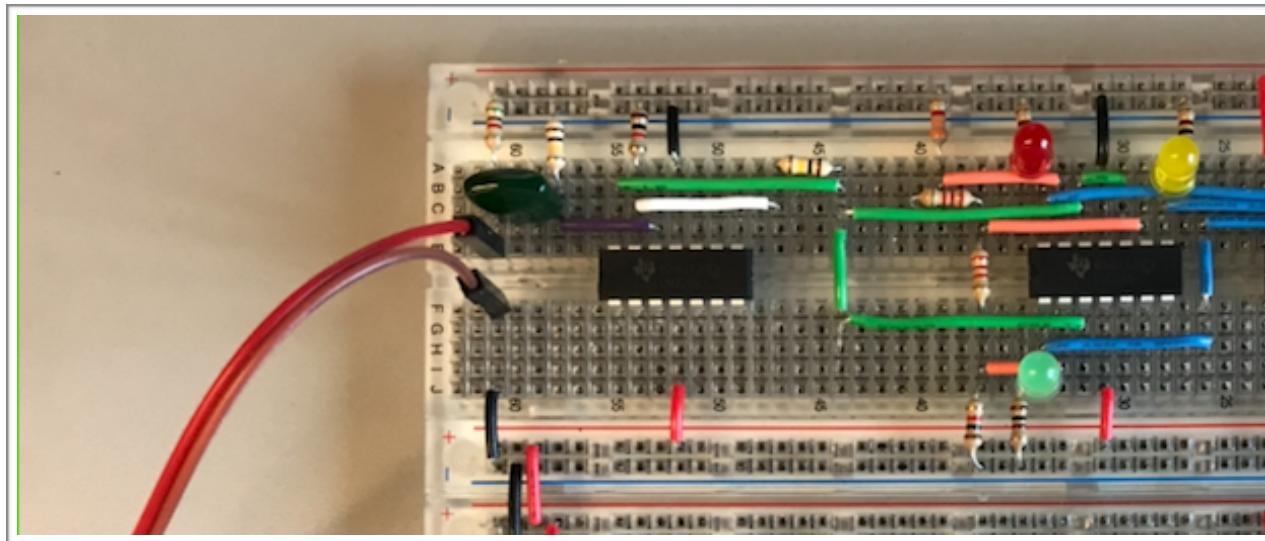
The voltage tree I created is shown below and compare them with input voltage can let R1, Y1 and G1 light up when input voltage is bigger than 5.59 V , Y1 and G1 light up when the input voltage is bigger than 3.31 V and only G1 lights up when the input voltage is bigger than 1.03V.

Input voltage /V	LED ON	volume condition
1~3.31	GREEN	LOW
3.31~5.59	GREEN YELLOW	Moderate
5.59~9	GREEN YELLOW RED	LOUD

Thus the circuit is acting like a thermometer, but with sound input.

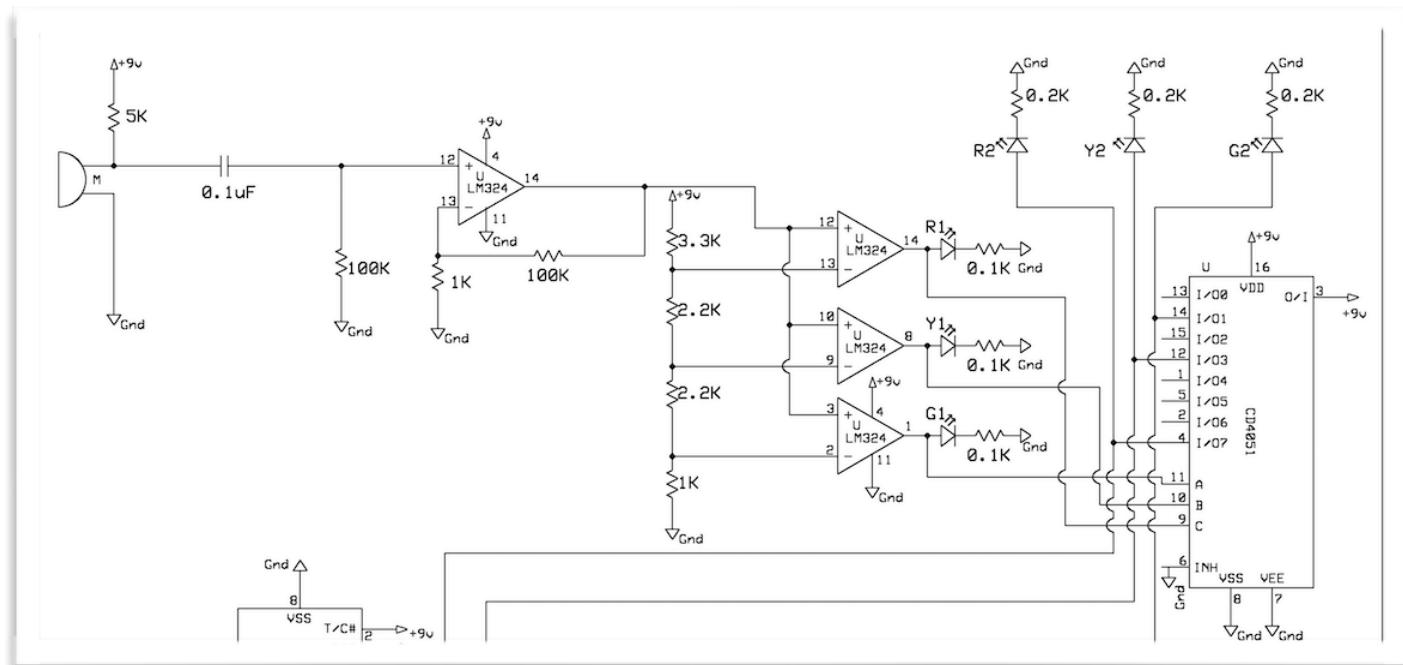


- Now, the sound input is successfully illustrated by three LED. And the test can be checked on the video along with this documentation.



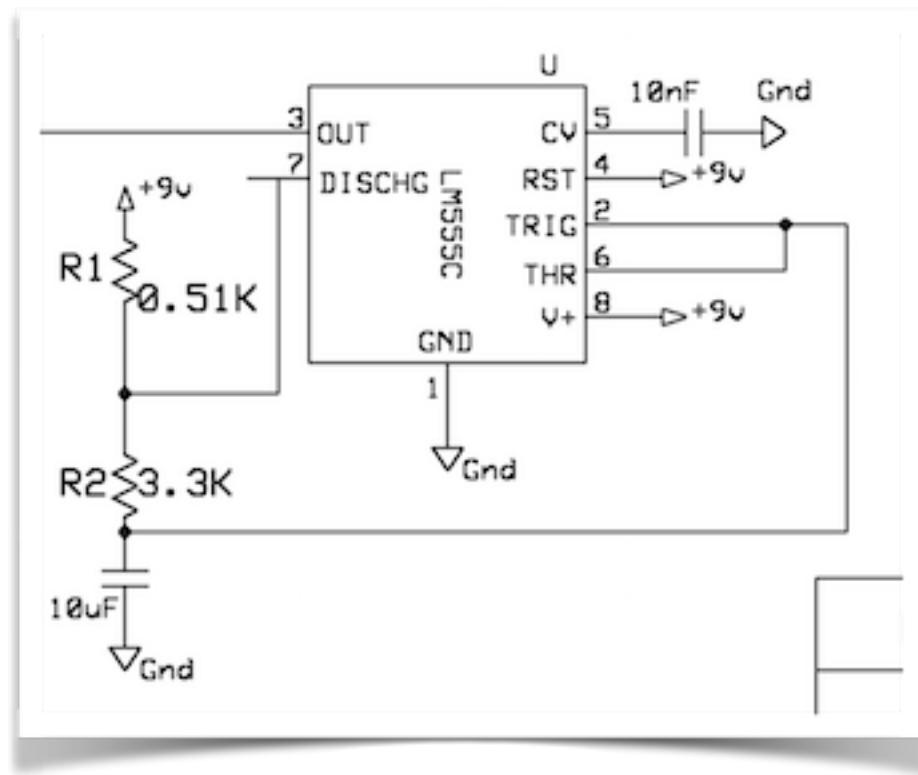
Input voltage /V	LED ON	volume condition
1~3.31	GREEN	LOW
3.31~5.59	YELLOW	Moderate
5.59~9	RED	LOUD

- Now, according to the specification in the problem, in the LOUD case, Red should be on with the other two off, and the same situation for the other cases.



So I put them into a demux, and connect the original three output into the selection line. 111,011,001 is connected to R2, Y2, G2 respectively to realize the requirement.

- After a test, the result is not ideal since the sound input, especially with a song, has very high frequency range around 4kHz, though the CMOS can operate the input very quickly, the three LED will just keep on while the song is playing since the song goes too quick. (obviously, Human eye can't handle blinks of LED with a few thousand Hz )
- So I think I should use a PIPO shift register to slow the sound input down with my own frequency. The three output from demux are put into the shift register and came out with my set frequency from an astable 555 timer circuit.
- To make the change of volume visible and clear, I decided to let the 555 output a 20Hz pulse to the shift register with using  $R_1 = 0.51\text{ ohm}$ ,  $R_2=3.3\text{K ohm}$  and  $C=10\mu\text{F}$  for the 555 circuit.

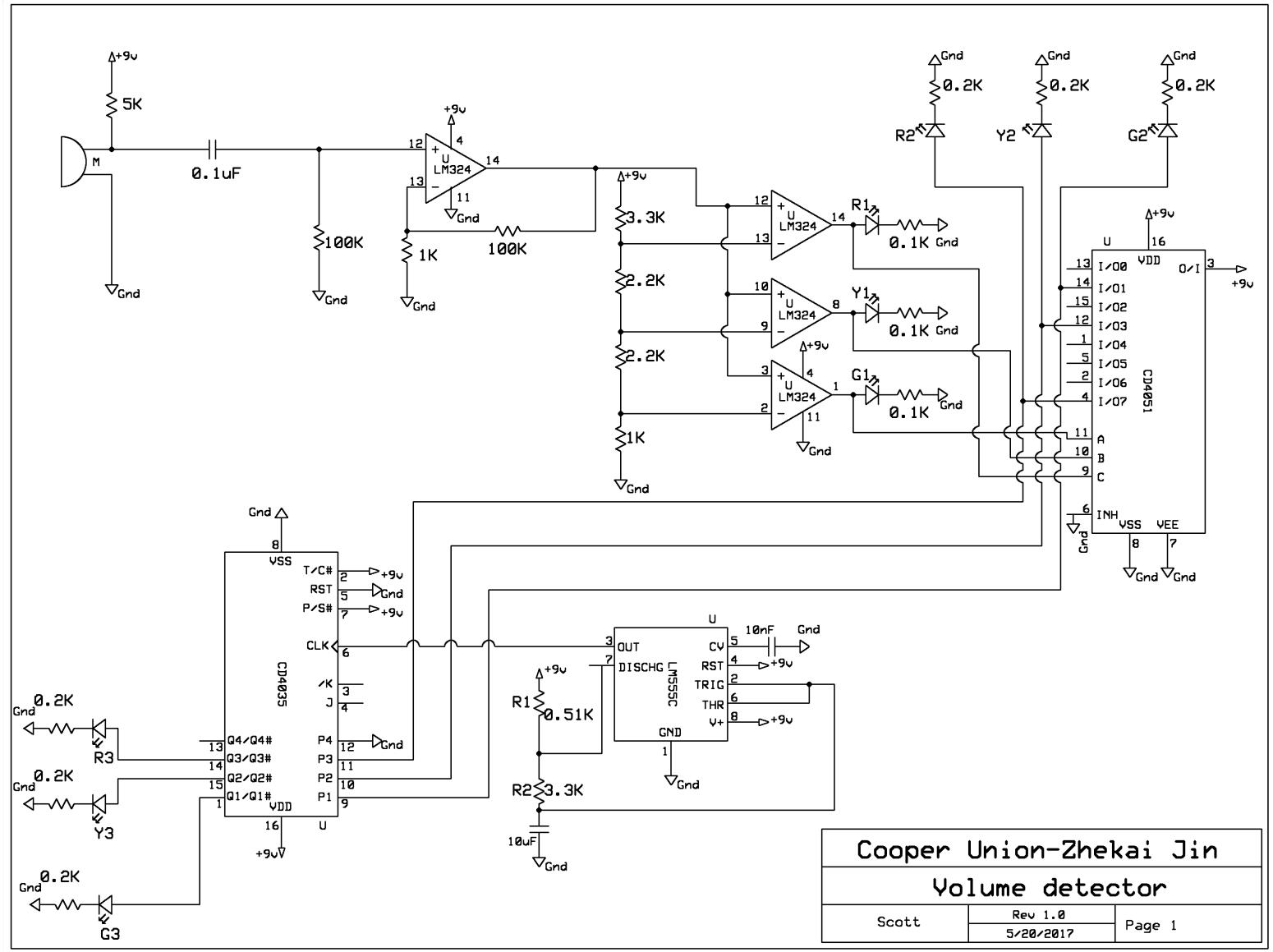


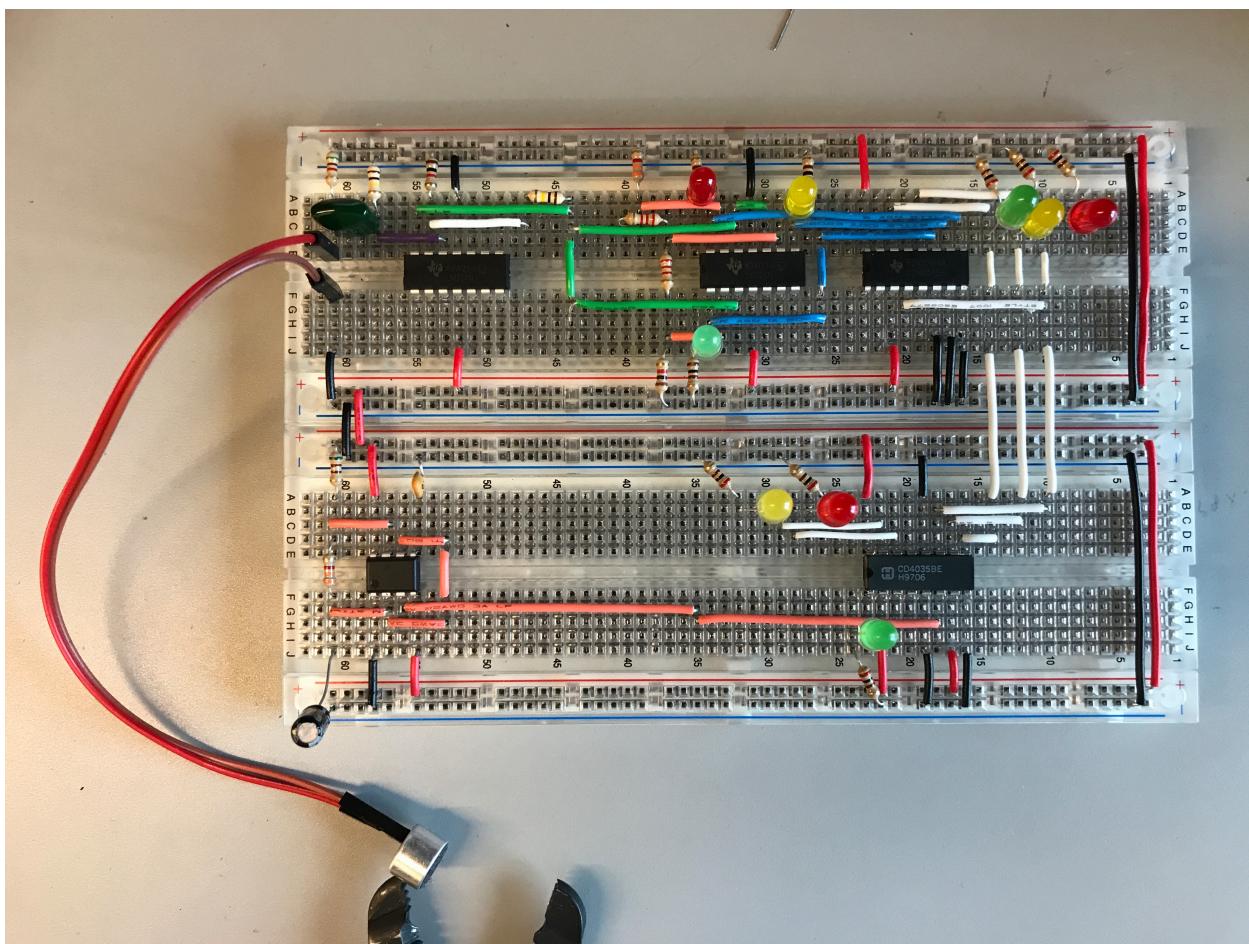
- The Property of this astable circuit can be easily calculated.

#### Property of 555 Astable circuit

Frequency	20.295 Hz	Duty Cycle	53.59%
Period (T)	49.272 ms	Time High (T <sub>1</sub> )	26.403ms
		Time Low (T <sub>0</sub> )	22.869ms

- Now putting everything together, the circuit works as expected and the schematic and real board is shown below.



**BIG TESTS AND BUGS:**

The main bug I have in this project is when I connect with the PIP0 shift register, I still use 100 ohm resistors for G2,Y2 and R2, but in that case the input will not be around 5V to the Parallel input for the shift register.(The input voltage is too high for the shift register to work properly since its a CMOS)  
instead, when I change all the resistors to 200ohm, the circuit worked out just fine.

## **REALIZATION 2: (ARDUINO )**

On Arduino, since the value of the input can be directly read, the function can be realized pretty easily and the input is taken from the sound detector which has a amplifier itself and an if else condition is set to let three LEDs connected light at different volumes.

