Unmanned Portable Dosimetry System for Inspection at Nuclear and Non-Nuclear Centers

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***Abstract*— In this paper, a new unmanned portable tracker system for gamma-ray, and assessing the location and amount of contamination, with no need for presence of people in the infected area, is presented. The sensitivity of the device to a wide range of gamma-ray energy has made the system a good tool for many gamma radiation sources, even at low doses. In addition to detecting infected areas and transmitting environmental information, this system is able to display the amount of environmental doses and alert notification if the dosage is higher than the regulatory limit for the safety of staff and individuals.**

***Index Terms*— Radiation contamination, dosimetry, microcontroller, portable, dose, gamma.**

I. Introduction

ONE of the mankind's greatest achievements in the twentieth century is the discovery of radioactivity and nuclear interactions and the properties of radiation, which has had a great impact on human goals [1, 2]. Radiation materials in the form of springs are used in a variety of industrial, medical, educational applications and in many consuming products. These springs are very diverse in terms of energy (energy spectrum), type of construction, and activity levels. Thousands of transported radioactive materials and radiant springs are transmitted daily around the world. Despite the great amount of attention to the safety, design and use of these springs, unfortunately, the accidents caused by them are far more than rational accidents [3]. Experience has shown that the use of radioactive substances can affect and endanger the health of humans [4]. What distinguishes radiation accidents from other accidents is that other accidents can be felt with some senses, such as vision, hearing and smell, but there is no such possibility in radiological accidents [5]. Designing and manufacturing dosimetric systems can reveal these beams and locate contaminated areas with nuclear radiation which can play a very important role in human life [6, 7]. The use of dosimetry and installation on a portable robotic system is the main objective of the new generation dosimeter that can be used to achieve a very acceptable dose even in unfavorable environments [8].

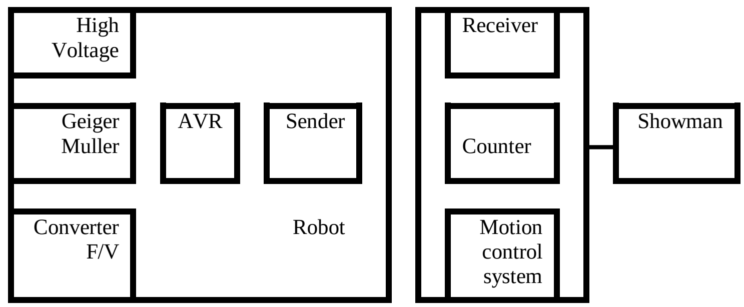

Fig. 1. Block diagram general unmanned moving dosimeters.

II. Method

Figure 1 shows a generic diagram block of a radiation pattern detected by materials or sources of radiation in the environment. The various blocks of this diagram are as follows.

III. Geiger Müller Detector

Using a DC to DC converter, we provide the voltage needed to use the Geiger Müller detector. Geiger Müller tube used in this project is a Russian manufactured model called CBM20. The mechanism of variation inside the Gaiger Muller is shown in Fig. 2 as soon as the gamma rays are detected.

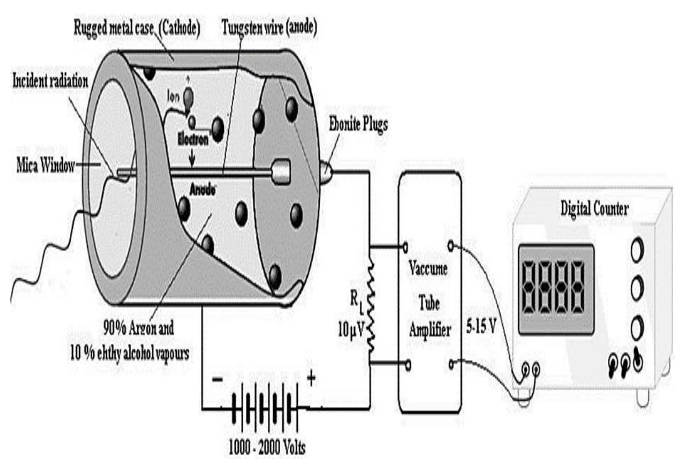

Fig. 2. Geiger Muller intrusion detection mechanism.

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Because the number of pulses per second of this gailler tube is lower, we use two parallel Geiger tubes. The method of parallelizing the tubes creates a fault, which is especially effective at high doses. This error results from the loss of a pulse when both Geiger tubes receive a photon, and only one pulse is emitted out of the Geiger block at that time, and to troubleshoot this error proper amount resistors and capacitors were used as shown in the circuit of Fig. 3. In the figure below, the corresponding electronics circuit and high voltage block are shown for two Geiger Mueller tubes. The proposed voltage for the CBM20 is 350 to 450 volts.

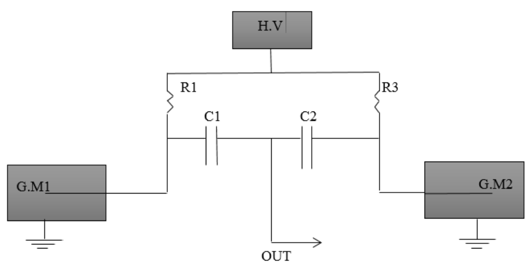

Fig. 3. An electronic circuit for troubleshooting two parallel gauge tubes.

IV. High Voltage Power Supply Block

For this circuit, like all electronic circuits, different methods can be designed and used. One of the easiest possible methods to be used after several circuit checks is discussed this section. This circuit has a feature that does not cause any impairment in the functioning of the Geiger Müller tube. Figure 4 shows the circuit used to feed the Geiger molar DC tube.

V. F / V Converter

One method of measuring the dose in a time unit (Dose Rate Meter) in an orbital diagram block is shown in Fig. 5.

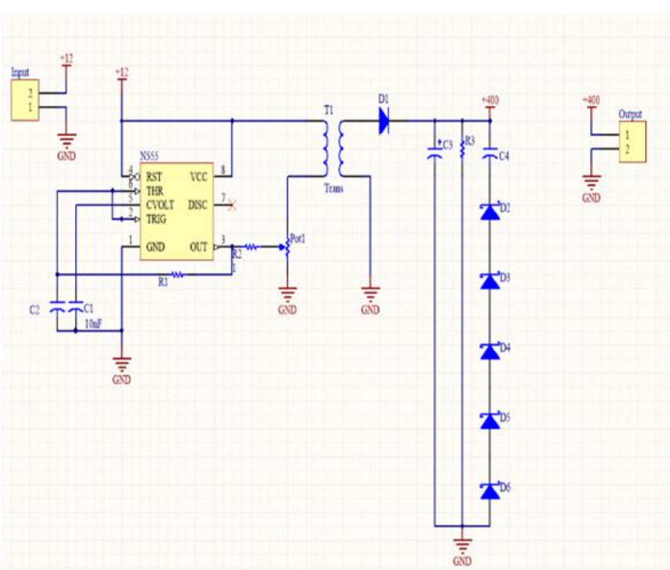

Fig. 4. The circuit used to feed the tube of Geiger Muller.

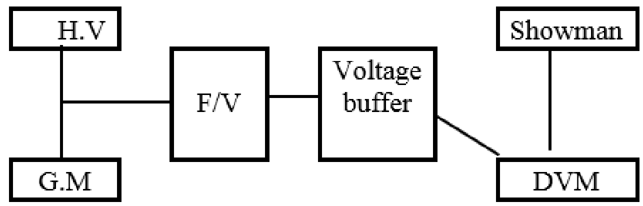

Fig. 5. Orbital diagram block F / V.

The H.V block is responsible for supplying the Gaiger Muller tube, which provides the necessary electric field for gamma photons. With the capture of each photon inside the tube, a voltage pulse is generated at the output. The voltage pulses generated are transmitted to the frequency converter to the voltage (F / V). The resultant voltage block will be proportional to the input pulse frequency. The buffer floor is located next to the F / V floor, this buffer floor transfers the same voltage to the voltage converter to the next floor and uses a DVM circuit to display the voltage generated on the F / V output.

VI. Ability to Change Range

This device is designed for use in low and high doses. In a low dose area, the device can be placed in low range mode, and the display will more accurately display the dose value per unit time, and on the contrary, in a high dose region, the device mode can be adjusted to a high level and the dose in the display indicates it.

VII. Sender and Recipient of Information

The result of electronic circuits is a Gaiger-Muller detector that converts absorbed gamma-ray into electric pulses, and converts these pulses into voltages proportional to doses, and finally displays this voltage digitally. Sending and receiving data using a modem will allow us to remotely control the dosimetry and moving system, so that we can direct it to the radiation-infected area and receive dosimetric data online.

VIII. Unmanned Moving System (Robot)

Here we used a controllable system so that we can install a dosimetry system into a contaminated environment and detect contamination by dosimeter. This robot is made of a combination of mechanics and electronics. Figure 6. shows designed sample of this unmanned moving dosimetry system that has been tested in one of the research institutes of the nuclear region in Isfahan.

Fig. 6. Unmanned moving dosimetric system.

IX. RESULTS

In this project, we succeeded in detecting gamma rays as well as radioactive sources of Co-60 and Cs-137 in a remote environment in an infected environment using a dosimetry system. In addition to the detection of the radiation source (spring, environment, regional), environmental pollution data sending, this system is able to display the amount of doses of the environment and alert if the dosage is higher than the regulatory limit for the safety of the personnel and individuals.

X. CONCLUSION

Considering the measures taken, the project includes research into radiation dosimeters, a drone moving system, radiation monitoring guidelines, hardware supplies and various tests, and a review of its performance with the relevant standards ultimately led to the construction of an unmanned mobile dosimetry device for gamma-ray areas, briefly reported in this paper.

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