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Automated Noise Levels Measurement, Analytics and Alert Generation System

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Abstract—*Noise levels have increased drastically these days and have become nuisance, especially in urban life. This is hazardous to the human life in multiple ways. Government and social bodies implemented multiple measures to educate citizens on the importance of reducing noise levels and to increase Civic sense against contributing to the noise levels. Even laws are devised to punish violators. But implementation is not effective. I felt, there is a need to put an automated system in place to send alert, in case of violations, to authorities so that appropriate action can be taken. The work proposed in this paper is focusing on use of technology to develop economical device to measure noise pollution in mapped area and generate data to develop analytics to indicate patterns and generate automated alert to be sent to municipal authority in case of violations.*

Index Terms*: Noise, IOT.*

1. INTRODUCTION

With active populations, road traffic, industry, and construction, cities are expectedly noisy places. Exposure to prolonged or excessive noise has been shown to cause a range of health problems ranging from stress, poor concentration, productivity losses in the workplace, and communication difficulties and fatigue from lack of sleep, to more serious issues such as cardiovascular disease, cognitive impairment, tinnitus and hearing loss.

Effects of noise pollution:

- Loss of hearing and deafness
- Cardiac disturbance
- Sleeplessness
- Headache
- Irregular blood pressure
- Stress, tension and aggressiveness
- Psychological imbalance

Government and social bodies implemented multiple measures to educate citizens on the importance of reducing noise levels and to increase Civic sense against contributing to the noise levels. Even laws are devised to punish violators. But implementation is not effective. I felt, there is a need to put an automated system in place to send alert, in case of violations, to authorities so that appropriate action can be taken.

Powai is suburb of Mumbai Metropolitan city. I did grow up in this area and has been observing increase in Noise levels. Most of the time it is ignorance about the Noise levels we are exposed to and it's effect on health. Mumbai Municipal authority is aware about this nuisance of increased Noise pollution levels. The police authorities have also announced telephone, WhatsApp numbers as well as email IDs to enable people to file their grievances in this regard. Brihanmumbai Municipal Corporation (BMC) has also launched a toll-free number. Police station wise, the list with the name and information of the officers to prevent and control noise pollution has been displayed on BMC's web portal http://portal.mcgm.gov.in. The maximum noise levels permissible under the rules for various areas range between 50 and 75 decibels during the day and between 40 and 70 decibels at night under Noise Pollution Rules-2000. Such reporting of complaints is mostly based on awareness of the citizens. Issue is citizen's awareness about allowed Noise levels and route to take action for reporting such violation.

Solution is - If Noise levels are continuously measured by some device and reported automatically to authority if it crosses allowable limits, will be more effective. This will enable authority to take action with authentic record.

2. SYSTEM DESIGN

Selection of Type of Noise measuring Instrument:

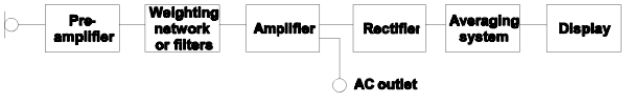
The most common instruments used for measuring noise are the sound level meter (SLM), the integrating sound level meter (ISLM), and the noise dosimeter.

Following is instrument selection guidelines:

Type of Measurement	Appropriate Instruments (in order of preference)	Result
Personal noise exposure	1) Dosimeter	Dose or equivalent sound level
	2) ISLM*	Equivalent sound level
	3) SLM**	dB(A)
Noise levels generated by a particular source	1) SLM	dB(A)
	2) ISLM	Equivalent sound level dB(A)
Noise survey	1) SLM	dB(A)
	2) ISLM	Equivalent sound level dB(A)
Impulse noise	1) Impulse SLM	Peak pressure dB(A)

Assembly of Sound measuring device:

Block Diagram:

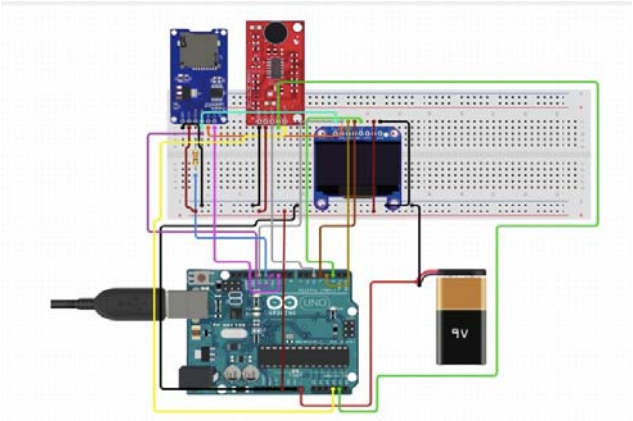


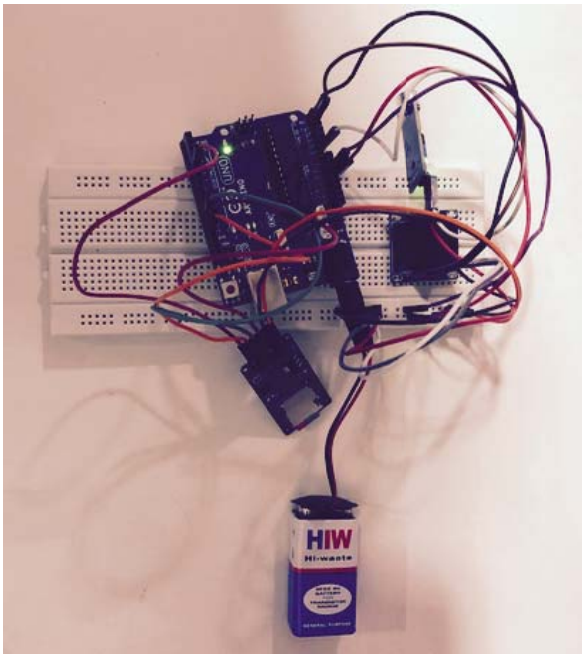
Necessary components of such noise measuring system are:

- Transducer i.e. the microphone;
- Electronic amplifier
- Calibrated attenuator for gain control;
- Frequency Analyzer;
- Data Storage;
- Display.

Assembly Diagram:

Following is assembly diagram of various components used in the device along with it's details:

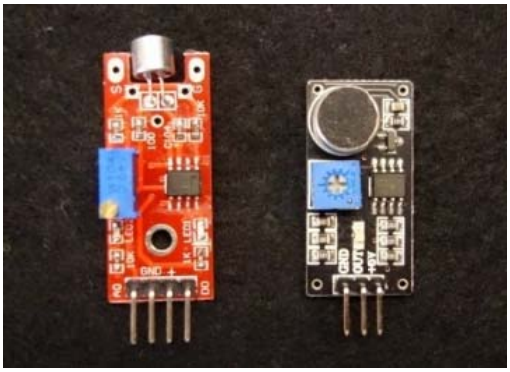




Parts Required:

- 1x Arduino Microphone sound sensor
- Arduino UNO Board
- 1x Breadboard
- 1x 0.9 inch LED Display
- 1x 220 Ohm resistor
- Jumper wires
- Arduino sd card reader
- 12 Volt battery

Sound Sensor:



Microphone sound sensor: It gives a measurement of how loud a sound is.

At the leftmost side, you can see the KY-038 and at the right the LM393 microphone sound sensor.

The sensitivity of a microphone is defined as the amplitude (in mV) of the output signal for an incident sound pressure of amplitude 1 Pa (94 dB) at 1000 Hz. It can also be expressed in decibels by the following expression:

$$Sensitivity = 20\log_{10}\frac{Vp_0}{V_0p} \quad \text{dB re 1V/Pa}$$

Both sensor modules have a built-in potentiometer to adjust the sensitivity of the digital output pin.

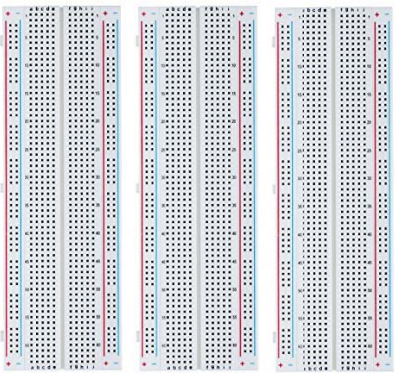
Pin Wiring

Pin	Wiring to Arduino
A0	Analog pins
D0	Digital pins
GND	GND
VCC	5V

Arduino UNO

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 pins that may be interfaced to various expansion boards and other circuits.

Breadboard



A breadboard is a solder less device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate.

LED

A light-emitting diode is a semiconductor light source that emits light when current flows through it.

Resistor

Resistors kits with 1/4 watt 1% metal film resistor. A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines

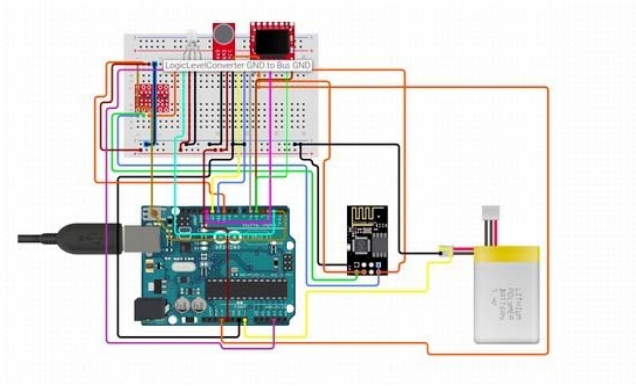
Jumper wires

Kit with 120 jumper wires for your electronics prototyping projects. Includes 40 wires of each type: male to male, male to female, and female to female.

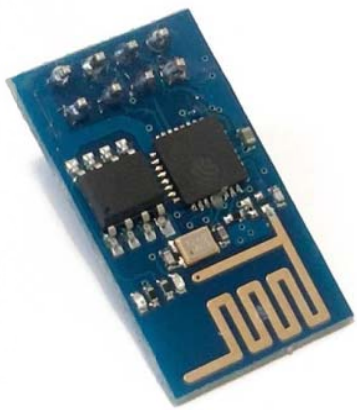
Arduino sd card reader

The SD library allows for reading from and writing to SD cards, e.g. on the Arduino Ethernet Shield. The communication between the microcontroller and the SD card uses SPI, which takes place on digital pins 11, 12, and 13 (on most Arduino boards) or 50, 51, and 52

Assembly of SMS Sending device:



For sending automated messages to authority, GSM module was integrated with Noise measurement system above.



Parts Required:

- esp866 wifi connection
- SMS send api (way2sms)

Customization of the device:

System was programmed to achieve the designed functionality. Programming was done for following:

- Storing measured Noise levels, based on location, date and time
- Monitoring Noise level limts and sending text message to configured authority numbers in case of violation

```
#ifdef NEO_KHZ400 // 800 KHz check needed only if 400 KHz support enabled
  if(is800KHz) {
#endif
    cyc = ARM_DWT_CYCCNT + CYCLES_800;
    while(p < end) {
      pix = *p++;
      for(mask = 0x80; mask; mask >>= 1) {
        while(ARM_DWT_CYCCNT - cyc < CYCLES_800);
        cyc  = ARM_DWT_CYCCNT;
        *set = 1;
        if(pix & mask) {
          while(ARM_DWT_CYCCNT - cyc < CYCLES_800_T1H);
        } else {
          while(ARM_DWT_CYCCNT - cyc < CYCLES_800_T0H);
        }
        *clr = 1;
      }
    }
    while(ARM_DWT_CYCCNT - cyc < CYCLES_800);
#ifdef NEO_KHZ400
  } else { // 400 kHz bitstream
    cyc = ARM_DWT_CYCCNT + CYCLES_400;
    while(p < end) {
      pix = *p++;
      for(mask = 0x80; mask; mask >>= 1) {
        while(ARM_DWT_CYCCNT - cyc < CYCLES_400);
        cyc  = ARM_DWT_CYCCNT;
        *set = 1;
        if(pix & mask) {
          while(ARM_DWT_CYCCNT - cyc < CYCLES_400_T1H);
        } else {
          while(ARM_DWT_CYCCNT - cyc < CYCLES_400_T0H);
        }
        *clr = 1;
      }
    }
    while(ARM_DWT_CYCCNT - cyc < CYCLES_400);
  }
#endif // NEO_KHZ400
```

Methodology for preparing Noise map for the area:

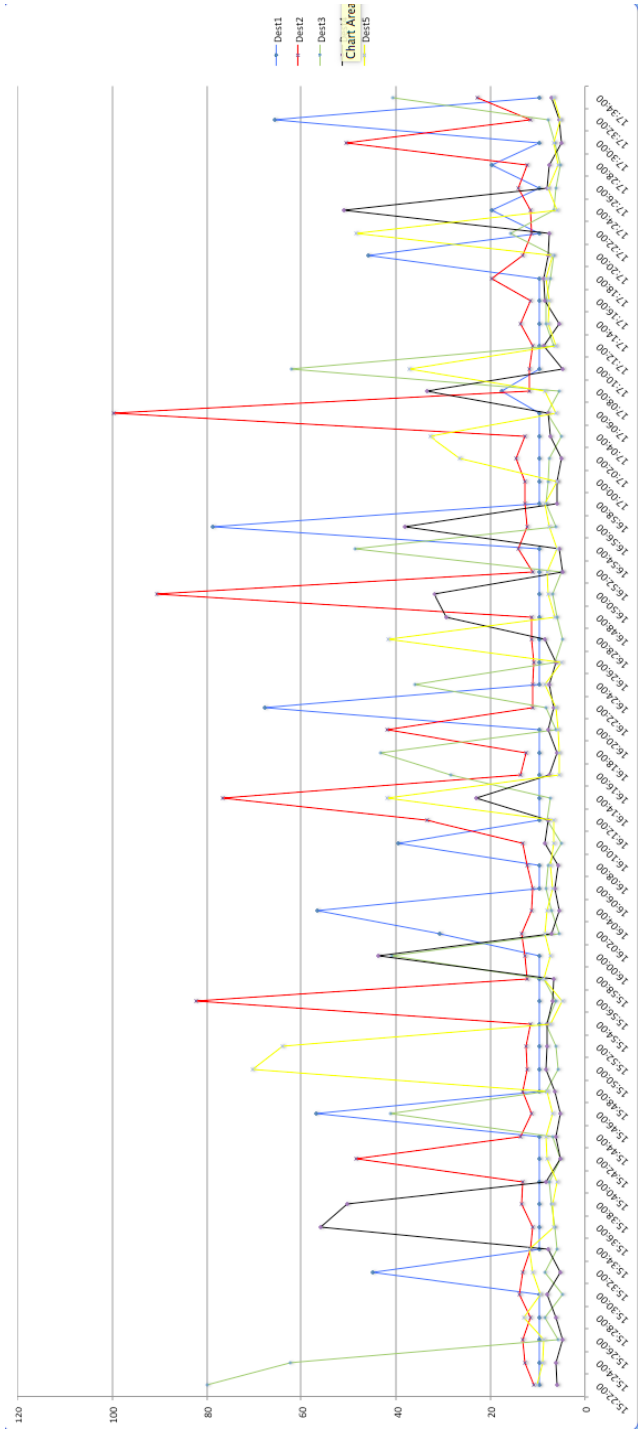
Powai area was divided in 10 Noise measurements points, which are identified as important for the eco-system in this subrb, as shown below:

- IIT Mumbai Sqaure
- Powai Plaza Sqaure
- Hiranandani Hospital Sqaure
- My House
- Hiranandani Garden Square
- Interface to Kailash Complex
- D- Mart Square
- Lake Exit
- Hiranandani School
- Market

Noise measurement System was deployed at these points and data was collected to plot the Noise map of the area. This helped in identifying areas where local systems and authorities need to focus more and analyze sources of Noise of pollution and take appropriate measures and action.

3. RESULTS

Based on the data collection and analysis, chart was plotted as below for 5 points where Noise levels were higher. Chart below indicates Noise levels during peak hours.



Also Heat-map was prepared for the area of higher noise levels for peak time.

Time	Dest1	Dest2	Dest3	Dest4	Dest5
15:22:00	9.74	10.81	79.87	5.94	10.22
15:24:00	9.74	12.85	62.43	6.18	8.90
15:26:00	9.74	13.10	5.83	4.71	8.80
15:28:00	9.65	11.54	8.44	6.31	13.02
15:30:00	9.74	13.94	4.77	8.10	9.39
15:32:00	44.94	13.22	8.48	5.19	11.16
15:34:00	9.65	11.50	6.04	7.84	11.78
15:36:00	9.65	11.11	6.49	55.92	6.56
15:38:00	9.74	13.49	7.07	50.38	6.97
15:40:00	9.74	13.11	7.52	8.28	5.96
15:42:00	9.74	48.46	5.30	5.25	8.16
15:44:00	9.74	13.57	6.83	6.24	8.42
15:46:00	56.74	11.44	41.18	5.19	6.81
15:48:00	9.65	13.30	8.25	6.39	8.18
15:50:00	9.74	12.30	5.81	8.23	70.26
15:52:00	9.74	12.59	6.15	8.02	64.10
15:54:00	9.74	11.60	8.38	7.96	7.43
15:56:00	9.74	82.33	6.27	6.98	4.91
15:58:00	9.74	12.17	8.70	6.75	8.69
16:00:00	9.74	12.76	40.95	43.85	7.41
16:02:00	30.74	13.43	5.40	7.21	8.49
16:04:00	56.65	11.26	7.03	5.39	8.12
16:06:00	9.74	11.03	8.22	6.51	6.90
16:08:00	9.74	12.30	7.86	5.64	7.26
16:10:00	39.65	13.31	5.06	8.54	6.71
16:12:00	9.74	33.44	8.11	7.74	6.60
16:14:00	9.74	76.68	7.43	23.08	41.91
16:16:00	9.74	13.73	28.33	7.65	5.61
16:18:00	9.65	12.39	43.30	5.96	5.47
16:20:00	9.74	41.92	6.19	7.85	5.79
16:22:00	67.74	11.21	8.37	6.67	6.22
16:24:00	9.74	11.20	35.99	7.72	8.52
16:26:00	9.74	10.92	6.36	6.26	5.04
16:28:00	9.74	11.38	4.83	8.42	41.59
16:48:00	9.65	11.24	6.05	29.40	6.36
16:50:00	9.74	90.60	6.86	31.83	7.80
16:52:00	9.65	11.12	5.10	4.76	7.99
16:54:00	9.74	14.16	48.65	5.57	5.90
16:56:00	78.74	12.27	6.13	38.22	7.70
16:58:00	9.74	12.79	8.41	5.94	8.62
17:00:00	9.74	12.74	7.92	6.07	5.98
17:02:00	9.74	14.62	7.52	4.93	26.43
17:04:00	9.65	12.75	4.97	7.41	32.80
17:06:00	9.74	99.65	8.12	7.90	6.29
17:08:00	17.74	11.81	5.48	33.39	8.46
17:10:00	9.65	11.87	62.21	4.82	37.13
17:12:00	9.65	11.17	6.75	8.69	6.28
17:14:00	9.74	13.72	8.37	5.49	7.88
17:16:00	9.74	11.63	8.23	8.46	7.66
17:18:00	9.74	19.67	7.33	8.68	8.26
17:20:00	45.74	13.28	6.70	7.95	6.98
17:22:00	9.74	11.37	15.73	7.61	48.47
17:24:00	19.65	11.69	6.59	51.09	5.97
17:26:00	9.74	14.18	6.17	7.96	7.79

4. CONCLUSION

Following were the conclusions drawn:

1. Areas around IIT Square and Powai Plaza Square have more noise levels
2. Time from 3:30 PM to 9 PM have highest noise levels during the day
3. There were almost multiple instances in a day when noise levels were crossing permissible limits. Device was able to send text to designated number

Thus system developed helps in collecting Noise pollution data at the designated area and helps societies to analyse patterns of noise levels at various points and timings of the day. It also helps in automatically raising alert to the authority to keep Noise level violations in check.

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