Study using internet of things to control radiation level

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Abstract. This Study using Internet of Things to control Radiation Level has been motivated by Trend 4.0 and the nuclear disaster in Fukushima after the unfortunate earthquake and tsunami struck Japan. We want to help radiation protection officer to measure the levels of radiation of the affected zones without compromising the life of the workers. For this reason we have created data from a temperature sensor is collected by an Arduino board and then transmitted to a smartphone via Bluetooth. The results of experiment the stuff can send measurement data to smartphone via Bluetooth at a range of 0-10 meters. By replacing temperature sensor with a Geiger counter kit we can get radiation control device via smartphone.

1. Introduction

This Study using Internet of Things to control Radiation Level has been motivated by the nuclear disaster in Japan after earthquake and tsunami. We want to help radiation protection to measure the levels of radiation without compromising the life of the workers. For this reason we want to create an autonomous battery survey meter which can read the radiation levels automatically and send the information in real time using wireless technologies like Bluetooth.

The idea is simple, designed tool acts as an autonomous and wireless Geiger counter. It measures the number of counts per minute detected by the survey meter and send this value using Bluetooth to Smartphone. With this technology radiation measurements can be known in real time without compromising the life of the radiation workers as they do not have to be inside the security perimeter in order to activate the Geiger counters. The information is extracted automatically and sent wirelessly to Smartphone.

Indonesian Government Regulation of 2007 on Safety and Health of Ionizing Radiation Utilization states that it is necessary to measure radiation exposure of X-ray machine for radiation protection for officers, patients and the public. [2]. At present there are very few devices that can measure the dose of radiation due to the limitation of radiation dose measurement device in health care institutions in Indonesia. Limitation of radiation dose measurement device is a quite alarming problem, so it becomes an obstacle in the implementation of radiation workers protection. Objective(s) Study using Internet of Things to control radiation level the result of radiation measurement.
2. Theory

2.1. Radiation
There are three types or radioactive particles, Alpha, Beta and Gamma which are generated in the nuclear plants.[3] Figure 1 shows an overview of three types of ionizing radiation to penetrate solid matter.

![Figure 1. an overview of three types of ionizing radiation to penetrate solid matter. Typical alpha particles (α) are stopped by a sheet of paper, beta particles (β) are stopped by aluminum plates. Gamma radiation (γ) is damped when penetrating lead.](image)

2.2. Internet of Things
The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

2.3. Arduino
Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message and turn it into an output - activating a motor, turning on an LED, publishing something online. Figure 2 shows Arduino Uno board.[4]

![Figure 2. Arduino](image)

2.4. Bluetooth
Bluetooth is a wireless technology standard for exchanging data between fixed and mobile devices over short distances using short-wavelength UHF radio waves in the industrial, scientific and medical radio bands, from 2.400 to 2.485 GHz, and building personal area networks. Figure 3 shows blue tooth card. Bluetooth is one of the most popular wireless communication technologies because of its low power consumption, low cost and a light stack but provides a good range.[5]
2.5. Smartphone
A smartphone is a cellular telephone with an integrated computer and other features not originally associated with telephones, such as an operating system, web browsing and the ability to run software applications.

3. Method
How to receive data from Arduino Sensor-Data on Your Android-Smartphone
This experiment was carried out by making a data collection tool from Arduino to smartphones via Bluetooth and as a substitute for radiation sensors with temperature sensors. In this project, data from a temperature sensor is collected by an Arduino and then transmitted to a smartphone via Bluetooth. The block diagram of these project is shown in Figure 4

![Block diagram of the project](image)

Figure 4. Block diagram of the project

4. Components and Supplies
4.1. Arduino
4.2. LM35 Sensor
4.3. Bluetooth
4.4. Smartphone

5. Tools and Machines
5.1. Arduino IDE
5.2. App Inventor II
6. Schematic
The interconnection of components in Figure 5

![Schematic](image1)

Figure 5. Schematic stuff

7. Sketch Code for Stuff
Arduino is programmed with the Arduino IDE.[6] So that it can measure temperature data and send to smartphones via Bluetooth as shown in Figure 6

![Sketch Code Arduino](image2)

Figure 6. Sketch Code Arduino
8. Developing The Android App
Like Arduino Smartphones are also programmed through the Inventor 2 app so they can communicate with Arduino to read temperature data. [7] The temperature monitor application is shown in Figure 7.

Figure 7. Develop App for Smartphone

9. Construction and Testing.
The circuit is assembled according to the circuit diagram in figure 5. How to test the circuit is quite simple. The Temperature Monitoring application that was built in the Inventor 2 app is downloaded via a barcode as seen in Figure 9. TemperatureMonitoring.apk file is installed on a smartphone. After
a successful installation, Bluetooth is turned on at the smartphone. Transmitter side is turned on, and paired to the Bluetooth module with an Android smartphone. The default password key for installation is 1234.

After successful installation, the Temperature Monitor application that has been installed on the smartphone is opened and click the Bluetooth logo. After the List of paired devices appears. HC-05 Bluetooth devices are selected from the list and connected to the smartphone. After successful connection, ‘connected’ message will be displayed on the main screen of the application. Android app will start to display the data received from the Arduino. A screenshot of the detected temperature observed on the smartphone is shown in Figure 10.

Figure 9. Barcode to download the application that was made

Figure 10. Temperature observed on Smartphone
10. Result and Discussion
Testing is done by measuring data at a distance of 0 to 12 meters as shown in Table 1 to see the ability to send data from the device to a smartphone.

Table 1. Ability to send data vs distance function

| Distance Stuff-Smartphone Meter | Legible 1st | 2nd | 3rd |
|--------------------------------|-------------|-----|-----|
| 1                              | Yes         | yes | yes |
| 2                              | Yes         | yes | yes |
| 3                              | Yes         | yes | yes |
| 4                              | Yes         | yes | yes |
| 5                              | Yes         | yes | yes |
| 6                              | Yes         | yes | yes |
| 7                              | Yes         | yes | yes |
| 8                              | Yes         | yes | no  |
| 9                              | Yes         | yes | yes |
| 10                             | Yes         | no  | yes |
| 11                             | No          | no  | no  |
| 12                             | No          | no  | no  |

From the table, it can be seen that at a distance of 11 and 12 meters the smartphone cannot display the measurement temperature. The maximum distance possible to transmit data by Bluetooth HC-5 is 10 meters. [8] By replacing the Temperature Sensor with a Geiger counter kit as shown in Figure 11 we can develop to get a radiation control device through a Smartphone. In other words, if the Arduino[9] input from the temperature sensor detection can be replaced with the radiation sensor detection result, it can also be transmitted via Bluetooth to the smartphone as well. So we can get device to control the radiation level through a smartphone[10].

Figure 11. Kit Geiger Counter for Arduino
11. Conclusion
The results of experiment the stuff can send measurement data to smartphone via Bluetooth at a range of 0-10 meters. The motive to replace the radiation sensor with a temperature sensor is simply a matter of Geiger counter availability.

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