Smart Air Quality Monitoring System Using Arduino Mega

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Abstract. Traditionally, pollution measurements are performed using expensive equipment at fixed locations or dedicated mobile equipment laboratories. The automatic air quality monitoring system using Arduino can save cost and easy to access. The project that we have undertaken has helped us gain a better perspective on various aspects related to our course of study as well as practical knowledge of electronic equipment and communication. Moreover, the project of air quality monitoring system has achieved to monitor and prevent the effect of high temperature and dusty air to the child and human just like the objective of the project needed. The project can detect the temperature and dust density and besides that it will send alert to the user when detecting the air quality is unhealthy. Furthermore, a project is design and develop air quality monitoring system using Arduino Mega which is to enhance safety affect such that even the minor eye irritation can make the user to lose his concentration and lead to serious accidents. Where the dust sensor and temperature able to detect hazy day that triggers buzzer to alert user to decrease the outdoor activities. Air quality is monitor for whole day at Ulu Pauh Putra by using this device and the data is recorded and make into a graph. The average dust density is 78.22ug/m3 and the range of dust density levels are about 68.07ug/m3 to 84.87ug/m3. By comparing the result to API reading show that air quality is moderate pollution that does not pose any bad effect on health. The testing of project was done for whole day is to verify the accuracy of the data. Moreover, it can help to avoid errors occur in the project. Focusing on the device produced, it detects high temperature and sense the dusty air immediately. Once the sensitivity is high, the buzzer module will active to alert user.

1. Introduction
Air is the most useful thing for every living thing. Regarding on this serious issue, this project was to estimate the quality of air for people and any other living thing which exist on earth. A very important to know for our living is how much safe we are now and how the weather and climate have changed for air pollution and it will sustain sound. This system will ease to know the answers for air quality [1].

This project able to monitor the air quality in terms of dust particle and surrounding temperature with a dust sensor and temperature sensor. The data show via liquid crystal display (LCD). Due to the high value of air pollution index can give high risk to human. This system is operated when the sensor has detected the level of dust particle in the air is greater or unhealthy to human, passive buzzer will active to alert humans. Furthermore, the device will be set up to take the environmental data and there will be a base standard value. The device will collect data and based on the set values it will show the output. This project is carrying out the automatic air quality monitoring system by using Arduino in everyday life on the health care in all range of ages. Literature reviews are a basis for research in
nearly every academic field [4]. As to develop the idea, the study of existing design is useful as a source of ideas and information about the air quality and air quality monitoring system that available in the market.

1.1. Problem Statement
According to WHO report, in each year 2.4 million people lose their life because of breathing disorders that originate from air pollution [1-2]. Polluted air might affect human heart, lung, eye, nose, throat and skin, leading to disorders such as breathing trouble, lung cancer, bronchitis and pneumonia. There are number of reasons for air pollution. There is another survey show that air pollution 50,000 to 100,000 premature deaths per year occur in the U.S. alone whereas in EU number reaches to 300,000 and over 3,000,000 worldwide [2]. The outpatient morbidity cases in health clinics increased with the rising occurrence of smoke haze in Johor Bahru. The average annual economic losses due to the outpatient health impact of haze were valued at RM83,233 and RM107,486 for Pasir Gudang and Larkin, respectively [3]. This is because there is no suitable device that can let people easily aware the quality of air. This result that health of the people was strongly affected.

1.2. Example of Existing Design
Malaysia is facing with the three main environmental issues in Malaysia - water pollution, air pollution, and industrial waste. Out of all the forms of pollutions, air pollution occupies the most prominent place in affecting the health condition of people as the pollutants can disperse through air to larger areas and remote locations rapidly. Primary air pollutants are the direct results of a natural or human induced activity, on the other hand, secondary pollutants are created by the interaction between the primary pollutants. Sulphur-dioxide emitted from through the burning of fossil fuels in factories or by vehicles is a primary pollution whereas smog caused by the interaction of several primary pollutants is an example for a secondary pollutant [4].

The major outdoor pollution sources include vehicles, power generation, building heating systems, agriculture/waste incineration and industry. In addition, more than 3 billion people worldwide rely on polluting technologies and fuels (including biomass, coal and kerosene) for household cooking, heating and lighting, releasing smoke into the home and leaching pollutants outdoors [5].

In New Zealand, poor air quality is estimated to cause 1175 premature deaths and cost over $4 billion each year. Poor air quality can damage both our cardiovascular and respiratory systems. Different types of pollutants have different effects on our health. So far, most research into air quality has focused on the outdoors, but we spend about 80% of our time indoors, so it is important that we gain a better understanding of the pollutants to which people are exposed indoors. Also, recent research indicates that exposure to pollutants can be much higher indoors than outdoors [6].

Air Pollution Index or API usually used by Malaysian country and the function is to describe and record the air quality or in Malay as IPU (Indeks Pencemaran Udara), which is calculated from several sets of air pollution data. API system includes 6 major air pollutants which could cause potential harm to human health should they reach unhealthy levels. Palangkaraya in Indonesia was recorded as the highest API value ever which is 1,986 on 22 September 2015 during the 2015 Southeast Asian haze phenomenon [5].

The current pollution measurement methodology uses expensive equipment at fixed locations or dedicated mobile equipment [7, 14, 18]. People need to know the extent to which their activities affect air quality. In addition, industrial air pollution monitoring system for safety and health enhancement was introduced to know the hazardous gasses and their impact [8,16,17]. This project proposes an air pollution monitoring system. The system was developed using the Arduino. The air pollution monitoring system was designed to monitor and analyze air quality in real-time and log data to a remote server, keeping the data updated over the internet. The air quality measurements taken by the designed system was accurate. Air pollution index (API) is basically a scale to gauge the severity or how polluted the air is. The greater number of the API represents the more dangerous the air quality to human health.
1.3. Summary of Existing Design

The product has been studied and analysed with the product creator and as the product creator to enhance the existing product. The idea has been adopted to make a product more sophisticated and more comfortable for consumers.

The concept of temperature control consists of two concepts: cooling / heat thermoelectric and Arduino Uno. Both concepts are very important in the success of cold / hot water products. Thus, the thermal conductor of the peltier plays a role in cooling and heating the water so that the target temperature is reached. Arduino Uno also acts as a programming medium for product control systems.

2. Methodology

2.1. Concept of Idea Generation

The evaluation to choose the appropriate idea to meet the design objectives must be taken. The most important aspect of assessment is to determine the evaluation criteria and assessment methods [9-13, 15,19,20]. The evaluation methods used for this project is Pugh chart. Pugh chart are methods which list the numbers of pros and cons of each concept generated [21-24]. Disadvantages and advantages can be reviewed and used to improve existing concepts or create new concepts better. This can be done by knowing the characteristics of an idea in mind.

2.2. Project Design

This project contributes in the direction of monitoring the quality of air. The system proposed here is air quality monitoring system in the Arduino Mega that measures the surrounding temperature, dust particles and presence of suspended items in the air using sensors. These sensed parameters are show to the authorized person via LCD module and follow with the sound of buzzer so that proper action can be taken by the people in outdoor activities to reduce the possible health problem that could occur. When the user switches off the buzzer by pressing button, yellow light emitting diode will light up. The diagram describing the proposed system and its interconnection along with the stages involved is as described below in Figure 1.

![Figure 1. Project Schematic Design](image)

Technical drawing is the act and discipline of composing drawings that visually communicate how something functions or is constructed. Technical drawing is essential for communicating ideas in industry and engineering. This project is drawing in two dimensions (“2D”) and three
dimensions ("3D"). With this drawing, the product can understand easily because use familiar symbols, dimensions and page layout. Technical drawing of casing in three dimensions is to make sure the idea is correct, and the location of component is place in the right position shown in Figure 2.

![Project Sketching with component position](image)

**Figure 2.** Project Sketching with component position

### 3. Results and Discussions

A result is the final consequence of a sequence of actions or events expressed qualitatively. As what have known by people, the average temperature is 28 °C in Malaysia while the normal temperature for the human body is 37°C. The project is testing for whole day of 6 September 2019 to get the best result of quality function. For this project, an experiment is carried out for a whole day at Ulu Pauh Putra where the data of temperature and dust density are recorded in every minute to get the analysis result. The data are recorded based on the time taken. After that, the average temperature and dust density will be calculated in this chapter. The range of dust density and temperature levels will also know. The result will compare to API reading to know about the air quality.

In the result, testing must be done to make sure that the project is function properly. To start testing the project, the sketch needs to compile and debug for error. After the verifying process is done, the sketch is uploaded to the Arduino Mega through USB cable. Figure 3 shows the sketch is being uploaded to the Arduino mega. As the sketch is uploaded, the sensor will start functioning and collect the data. The data of temperature and dust density will show in serial monitor. Once the value of temperature and dust density is over the healthy levels, the passive buzzer module will active.
The values received at the temperature sensor and dust sensor when the system was implemented have been shown the Figure 4.

This graph in Figure 5 represents the data that are collected and recorded. This result is record from 6 September 2019 12am until 12pm at Kolej Kediaman Tuanku Tengku Fauziah, Ulu Pauh Putra.
4. Conclusions
As a conclusion, various tests were being tested and carried out effectively. From the data of result, it shows that the experiment is functioning. The purpose of testing and commissioning is to know whether the product is functioning or not. Besides, the data of temperature and dust density around Perlis can be monitored and recorded. Therefore, the objective of monitoring air quality in the city of Malaysia can be achieved. As the average temperature is 28°C and the range of temperature levels are about 24°C to 33°C. The data are recorded based on time taken. The average dust density is 78.22ug/m³ and the range of dust density levels are about 68.07ug/m³ to 84.87ug/m³. By comparing the result to API reading show that air quality is moderate pollution that does not pose any bad effect on health. The testing of project was done for a whole day to verify the accuracy of the data. Moreover, it can help to avoid errors that occur in the project. Focusing on the device produced, it detects high temperature and sense the dusty air immediately. Once the sensitivity is high, the buzzer module will activate to alert users.

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