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The design of digital instrument connected to android based smartphone to measure radiation

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ABSTRACT

Background

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. 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)

The designing of a radiation measurement device using Geiger Muller detector, microcontroller and smartphone to display the result of radiation measurement.

Methods

Applied study, true experiment study design, type of design was post test group only. The study consisted of 1 intervention group and 1 control group. The intervention group used a design of radiation measurement device while the control group used a standard radiation measurement device. Stability test was performed.

Results

The stability test obtained Chi Square Test value (x2) of 2.6899, the measurement result was accepted because it was still in the range of 2.088 to 21,166.

Conclusion

A digital radiation measurement device that could be connected with android-based smartphone via Bluetooth connectivity was designed.

Keywords: Radiation, Detector

INTRODUCTIONN

The utilization of ionizing radiation in the radiodiagnostic field for various medical purposes needs to pay attention to various aspects i.e. the risks and benefits achieved. The facts show that radiological installations are particularly vulnerable if the measurement of protection and radiation exposure is not done. The impact will be directly felt by the radiographer and the impact will be indirectly felt by the surrounding community. Thus, in accordance with the Government Regulation of 2007 on the Safety and Health of Ionizing Radiation Utilization, it is necessary to measure radiation exposure of X-ray machine for radiation protection for officers, patients and the public. [1]

Radiation protection efforts aim to reduce exposure or know the accepted doses of radiation on radiation workers and the public in general, as well as on radioactive materials which interaction process is utilized for the benefit of society. Since these materials produce radioactive particles such as alpha, beta, neutron and other particles, it is necessary to protect against the radiation. [2]

Radiation protection system becomes very important in a nuclear facility because it protects humans especially workers exposed with radioactive substances. Radiation monitoring is intended to directly know the radiation activity in a working area, while monitoring of environmental radioactivity is intended to determine the level of radioactive contamination on both the working area and the environment surrounding the nuclear installation area. This environmental radiation monitoring system basically applies the principle of a radiation measurement devicel used to measure radioactive activity and provide measurement data in the form of counts per unit of time. Given the limitation of humans who do not have ionizing radiation sensor, they must completely depend on device to detect and measure radiation. [3]

A radiation detector is a tool used to track, detect or identify high-energy particles or radiation from natural or artificial sources. [4] A very important part in a radiating counter system is a detector. The detector serves to capture the radiation and convert it into a signal or electrical pulse. [5] All types of detectors can provide immediate results, such as gas, scintillation and semiconductor detectors, can be used. In terms of practical and economical manners, Geiger Muller gas field detector is the most widely used. [6]

Geiger Muller detector is one of the oldest types of existing radiation detectors. It was introduced by Geiger and Muller in 1928. Due to its simplicity, low cost and ease of operation this detector in still used today.[6] The number of ions produced by this detector is very much so that the pulse is relatively high and does not require any more pulse amplifier. Most of the radiation protection devices, which must be portable, are made of Geiger Muller detector. [5]

The development of electronics and computer devices technology in the last decade has resulted in more reliable, integrated and even cheaper electronic devices. This enables the design creation of a more compact, fast and complete device in data processing and performance, and optimization of the use of computers and computing systems. Control of functions in an equipment system can be done by a microcontroller, and through the system interface with the computer, so that all data processing and calculation required can be implemented quickly and accurately. [7]

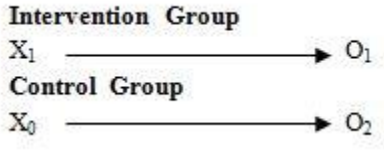
In this study, the design of digital survey-meter using Geiger Muller detector was conducted which of course would facilitate the measurement of radiation exposure level in certain place. Digital survey-meter has a digital display by utilizing android-based smartphone to display the measurement results without the use of connecting cables and with a relatively low cost because it uses components that are sold in the country and with good quality. So if there is a damage of one spare part, it can be directly replaced with other similar components in the market.

METHODS

This study aims to create a radiation measurement device using Heiger Muller detector, microcontrollers and smartphones to display radiation measurement results.

This was an applied study the form of explorative experiments by making a design and conducting function test on radiation measurement device design using Geiger Muller detector and smartphone to display radiation measurement results with post-test group only design. In this study the samples were divided into 2 groups namely 1 intervention group and 1 control group.

The intervention group used a design of radiation measurement device while the control group used a calibrated standard radiation measurement device (survey-meter).



RESULTS AND DISCUSSION

To know the performance of the device, it is necessary to do a test. This test is conducted as a benchmark, whether the device made can function as expected.8 in this study, stability test was conducted by comparing the design of digital radiation measuring device with standard calibrated radiation measurement device.

The test was conducted at the Laboratory of Radiodiagnostic and Radiotherapy Engineering Study Program of Semarang Health Polytechnic. The walls of the lab room were coated with lead with the diameter of 2 mm and there was a partition of Pb glass between the two laboratory rooms. The radiation source used was from an X-ray machine. The design of radiation measurement device was positioned 1 meter in front of the X-ray tube and the smartphone was placed in another room 4 meters away from the measurement device.

The stability test aims to determine the consistency of radiation output measurement results in some exposures in a fixed radiation output setting.

Table 1.1 Data on Stability Test Results

No	Dosage Rate	$(X_i - \overline{X})$	$(X_i - \overline{X})^2$
1	315	0.4	0.16
2	320	4.6	21.16
3	324	8.6	73.96
4	310	5.4	29.16
5	312	3.4	11.56
6	305	10.4	108.16
7	311	4.4	19.36
8	330	14.6	213.16
9	300	15.4	237.16
10	327	11.6	134.56

$\sum_{i=1}^{n=10} X_i = 3154$ $\quad\quad$ $\sum (X_i - \overline{X})^2 = 848.4$

$\overline{X} = 315.4$

$$X^2 = \frac{\sum (X_i - \overline{X})^2}{\overline{X}} = \frac{848,4}{315,4} = 2,6899$$

Test was done by conducting an exposure with a fixed exposure factor value of 50 kV and 5 mAs. The result showed the measurement values when the device operated. The data obtained were analyzed statistically by using Chi Square Test method. Based on the theory, the value of Chi Square Test (X2) for 10 data was in the range 2,088 to 21,166. From the test result data, it was obtained Chi Square Test value of 2.6899 and a confidence level of 99%.

CONCLUSION AND RECOMMENDATION

Thestability test obtained Chi Square Test (X2) value of 2.6899 for 10 data in the range of 2.088 to 21.66 which indicated that the design of radiation measurement device was feasible to use.

Further development in this study needs to be done in the form of conducting a study on maximum distance of bluetooth connectivity towards the distance between radiation detection device and smartphone.

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