International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 11 Issue 12, December-2022, Impact Factor: 7.957

Design and implementation of IOT based device noise level detector using Arduino Uno

Asima Adak[1], Dr. Soumya Mukherjee[2]

[1]Department of Electronics and Communication Engineering, Heritage Institute of Technology, Kolkata, West Bengal, 700107, India,
[2] Department of Metallurgical Engineering, Kazi Nazrul University, West Bengal, 713340, India

*Corresponding author: smmukherjee4a@gmail.com

ABSTRACT

Noise pollution is an important factor of high population density. A normal human ear could hear sound levels from 0dB to 140dB in which sound levels from 120dB to 140dB are considered to be noise. To measure sound in decibel scale it is not economical to purchase expensive microphones but alternatively we can fabricate a device linked to Arduino based microcontroller which have the capability to measure the sound level in a small classroom or living room. Electrets condenser microphone is coupled with Arduino microcontroller to function as a sound measuring device, coupled with amplifier circuit for amplification of audio signal. Regression method is carried for sound measuring along with Blynk application for correction of measurement to improve precision.

Keywords: ***arduino IDE; blynk; electret condenser; microphone; arduino; noise pollution***

INTRODUCTION

Security is the most important area of any civilization. When technology is mixed up with our daily life and makes our life easier, a need arises to involve technology for security purposes. In this digital era, everything tends to electronics especially digital. From noise pollution by industrial activities it is concluded that on several occasions it exceeds 85dB(A) as measured by comparing noise level from different mill industry [1]. It is observed that the noise level of the traffic noise pollution lies in between 60.1 dB(A) and 110.2 dB(A) respectively in a semi urban town. Motor vehicles is the main source of noise pollution in the town which lies in the range from 121 to 91.2 dB(A) [2]. It has been observed that noise pollution created by vehicle at most of the city junction point exceeds 65dB(A) [3]. As we know that noise is a random variable so calculating the noise level of traffic intersection is found to depend on factors like speed of vehicles, volume of traffic and road conditions and generally it is measured up to 65dB(A) [4]. Sometimes researchers used a model which is used to optimize road traffic known as road traffic model (RTM) which gives good results and to measure the strength of the noise level according to Indian condition [4]. As we know that the permissible limit of noise pressure level of educational and research institutes is from 30 dB to 75 dB but if we survey from different city then we will get noise pressure level ranging from 50.70 dB to 82.54 dB [5]. Microcontroller Atmega 16 using a microphone is used as sound catcher sensor to detect noise level 55dB where the range is 56-75dB [6]. We can measure the intensity of sound based microcontroller using sound level meter [7]. Sometimes for high power user some device is designed which is environmental noise based on IoT sensor nodes though it is costly and limited usability[8]**.** A small scale and IOT based noise level distributed sound sensing system is visualized for noise pollution which has the advantage of reduced cost [9]. In our real life, the idea of internet of things is established by the communication of sensors and electronic devices capable of offering low price monitoring at the site of a growing infrastructure, allowing tasks to be performed with a reduced cost. According to some industry comparative analysis it has been seen that in 2015 there were between 10 and 20 billion monitoring units or objects connected to the Internet and it is generally estimated that this number would be projected to 40-50 billion in 2020[10]. Microcontroller ATMEGA328 is mounted on arduino-uno board to measure the fluctuations in noise levels with high sensitivity microphone sensor module[11]. In order to achieve re-usability and heterogeneity, VITAL-OS2, an open-source IoT platform for Smart Cities has been performed [12]. A microcontroller is synthesized by ATmega 328 arranged in a board model Stalker v.3 from Seeedstudio [13]. A Wi-Fi transmitter model ESP8266 from Espressif Systems Inc[14], a wireless sensing unit (WSU) is designed that has the same functionality as a handheld sound level meter[15]. For the comparison view, the conventional noise mapping procedures is costly and time-consuming while measurement occurs with a traditional high-priced noise

level meter, while the low-cost wireless sensor networks provide a method for achieving data collection and analysis with a higher level of granularity. A wireless noise sensor unit is designed for continuous environmental noise level monitoring used as a framework for the realization of the internet of things (IoT) and "Smart city" concept[16]. A device is designed to analyze the sound resonance phenomenon and also calculate sound velocity in the air and the concept is that the complete noise data can be calculated from sensor structure and data analysis[17]. In the present article an attempt is taken to use the cheaper materials and low precision sensor, single-chip microcomputer (MCU) with WI FI connection ability to develop a dedicated noise level detective device. The best type of microphone for sound level meters is the condenser microphone, which combines precision with stability and reliability. Decibel meter is commonly used in noise pollution studies for the quantification of different kinds of noise, especially for industrial, environmental, mining, and aircraft noise. Decibel meters are commonly used in studies to identify various types of noise pollution, particularly industrial, environmental, mining, and aircraft noise [18].

EXPERIMENTAL METHODOLOGY

Experimental details
Circuit diagram:

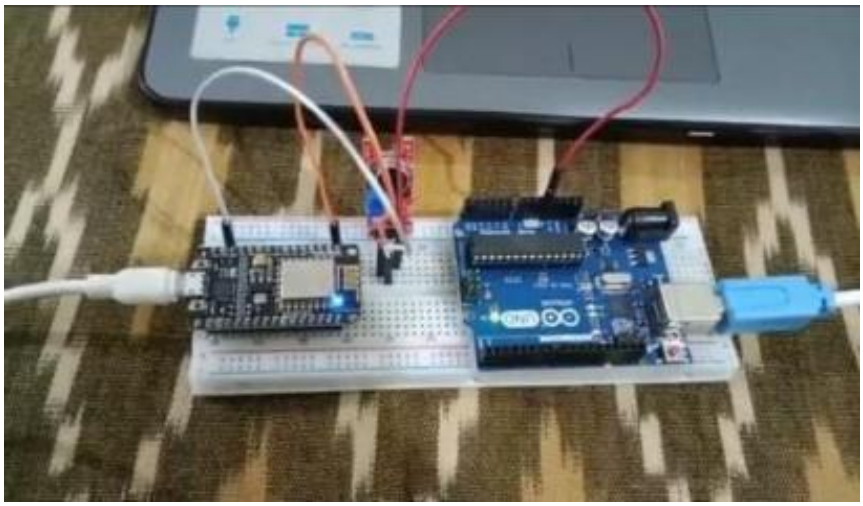
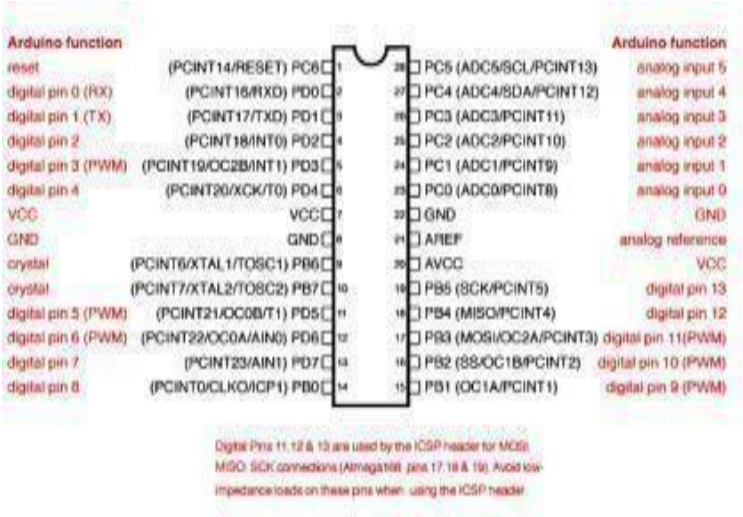


Fig. 1 Noise level detector using arduino and a sound sensor

Description of circuit
Arduino UNO
Arduino Uno is n open source microcontroller board based on the Microchip ATmega328P and developed by Arduino. cc. The board is connected with sets of digital and analog input/output (I/O) pins that can be interfaced to various expansion boards (shields) and other circuits [19]. The board has 14 digital I/O pins (six capable of PVM (output), 6 analog I/O pins, and it is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts



voltages between 7 and 20 volts.

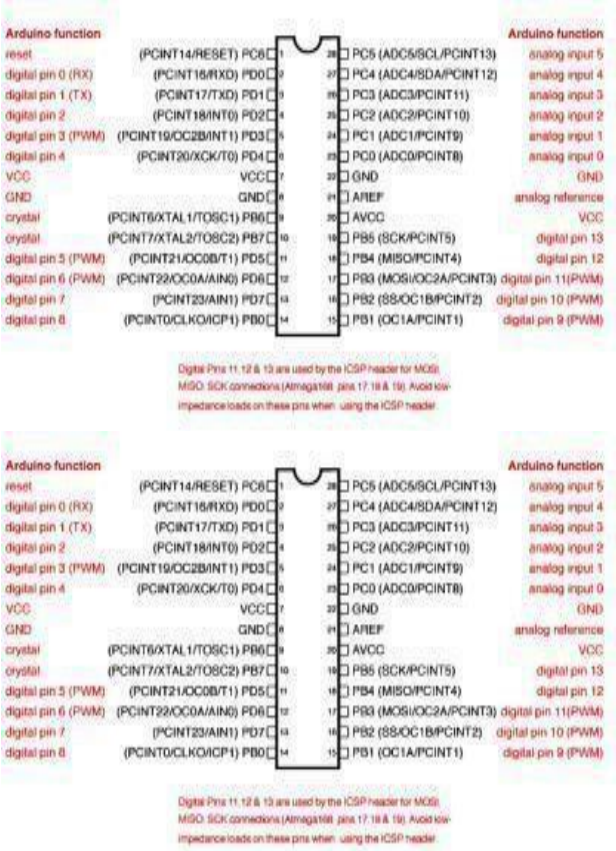


Fig. 2 Arduino uno

Each node device is connected with a loudness/sound sensor, and a NodeMCU (ESP8266) module, all powered by a single 5V DC. Node MCU (ESP8266): This is the node device's brain. It provides as an IOT platform. It's a Wi-Fi module with esp8266 firmware. It uploads processed sensor data from the Arduino to the database. The ESP8266 Open source Community created this board. It operates on the Node MCU operating system, which is based on the LUA scripting language. The processor is an ESP8266 (LX106). It has 128 Kbytes of internal memory and a storage capacity of 4 Mbytes. A sound-level meter is implemented interfacing IOT system based on MQTT protocol [20]. The implemented system has been created by using Raspberry Pi 3, Arduino MEGA, ESP8266 Wi-Fi module and sound pressure level meter. The term Node MCU refers to the firmware used than the development of kit hardware. Node MCU is similar to the ESP8266 ardiuno board. Node MCU has packaged the ESP8266 into a compact board with various features like a microcontroller plus capabilities for Wi-Fi as well as a USB to Serial communication chip [21]. Node MCU 1.0 is used as a microcontroller and as a center for processing incoming and outgoing data simultaneously and used as functions to fulfill the internet network needed to connect Telegram [22].

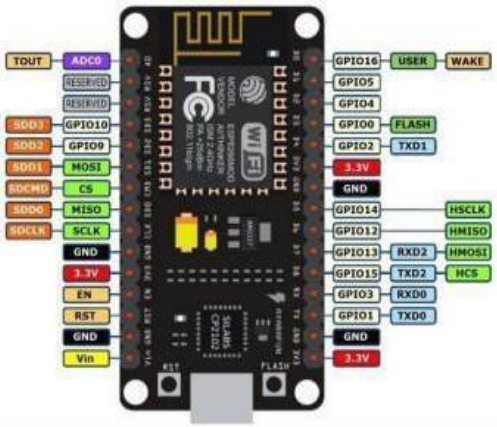


Fig. 3 node MCU

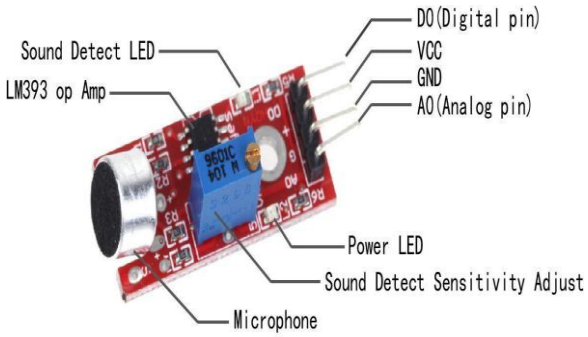


Fig. 4 sound sensor

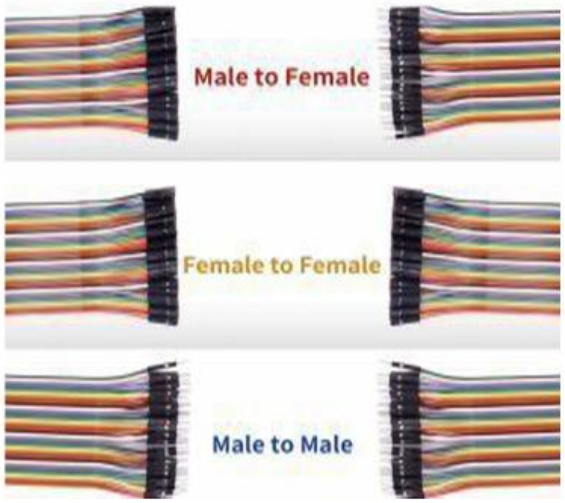


Fig. 5 jumper wires

In Fig. 4 The sound sensor is a small board that is combines with a microphone (50Hz-10kHz) and some processing circuitry to convert sound waves into electrical signals [23] . Analog Sound Sensor is a simple module that functions as a sound detector [24]. The sound sensor can be added to the Arduino project, it can activate the actuator with certain sounds, whether it's the sound of the engine - the factory engine is running, whistling, knocking on the door, and so on. The Audio Analyzer to receive input in the form of sound from outside [25]. This electrical signal is fed to on-board LM393 High Precision Comparator to digitize it and is made available at OUT pin. The module has two LEDs:

○ The Power LED lights up when the module is powered.

○ The Status LED lights up when the digital output goes LOW.

The sound sensor only has three pins:

○ VCC pin supplies power for the sensor & works on 3.3V to 5V.

○ GND is a ground connection.

○ OUT pin outputs HIGH when conditions are quiet and goes LOW when sound is detected.

If the sound reduction index values of each element are known, the values for the combined construction can be calculated [26] from the area-weighted sums of the sound energy transmitted through each separate element. The effective perceived noise level measure (EPNL) is derived from
perceived noise level (PNL) values and is intended [27] to provide a complete rating of an aircraft fly-over .

The intelligibility of speech depends primarily on the speech-to-noise ratio. If the level of the speech sounds are 15 dB or more above the level of the ambient noise, the speech intelligibility at 1 m distance will be close to 100% . This can be most simply rated in terms of the speech-to-noise ratio of the A-weighted speech and noise levels.

● When indoors, speech intelligibility also depends on the acoustical properties of the space [28]. The acoustical properties of spaces have for many years been rated in terms of reverberation times.

In Fig. 5 Jumper wires typically come in three versions:

○ Male-to-male

○ Male-to-female

○ Female-to-female

The difference between each is in the end point of the wire. Male ends have a pin protruding and can plug into things, while female ends do not and are used to plug things into. Male-to-male jumper wires are the most common and what you likely will use most often.

ThingSpeak (Software):
According to its developers, "ThingSpeak is an open-source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP and MQTT protocol over the Internet or via a LAN. It enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates. ThingSpeak was originally launched by ioBridge in 2010 as a service in support of IOT applications.

It has integrated support from the numerical computing software MATLAB from MathWorks, allowing ThingSpeak users to analyze and visualize uploaded data using MATLAB without requiring the purchase of a MATLAB license from Mathworks. ThingSpeak has a close relationship with Mathworks. In fact, all of the ThingSpeak documentation is incorporated into the Mathworks' MATLAB documentation site and even enables registered Mathworks user accounts as valid login credentials on the ThingSpeak website. The terms of service and privacy policy of ThingSpeak.com are between the agreeing user and Mathworks, Inc. It is written in Ruby Language. ThingSpeak is an open-source Ruby software that allows users to communicate with internet-connected devices [29]. It simplifies data access, retrieval, and logging by exposing an API to both devices and social network websites. ThingSpeak was originally launched in 2010 by ioBridge as a service to support IoT applications [30]

Arduino IDE :
The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, mac OS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards. Arduino IDE is a derivative of the Processing IDE.

With the rising popularity of Arduino as a software platform, other vendors started to implement custom open source compilers and tools (cores) that can build and upload sketches to other microcontrollers that are not supported by Arduino's official line of microcontrollers. The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures.

Figure 6 multimeter

A **multimeter** is a measuring instrument that can measure multiple electrical properties. A typical multimeter can measure voltage, resistance, and current, in which case it is also known as a volt-ohm-milliammeter **(VOM)**.

Analog multimeters use a microammeter with a moving pointer to display readings. **Digital multimeters** (**DMM**, **DVOM**) have numeric displays and have made analog multimeters obsolete as they are cheaper, more precise and more physically robust than analog multimeters. Multimeters vary in size, features, and price. They can be portable handheld devices or highly-precise bench instruments.

Blynk (Software)
Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things.

How Blynk Works:
There are three major components in the platform:

❏ **Blynk App** - allows you to create amazing interfaces for your projects using various widgets we provide.

❏ **Blynk Server** - responsible for all the communications between the smartphone and hardware. We can use our Blynk Cloud or run our private Blynk server locally. It's open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.

❏ ❏**Blynk Libraries** - for all the popular hardware platforms - enable communication with the server and process all the incoming and outcoming commands.

RESULTS AND DISCUSSION

Working of the circuit
In this circuit, we have used a sound sensor which has a microphone and an amplifier circuit which is read by a microcontroller. This microphone can detect sound signals from the air medium. It has an IC LM393 which is a comparator IC. The module has a built-in potentiometer for sensitivity adjustment of the OUT signal. We can set a threshold by using a potentiometer. So, when the amplitude of the sound exceeds the threshold value, the module will output 'LOW', otherwise it will be 'HIGH'. Firstly, we need to connect the GND pin of Node MCU to the GND pin of the sound sensor. We have connected the sound sensor to an analog pin (A0) of the Node MCU because the sound sensor is an analog sensor.

Next, we will connect the Vcc pin of the sound sensor with the 5v pin of the Arduino because the Vcc pin supplies power for the sensor and works only between 3.3v to 5v. As soon as we connect the Arduino and the Micro USB port to the source, the Power LED of the sensor will light up. Then we have to upload the code in the Node MCU. As soon as the code starts uploading the On-Board LED D0 pin of Node MCU will start blinking. Lastly, we can see the output on the phone screen and get the graph of the intensity of the sound signal on Thing Speak. Implementation of this device will give a cost effective and well systemized solution for keeping a track on environmental noise at real time monitoring [31].

Testing of the circuit:

The Circuit for Decibel Meter using Sound Sensor & Arduino should be tested like:

● The power supply of the training board is switched ON so the LCD lights up.

● Initially, when everything is silent, number 0 or 1 will be displayed on the LCD indicating 'LOW'.

● If the music player is turned on and the module is brought near the speaker source, a change in number and level shifting from low to medium or high are observed.

● Similarly, turning the volume up or down, the level of sound is checked. When extremely high volume is detected red led will glow, indicating alert.

3.3 Output of the circuit:

The output of serial monitor and Blynk software are given below

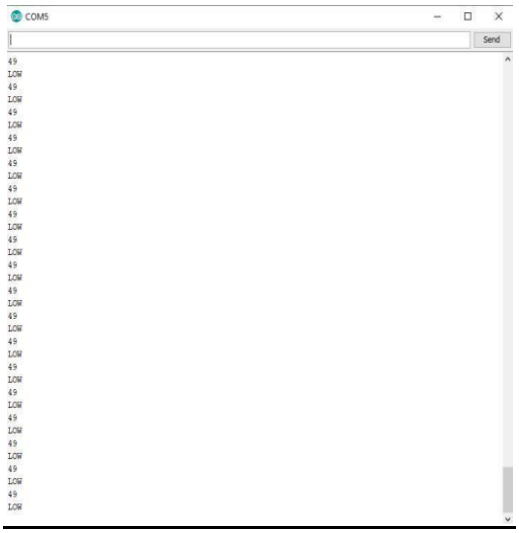


Fig. 7 output in arduino IDE

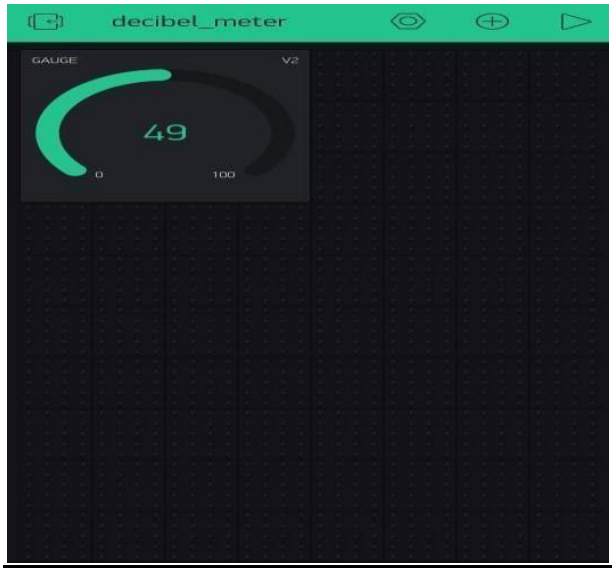


Fig. 8 output in Blynk

CONCLUSION

In this paper, getting the concept regarding noise level detector, which provides noise detecting process. This can be used as our modern electronic security system, doorbells at our homes or offices. The circuit diagram is also similar to a cellphone detector, metal detector etc. As output we receive how gain is produced in amplification and how the reference voltage changes the intensity of output is effected.

ACKNOWLEDGMENT

We would like to thank Department of Electronics and Communication, Heritage Institute of technology and Metallurgical Engineering, Kazi Nazrul University for joined research work.

REFERENCES

[1]. 1.BOATENG AND AMEDOFU (2004) ," INDUSTRIAL NOISE POLLUTION AND ITS EFFECTS ON THE HEARING CAPABILITIES OF WORKERS: A STUDY FROM SAW MILLS, PRINTING PRESSES AND CORN MILLS", AFRICAN JOURNAL OF HEALTH SCIENCES 11(1-2):55-60, FEBRUARY 2004.

[2]. V. Krishna Murthy*, 2 Ahmad Kamruzzaman Majumder, 3 Sanjay Nath Khanal, 4 Deepak Prasad Subedi, "ASSESSMENT OF TRAFFIC NOISE POLLUTION IN BANEPA, A SEMI URBAN TOWN OF NEPAL", KATHMANDU UNIVERSITY JOURNAL OF SCIENCE, ENGINEERING AND TECHNOLOGY VOL.I, No.IV, AUGUST, 2007.
[3]. Ozer et al., "Evaluation and Analysis of Noise Levels in Ilorin Metropolis, Nigeria", February 2009, Environmental Monitoring and Assessment 160(1-4):563-77.
[4]. Tripathi, M. K.; Chaudhary, B.; Sarkar, S. K.; Singh, S. R.; Bhandari, H. R.; Mahapatra, B. S., 2013. Performance of sunnhemp (*Crotalaria juncea* L.) as a summer season (pre-monsoon) crop for fibre. J. Agric. Sci., 5 (3): 236-242
[5]. Dev Pramendra, Singh Vartika, *"Environmental Noise Pollution Monitoring And Impacts On Human Health In Dehradun City, Uttarakhand, India", IISTE, vol 1, No 1, (2011).*
[6]. Kharis, (2013), Rancang Bangun Sistem Deteksi Kebisingan sebagai Media Kontrol Kenyamanan Ruangan Perpustakaan, Skripsi, Fakultas Sains dan Teknologi, Fisika, Universitas Islam Negeri Sunan Kalijaga, Yogyakarta
[7]. Jamaludin, J., Suriyanto, S., Adiansyah, D., & Sucahyo, I., (2014), Perancangan dan Implementasi Sound Level Meter (SLM) dalam Skala laboratorium sebagai Alat Ukur Intensitas Bunyi, Jurnal Pendidikan Fisika dan Aplikasinya (JPFA), Vol. 4, No. 1 Juni 2014, 42 – 46
[8]. A. Siamwala, Z. Lochhead and W. Abdulla. (2019). Environmental Noise Monitoring Using Distributed IoT Sensor Nodes; 2019 International Conference on Electronics, Information and Communication (ICEIC), 2019, pp. 1-10, DOI: 10.23919/ELINFOCOM.2019.8706473
[9]. Y. Tsao, B. Su, C. Lee and C. Wu. (2017). An implementation of a distributed sound sensing system to visualize the noise pollution; 2017 International Conference on Applied System Innovation (ICASI), 2017, pp. 625-628, DOI: 10.1109/ICASI.2017.7988503
[10]. Rus C., Negru N., Patrascoiu N. Low-cost system to acquire environmental parameters in urban areas in the context of IOT. Journal of Environmental Protection and Ecology, Vol. 20, Issue 3, 2019, p. 1451-1461.
[11]. Shukla K., Barot J. A large-scale spreaded sensing system for road conditions, air and sound effluence. International Journal of Research and Analytical Reviews, Vol. 6, Issue 2, 2019, p. 78-79. [9] Kazmi A.,
[12]. Tragos E., Serrano M. Underpinning IoT for road traffic noise management in smart cities. IEEE International Conference on Pervasive Computing and Communications Workshops, 2018, p. 765-769.
[13]. Sani A. B. B. A., Beauty P. E. Smart framework for environmental pollution monitoring and control system using IoT-based technology. Sensors and Transducers, Vol. 229, 2019, p. 84-93.
[14]. Velásquez P., Vásquez L., Correa C., Rivera D. A low-cost IoT based environmental monitoring system. A citizen approach to pollution awareness. Conference on Electrical, Electronics Engineering, Information and Communication Technologies, 2017.
[15]. Peckens C., Porter C., Rink T. Wireless sensor networks for long-term monitoring of urban noise. Sensors, Vol. 18, Issue 9, 2018, p. 3161.
[16]. Maja Anachkova1 , Simona Domazetovska2 , Zlatko Petreski3 , Viktor Gavriloski4, Design of low-cost wireless noise monitoring sensor unit based on IoT concept, JOURNAL OF VIBROENGINEERING, DOI https://doi.org/10.21595/jve.2021.21709.
[17]. Bambang Heru Iswanto1,a), Oriza Nurwanti1,b), and Esmar Budi, Sound Resonance Practice Device based on Arduino Uno to Improve the Science Process Skills of High School Students, AIP Conference Proceedings 2320, 020058 (2021); https://doi.org/10.1063/5.0037701
[18]. Afziya Waknis, Shubham Yadav, Tejashree Bahikar, Decibel meter using IoT with notice board, International Research Journal of Engineering and Technology (IRJET), Volume: 09 Issue: 04 | Apr 2022.
[19]. Sanjay Sharma , "Communication Systems (Analog and Digital)", June,2010
[20]. Lekić M., Galić J., Matić S. An IOT solution for secured and remote sound level monitoring. IEEE 18th International Symposium INFOTEH-JAHORINA, 2019
[21]. Florentinus Nino., Azahari., Awang Harsa Kridalaksana, Nodemcu Based Prototype Tool for Noise Detection, TEPIAN Vol. 2 No. 2 (June 2021) p-ISSN 2721-5350 e-ISSN 2721-5369, doi.org/10.51967/tepian.v2i2.358.
[22]. Ellison, T. 2018. NodeMCU ESP 12E Datasheet. https://nodemcu.readthedocs.io/en/master/, Accessed 26 April 2018.
[23]. B.P. Lathi, Zhi Ding," Modern Digital and Analog Communication Systems ",2010
[24]. Siregar, AWP 2018. Noise Level Indicator in the Arduino-Based Workshop. Journal Vol: 1 (1) 21
[25]. Dinata, A. 2018. Fun Coding with Micropython. Jakarta: PT. Elex Media Komputindo
[26]. Brüel & Kjær," Environment Noise / Noise Assessment".. Retrieved 24 February 2021
[27]. Laura Anastasi Seseragi Lapono, Redi Kristian Pingak, "Design of Noise Level Monitoring Based On Arduino Uno", Conference: International Conference and Exhibiton on Sciences and Technology (ICEST), Faculty of Science and Engineering, UNDANA, At: Labuan Bajo, East Nusa Tenggara, Indonesia, Volume: 1, 2018
[28]. Velásquez P., Vásquez L., Correa C., Rivera D. A low-cost IoT based environmental monitoring system. A citizen approach to pollution awareness. Conference on Electrical, Electronics Engineering, Information and Communication Technologies, 2017.

[29]. Kalengkongan, T. S, Dringhuzen J. Mamahit, Sherwin RUA Sompie, 2018. Design of Arduino Uno-Based Noise Detection Tool, Journal of Electrical and Computer Engineering Vol: 7 (2) 183-186.
[30]. Ashwini kumar sinha, "Noise Detector with Automatic Recording System Using Arduino With The IoT" , electronicsforu.com, November 4, 2019.
[31]. Abdur Rahim, M., Arafatur Rahman, M., Rahman M.M., et al.: Evolution of IoT-enabled connectivity and applications in automotive industry: a review. Veh. Commun. 100285 (2020). https://doi.org/10.1016/j.vehcom.2020.100285