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The Construction Site Ambient Noise Monitoring System with Internet of Things (IoT)

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OSHA.

Abstract

The noise level of the construction site can be very dangerous as various sounds occur on the construction site. Ambient measurement is a prerequisite for identifying Occupational Safety and Health Administration (OSHA) sound standard limits. Existing systems used to capture and measure sound using the Noise Level Meter tool at the construction site are limited to working hours only. Humans are required to assist devices at construction sites. Measuring noise using only noise level meters is very limited as devices need to be monitored at construction sites. Therefore, improvement is needed to measure ambient noise in construction site areas to address existing system limitations. Ambient Site Ambient Site Monitoring System (IoT) is developed to measure ambient noise throughout the day and provide real-time updates of current sound. Data is collected and stored on cloud servers using the Favoriot platform. Data analysis features are provided in a web-based system that allows users to take further action. If the recorded sound exceeds the specified limit, the system generates a warning notification. Web systems are also developed to retrieve data stored on the cloud server and users can perform analysis and reporting. Improvements to existing processes derived from this study are expected to benefit in monitoring site noise through efficient data collection, storage and analysis.

1. Introduction

Construction site noise level can be very hazardous due to various sound occur at the construction site. Noise level at site may be different depending on types and stage of the progress either indoor or outdoor [1, 2]. All activities at construction site are constantly changing as stage complete. This shows that noise at certain stage are not at constant level; it might be low or high. For example, early stages at the construction site project involves carpenter, cement workers, steelworkers, roofers, bricks workers part. In the subsequent stages, carpenter, ventilation installer, electricians, and plumber begin their work at the same time drywallers, painters, and floor and ceiling do their job. Each of these stages use different type of equipment depend on their work part. This will cause variety kind of noise to occur which is hazardous if over the standard limit of noise allowed [3].

Every equipment used in the construction site produces different type of noise. Each noise produced have maximum noise allowed in OSHA standard limit [4- 8]. This limit is for safety of the workers, for environment, for residential area, and even office area. Noise Level device is used to measure any type of noise generated on a construction site in a decibel unit, dB [9]. Ambient noise produce at construction site can be measure with this device. Noise consultant team will come at the site and use the device to measure the frequency of the noise [10]. Noise consultant team is a team to measure the noise and from the noise level received. The team will give an advice on how to prevent an accident to happen such as hearing loss by suggesting wearing and earplug or noise is too loud for surrounding can be control by adding wall barrier or plastic 10m thickness as absorption materials [11, 12].

Ambient noise at construction site happened every day during working hours. The consultant team might record the noise at its lowest noise produced on the day. The existing system used to capture and measure the sound and noise level at the construction site is limited to working hours only. Moreover, currently, the team should go to the construction site and bring a Noise Level Tool to measure noise and capture ambient noise. Consultants' teams should stay in the site of the construction site throughout the day and wait for

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data recorded by the device. Once the data is collected, the decision-making process can be made like, determine the level of noise or identify the level of noisy noise for further action. Such processes take longer, since decision makers should wait for data to be collected from the device and transferred to another software for data analysis. This results in inefficiencies in data processing and delayed the decision-making process [14- 18].

Thus, an improvement to the existing process is needed to measure the ambient noise at construction site to address the limitations in existing system. The Construction Site Ambient Noise Monitoring System with Internet of Things (IoT) is developed to measure the ambient noise the whole day and give real-time update of current noise. The device will be placed at the construction area to gather the data of the noise occur. Data is accumulated and stored in the cloud server. The current low and maximum dB of noise at the construction will be displayed in the respective website. This data can be accessed through Internet. Consultant team only need to implement this device at the construction site and monitor from the office. If there is more than one construction site, the team can monitor all construction site easily. If any of the device detect exceed noise allowed or the noise occur outside working hours, an alarmed alert will be activated. In recent years, intelligent methods have been widely applied in many industrial fileds and excellent results have been obtained [19- 24].

The rest of the paper is organized as follows: Section II describes the related work on Noise at construction site and Internet of Things. Section III presents the system design. Section IV the implementation and Section VI concludes the work.

2. Related Work

The ambient noise at the construction site is one of the factors contributing to noise pollution. Large construction areas will result in higher noise pollution. This sound reveals the dangers to the health of workers and residents in the surrounding area [13]. Excessive amount of noise or an unpleasant sound can cause hypertension, high stress levels, tinnitus, hearing loss, sleep disturbances, and other harmful effects [14]. For in-stance, loss hearing or deaf is one for major problem that caused by noise pollution. Without correct device to protect ears from the noise it is dangerous. Noise can be described in term as intensity perceived as loudness and frequency perceived as pitch. Expose to both of this for eight-hour period can lead to permanent hearing loss with exposures to 85 dB(A) or higher [15- 17]. Workers need to be trained to use the Hearing Protection Device (HPD) while working at the construction site to reduce the noise received by ears. Although construction site can't avoid such noise which causes by various machine and site instrument, procedural action can be made to secure the security of the worker and people at surroundings.

Noise produced in many ways by natural surrounding or even by human. In construction site a worker uses many types of equipment to build the building, from equipment will produce noise to surrounding. The noise is one of factor that provide noise pollution especially to residential area. Every construction site needs a consultant team to do observation and monitor the noise and manage the construction site noise to suggest the best way to reduce it accordingly. Currently, the ambient noise data is collected and measured manually in the site by using Noise Level Meter. The permissible OSHA standard limit is mention in OSHA Region III.

The internet of things is a physical device that connected with internet. using cloud server to exchange the collected data using internet. an information framework use to create a smart city to enhance the technology with high-level intelligence. as the internet of thing emerging with technology, using internet and cloud storing system also requires high-level securities protocol to ensure the safety of the data. IoT architecture contain three layers for a basis architecture for an IOT. The layer consists perception layer, network layer, and an application layer. IoT in new modern technology can improve business or customer engagement. Furthermore, IoT provide real-world information to support effective management of resource. This facility allows real-time monitoring with huge size of data and efficient data transaction.

3. System Design

Design of the developed system is created based on the requirement specification gathered. The requirements are analyzed and modeled to get clearer view of the correct system to be developed. The requirements are modeled using structured approach. This system consists two user such as administrator and site developer. Both users have same view for the dashboard. As administrator need to register and login into the system to view, add, delete or update the construction site name, noise data and location. Site developer need to register and login into the website. Once login, the user can view, make document report, and act from the result at the construction site.

The associated device for this project requires some configuration to activate the device and display the operating system for the Raspberry Pi 3 B+ model. The device requires minimum 8gb memory with New Out Of Box Software, NOOBS. NOOBS is the pre-installed operating system OS for the Raspbian. The installation of the OS will automatically be initiated once the power supply and screen display have been set up. To set up the power supply only require any micro USB b type wire connected with the device.

There are two ways to display the OS of the Raspbian; monitor and remote desktop. The monitor will display the raspberry pi OS. Raspberry Pi 3 B+ have built-in High-Definition Multimedia Interface (HDMI) output is used to display the system. HDMI cable enables the device to connect with any monitor with HDMI.

The remote desktop will allow connection between two computers to be controlled by one another. There is a few software that can be used for remote desktop with raspberry pi. For example, window remote desktop and tightvnc. To enable access for remote desktop, it requires PuTTY software which is free software that can be download at the putty website. PuTTY require an IP address from raspberry pi as a basic configuration for the remote desktop process to activate the device remote desktop.

Sound Level Meter sensor is then connected with the raspberry pi using the USB port. The sensor automatically power up once the USB cable connected. Figure 8 shows the

Raspbian Operating System user interface. Raspbian OS can run python file to execute the code for sending and receiving the ambient noise to the cloud server. The process of sending and receiving the data uses terminal in Raspbian OS or in command prompt interface. Figure 1 shows the device and sensor connected and activate to start receiving the ambient noise.

Figure 1. Device and sensor [18]

Ambient noise occur can now be collected using the sensor, collected noise or data in the database will be sent to device raspberry pi, and the device will pass the data through the internet to be saved at cloud server Favoriot Platform. Python programming language is used for coding. A python file to start first as in terminal or command prompt is required to initiate the collecting process.

The data received from the sensor is transferred through the raspberry pi. The raspberry pi calculates the noise in decibels unit and then the data is kept in the cloud server through Favoriot Platform. HeidiSQL as localhost MySQL database provides the connection between website and database. Data from the cloud server (Favoriot) will be transferred and stored in the localhost database for analysis purposes and displayed through the website.

4. The System

The main page of the system displays a piece of summary information about the collected noise data as shown in Figure 2. The information is displayed in a few forms include a graph, table, and notification alert for the noise monitoring process. Figure 3 presents an analysis page process which uses the line graph to demonstrates the information of current noise and compare it with permissible noise from OSHA standard limit allowed for a construction site. The noise data which is collected by using the noise sensor is used to generate the graph. Next, data history can be search in device interface shown in Figure 4. It is used to record and saves the data log for ambient noise which is collected from specific location or devices. The recorded data is presented in the table format. The information can be filtered by based on the start date and end date, or specific date. While, Figure 5 is used to generate report module produces a noise log data report based on the selected date. The report contains the log data and is accompanied by a graph.

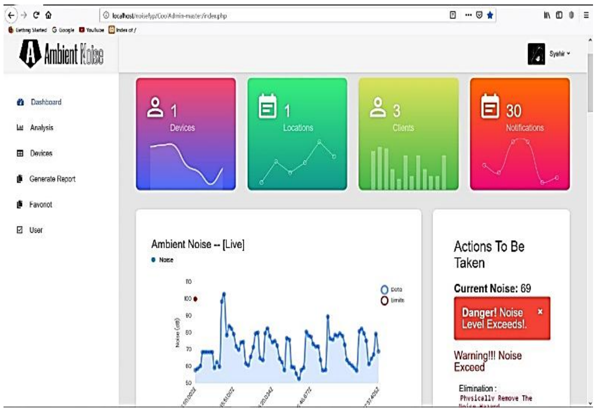

Figure 2. Main page and Information Summary

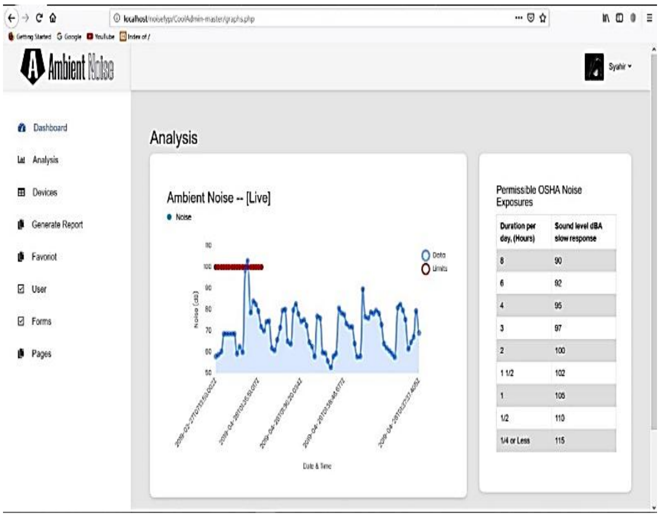

Figure 3. The Noise Data Graph Analysis Interface

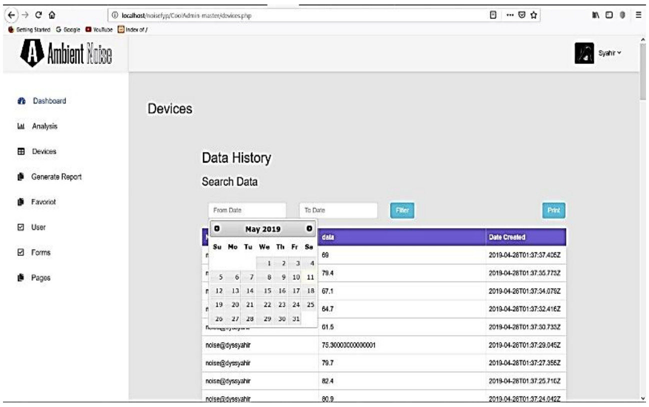

Figure 4. Data Log Management Interface

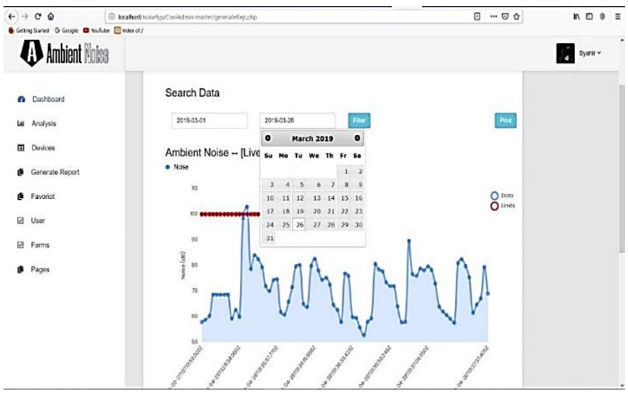

Figure 5. Data Report Page

Functional testing is conducted for each part of the project includes hardware and software testing. Device Raspberry Pi 3 B+, Sound Level Meter sensor, Favoriot connection for cloud server, SQL database, and website interfaces are tested.

8. Conclusions

At the end of the project it is expected that a monitoring system will be developed using Raspberry pi system and Favoriot platform. The Favoriot is used to collect all recorded noise data when the device is switched on and transfer it over a cloud server using an internet connection. If the recorded noise exceeds the prescribed limit, the system will generate a warning notification. From the Favoriot platform, the data will be transferred to the cloud server. Web systems are also developed to display data stored on cloud servers. data display is in the form of tables, diagrams and reports relevant to the user's use of the. The system is expected to work well as it has been set, easy to use and understandable to be handled by any user and can get the latest data to be documented.

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