DOMAIN: Internet of Things

TOPIC: Noise pollution monitoring

PHASE 5: Development Part 3

Abstract:

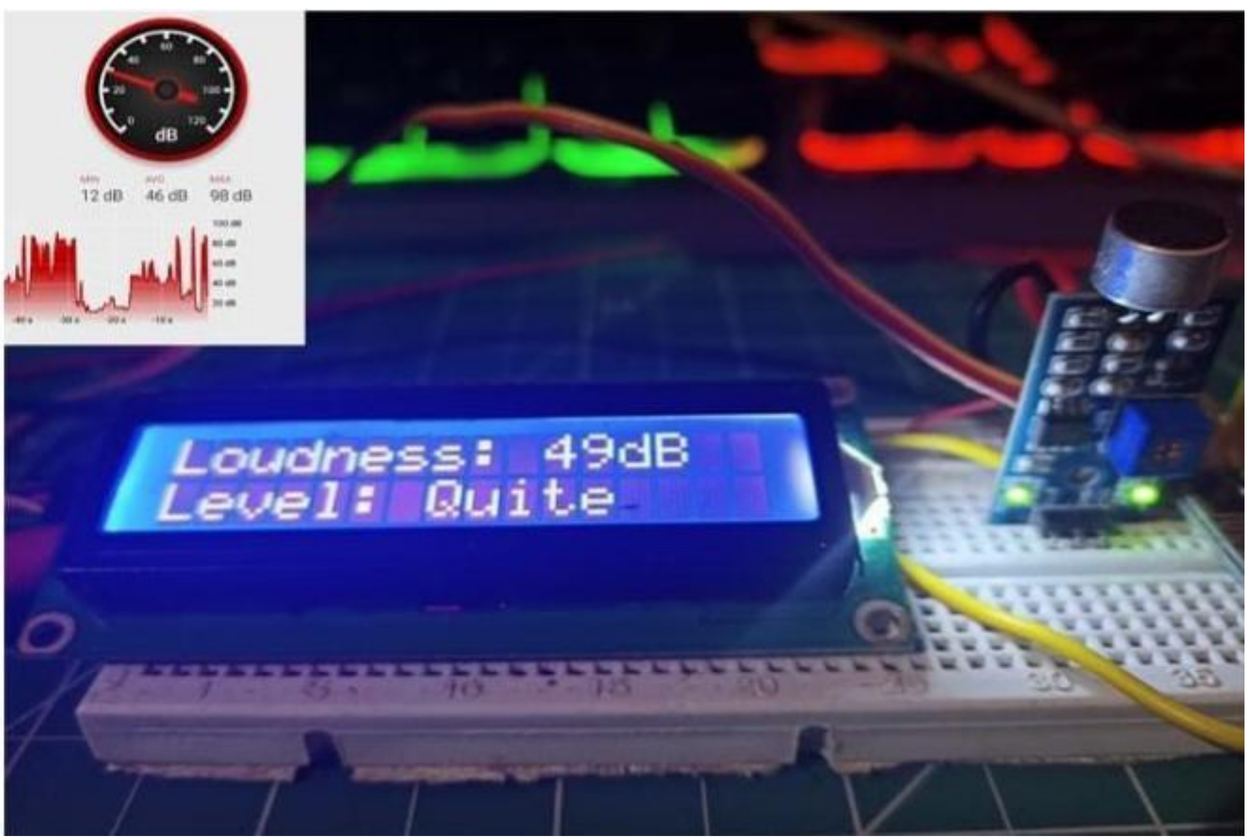
We surely can’t imagine a world without sound. Sound is one of an integral part of our day to day life, everything just becomes monotonous without the presence of audio. But too much of anything is dangerous, with the advent of automobiles, loudspeakers, etc. sound pollution has become a threat in recent days. So, in this project, we will build an IoT decibel meter to measure sound in a particular place and record the value in a graph using IoT. A device like this will be useful in places like hospitals and schools to track and monitor

the sound levels and take action accordingly. Previously we have also built an Air pollution meter to monitor air quality using IoT

Circuit Diagram:

Circuit Diagram for IoT Sound Meter

The connections are pretty simple, we just have to connect the sound sensor to one of the Analog pin and the LCD to the I2C ppins



STIPA Measurement:
The SM50 and SM90 Noise level meters are also STIPA meters to measure Sound Transmission Index (STI) as STIPA- which is the industry standard. Equipped with Quick STIPA (~18s per reading) as well as STIPA Pro (~25s per reading), even seasoned STI users will find all the features they were looking for- in a much simpler format in this instrument.

Function Guideline / Application SM30 SM50 SM90

Modules / Functions

Sound Pressure Level Meter (SPL / SLM) IEC-61672-1 : 2014, ANSI S1.4, Class 2 / Type 2 Class 2 / Type 2 Class 1 / Type 1

Frequency Weighting Choose frequency method A ,C, Z (A : weighted, C : weighted , Z : Unweighted)

Time Weighting Choose based on time framesFAST , Slow, Impulse

Equivalent continuous (EQ) Computes the time-integrated level over the measurement interval

Sound Exposure level (SEL) Time-integrated value normalized to 1 sec

Peak Value Highest instantaneous value within an interval

Max Hold Lock on highest values measured Maximum level during the measurement interval; Used with Fast, Slow or Impulse time weighting

Measurement Time Set duration of measurement Set Measurement Time or Continuous (for infinite)

LEQ Long-term logging/monitoring (LAEQ) Monitoring of continuous environmental noise / logging of sound levels, e.g. LAeq15min Track equivalent continuous sound pressure level (LEQ) develop over time with simultaneous logging of A/C/Z

Real Time Analyzer (RTA) Frequency Analysis for separate frequency bands Frequency analysis in range 20 Hz to 20 KHz for frequency bands 1/1, 1/3, 1/6 or 1/2 octaves. Two spectral views present- frequency weighting or time weighting

Fast Fourier Transform Analyzer (FFT) Perform spectral analysis with higher frequency resolution Up to 32768 data points, with Zoom In/Out feature, Spectral analysis for identifying exact frequency and level of signal components and study of harmonic structure of sound

L%, Statistical acoustics Acoustic statistics based on threshold expressed as percentile, e.g. L10 to L95 can be measuredSimultaneous measurement and display of six different settings

RTA Logging   Long term monitoring of special characteristics of sounds
    Spectrograms, with averaging window between 1 to 999 seconds of spectrum in 1/1, 1/2, 1/6 or 1/12 octave as well as A, C , Z weighted equivalent continuous levels

Acoustics

Electro-Acoustics & Electric Analysis

Digital Storage Oscilloscope Inspect acoustic signals, in particular periodic signals, in time domain Yes, up to 20kHz

Polarity Check polarity of loudspeakers Yes, Use test signals provided or use with BTB65 Talkbox

AC Volt Meter for Line Level Signals Assess Output level Yes, Measure Vrms, dBU, dBV

Total Harmonic Distortion & Noise (THD+N) Quantify distortion levels in electro-acoustic equipment. Value THD+N is expressed as a percentage (%) or a signal-to-noise ratio (dB)

Fundamental Frequency Estimation
Yes, Measurement in Hz with pitch & offset

Building / Structural Acoustics

Sound Insulation: Evaluate airborne sound transmission loss 4 different frequency dependent measures : D, Dn, DnT, R

Sound Reduction Index; Sound Transm. Class (SRI / STC) For specifying and measuring sound insulation 4 metrics R'w ; Dn,w ; DnT,w ; STC

Room Acoustics

Reverberation Time (RT60) Measure sound energy decay Full Octave and 1/3rd octave measurements are supported. As per ISO-3382, Suggested to be used with BTB65 Talkbox

Noise Curves Choose method based on standard. NR, NC, PNC, NCB, RC, RCII

Speech Intelligibility Test (STI) Measurement

Basic Intelligibility Measurements (Quick STIPA) For Public address systems, quick measurement in 18 secs No Yes

Advanced Intelligibility Measurements (STIPA Pro) For Public address systems, measure in 25 secs No Yes, with capability to enable/disable additive noise

Full STI (IEC-60268-16) Most reliable complete STI measurement in 65 secs No

Yes, 14 Modulation frequencies tested in 7 Octaves

Speech Level Meter No Yes, (CF. 602168-16)

Qualification Band Shown No A (Excellent) to U(Bad)

Acoustic Specifications

Linear Range, Electric Input (dBuV) 21 ~132dB 21 ~132dB 21-132 (expandable to 145 with attenuator)

Measurement Range (dB) , Linear Range with Supplied Microphone, dBA SPL 30 ~122dB 30 ~122dB 25-130 (expandable to 145 with attenuator)

Frequency Range (Hz) Covers entire range heard by human ear 20 ~20.000

Accuracy (dB) 0.5 0.1

Resolution (dB)   0.1

Octave Filter   Class 1 1/1, 1/3, 1/6 and 1/12 octave filters

31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz, 16 kHz

Analysis Rate   93.5 times/sec

Sampling Frequency (kHz)   48

Input

Add Text Annotations to Measurements
Yes

Capability to Record Audio of all Measurements   Yes, in .wav format

Calibration

Automatic Level Calibration Procedure
Yes

Calibrated Recording of Audio on Internal Memory Yes

Real-time Calibrated USB Audio Device Mode Yes

Declaration of Conformity Declaration of conformity provided with individual Calibration certificate

External Calibrator Optionally available

Physical

Display Full-color 3.2” resistive LCD touchscreen display

Microphone Connector XLR 48V

Microphone Provided with Instrument Class 2 electret microphone & preamp (1/4”), 30 mV/Pa sensitivity Class 2 electret microphone & preamp (1/4”), 30 mV/Pa sensitivity Class 1 microphone (1/2” UNC capsule), 50 mV/Pa sensitivity

Data Storage for measurement data and audio (GB) 4 8

Remote Control from PC via USB (either through Serial Commands or Cloning of the Display) Yes

Data Output To PC, files can be saved as .csv for data viewing in spreadsheets ; audio recordings also saved in .csv files

Battery Rechargeable Internal Battery, 2500 mAh

Capability to Connect to External Power Supply For long duration continuous measurement Yes, instrument can connect via USB port to power banks or charger

Internal Real-time Clock and Calendar Yes

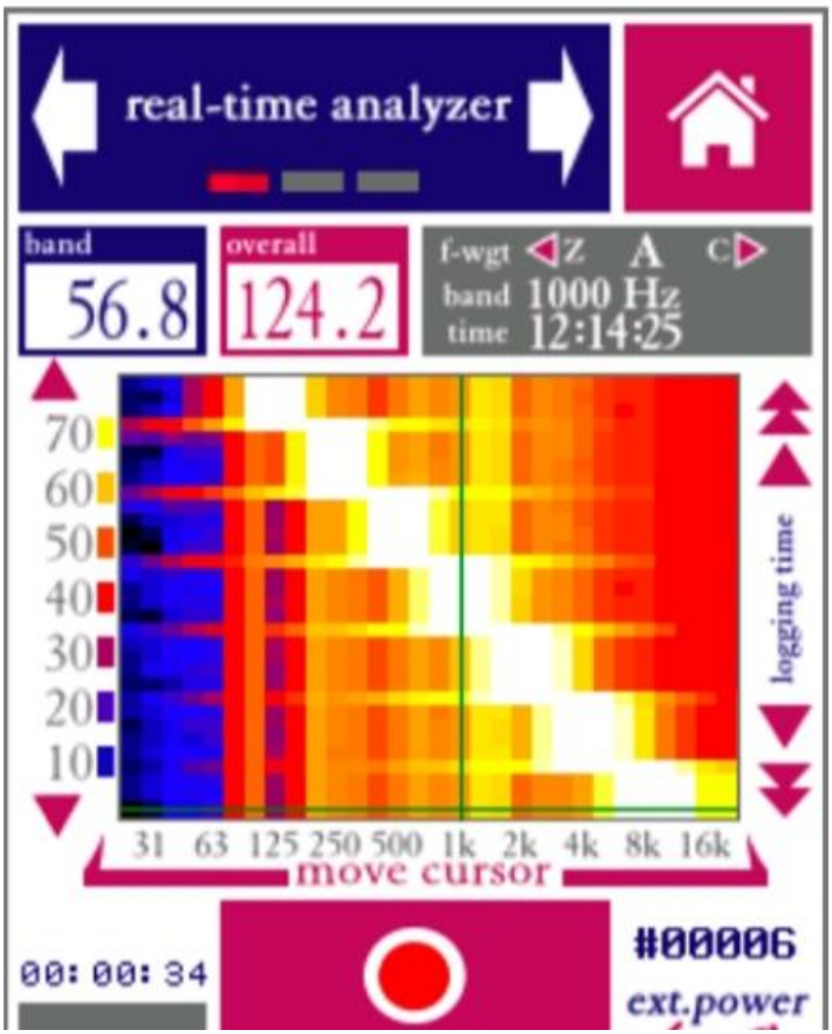
Size/Weight 210 x 85 x 55 mm(excl. microphone); 530 g (including microphone)

Temperature/ Relative Humidity -10 to +55 ºC; 0-95%

Colors Blue and black Grey and black Red and black

Supply will include Microphone (Class1 for SM90 / Class2 for SM50 AND SM30), USB charger, Intl. Charger

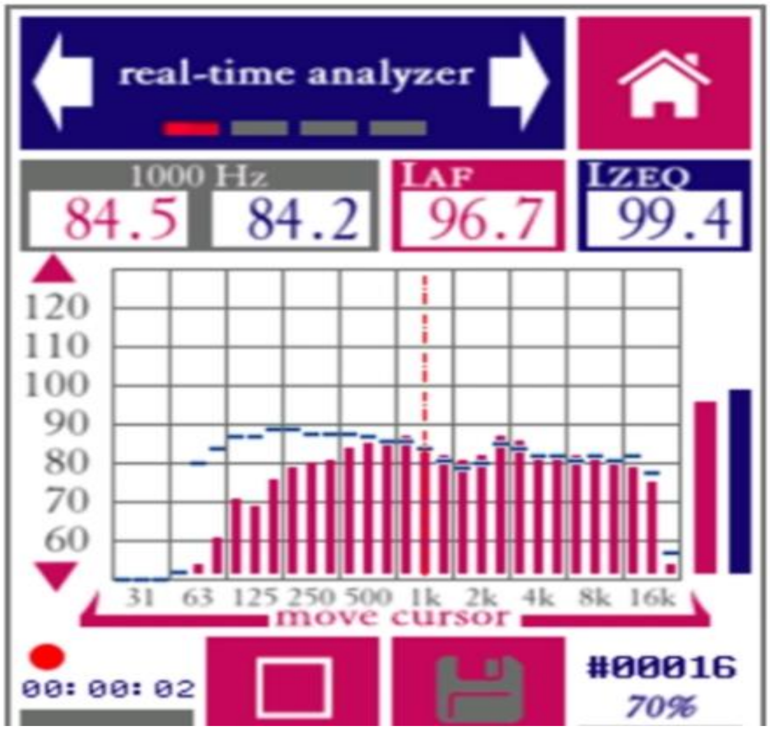
- **RTA Logging** – for long term monitoring c
spectral characteristics (1-999sec)



adapters, measuring instrument, cables, windscreen, manual, carrying cord, flash drive with test signals & software tools in a ruggedized waterpro

- **L%**- for statistical distribution of sound levels in measurement period

- **RTA**- for frequency analysis in range 20Hz-20kHz



Objectives for Noise Pollution Study:

1)Knowing the meaning of environment and pollution.

2.to know meaning of Noisepollution

3)to know how to measure noise.

4)to find the sources of noise pollution.

5.Review the problems that arise due to Noise Pollution

6)To review the harmful effects of noise on health.

7)Review the impact and steps should be do reduce noise pollution.

Public Awareness of the Impacts of Noise Pollution on Human Health

The study investigated the general public awareness of the impacts of noise pollution on human health. The study adopted a survey research design. Questionnaires were used to collect data from adult respondents through emails and their phone numbers. The results were analysed with pie and bar charts indicating the frequencies and percentages. The results of study revealed that negative impacts of noise pollution on health are headache, sleeplessness, psychological disorders, lack of concentration at work and other health impacts such as hearing loss, learning difficulties, stroke, hypertension and reduced quality of life. The study also indicated that the majority of the respondents are knowledgeable about the health effects of noise pollution. The study concludes that noise pollution adversely impact human health. The study recommends aggressive public enlightenment on the danger of noise pollution on human health and the strict implementation and enforcement of noise pollution abatement and control laws.

Code

```
#define BLYNK_PRINT Serial

#include <ESP8266WiFi.h>

#include <BlynkSimpleEsp8266.h>
```

```
#include <LiquidCrystal_I2C.h>
#define SENSOR_PIN A0
LiquidCrystal_I2C lcd(0x3F, 2, 1, 0, 4, 5, 6,
7, 3, POSITIVE);
const int sampleWindow = 50;
unsigned int sample;
int db;
char auth[] =
"IEu1xT825VDt6hNfrcFgdJ6InJ1QUfsA";
char ssid[] = "realme 6";
char pass[] = "evil@zeb";
BLYNK_READ(V0)
{
  Blynk.virtualWrite(V0, db);
}
void setup() {
```

```
  pinMode (SENSOR_PIN, INPUT);
  lcd.begin(16, 2);
  lcd.backlight();
  lcd.clear();
  Blynk.begin(auth, ssid, pass);
}
void loop() {
  Blynk.run();
  unsigned long startMillis = millis();  // Start
of sample window
  float peakToPeak = 0;  // peak-to-peak
level
  unsigned int signalMax = 0;  //minimum
value
  unsigned int signalMin = 1024;
//maximum value
  // collect data for 50 mS
```

```
  while (millis() - startMillis <
sampleWindow)
  {
    sample = analogRead(SENSOR_PIN);
//get reading from microphone
    if (sample < 1024)  // toss out spurious
readings
    {
      if (sample > signalMax)
      {
        signalMax = sample;  // save just the
max levels
      }
      else if (sample < signalMin)
      {
        signalMin = sample;  // save just the
min levels
```

```
      }
    }
  }
  peakToPeak = signalMax - signalMin;  //
max - min = peak-peak amplitude
  Serial.println(peakToPeak);
  db = map(peakToPeak, 20, 900, 49.5, 90);
//calibrate for deciBels
  lcd.setCursor(0, 0);
  lcd.print("Loudness: ");
  lcd.print(db);
  lcd.print("dB");
  if (db <= 50)
  {
    lcd.setCursor(0, 1);
    lcd.print("Level: Quite");
```

```
  }
  else if (db > 50 && db < 75)
  {
    lcd.setCursor(0, 1);
    lcd.print("Level: Moderate");
  }
  else if (db >= 75)
  {
    lcd.setCursor(0, 1);
    lcd.print("Level: High");
  }
  delay(600);
  lcd.clear();
}
```

The following shows some mitigating measures for some types of environmental noise.

Land Use Planning

Alternative Siting/Alignment

Screening by Noise Tolerant Buildings

Building Disposition

Decking Over

Podium

Noise Barrier/Enclosure

Architectural Features/Balcony

Building Orientation and Innovative Layout

Open-Textured Road Surfacing

Acoustic Insulation of Receiver.