Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 105 (2017) 81 – 86

Procedia Computer Science

2016 IEEE International Symposium on Robotics and Intelligent Sensors, IRIS 2016, 17-20 December 2016, Tokyo, Japan

Development of Autonomous Radiation Mapping Robot

[1]Abd. Hafiz Zakaria, [1]Yasir M. Mustafah, [2]Jaafar Abdullah, [1]Nahrul Khair, [1]Taufiq Abdullah

[1]Department of Mechatronics Engineering, Kulliyah of Engineering, International Islamic University Malaysia, P.O Box 10, 50728, Kuala Lumpur
[2]Department of Industrial Technology, Malaysian Nuclear Agency, MOSTI, 43000, Kajang, Selangor

Abstract

This paper discusses the development of a spatial radiation map by an autonomous mobile robot that is equipped with Geiger Muller sensor. Mapping of gamma radiation autonomously using robot as agents will help to prevent harm to human especially when radiation related disaster occur. Hence, we intend to develop a gamma radiation mapping system that reads and process location data of a mobile robot with encoder as well as the radiation data transmitted by the Geiger Muller sensor on the mobile robot. A grid based algorithm was develop to build the radiation map. The system was then tested under several conditions. The results of the spatial distribution map with respect to respective waypoints were discussed at the end of this paper.

Peer-review under responsibility of organizing committee of the 2016 IEEE International Symposium on Robotics and Intelligent Sensors(IRIS 2016).

Keywords: Autonomous; Mobile Robot; Radiation Mapping; Geiger Muller sensor.

1. Introduction

One of the best employments of mobile robot is to map harmful radiation values to facilitate the experts in relation to rescue operation in cases of disastrous radiation catastrophes. The live diagnostic tool performs tasks to help identify the most effective strategy to manage unfortunate accidents [1]. Autonomous radiation mapping robot could help to prevent human exposure from radiation hazard [2] [3]. Generally, robot motion planning system has been an increasingly important technology since it was first developed in 1950s by W. Grey Walter due to its excellent capabilities of monitoring and controlling in variety of applications [4]. Such application can greatly improve information needed for the preparation of accurate future plans thus maximizing results. An autonomous mobile robot must be able to interact with its surrounding regardless or not it is a robust environment to gain useful information describing the environment it experienced for decision-making purposes [5] [6]. In terms of robotic exploration, it can divided into two categories which is Frontier Based Exploration and Market Driven Exploration [7].

Radiation is an unseen threat that may either save a life or kill thousands of communities. A constant or a slight exposure to any level of radiation may be dangerous. Safety procedures and precautions must be taken by those who work with harmful radioactive sources without any failure to ensure their security and others around them. Therefore, in order to minimize risks of accidents, workers must use the right equipment to handle the right job. However, having the right equipment does not guarantee safety until one knows how to correctly operate the equipment.

* Abd. Hafiz Zakaria. Tel.: +60-389251082; fax: +60-389251082.
E-mail address: abdhafizakaria@gmail.com

1877-0509
Peer-review under responsibility of organizing committee of the 2016 IEEE International Symposium on Robotics and Intelligent Sensors(IRIS 2016).
doi:10.1016/j.procs.2017.01.203

2. Ionizing Radiation

Radiation sources can be divided into two main categories which are non-ionizing radiation and ionizing radiation. Non-ionizing radiation includes natural background sources and man-made sources. The sun is one of the major background sources of radiation. Certain minerals that make up part of the earth contain the radioactive elements. The levels may typically be in the range of 15 to 60 counts per minute that will vary depending upon one's location on the earth, and the efficiency of the radiation sensor used. Man-made sources that emit radiation include medical radiation sources and consumer products such as televisions and smoke detectors. Ionizing radiation includes Alpha, Beta and Gamma particles.

Alpha radiation consists of positively charged particles emitted from the nucleus of an atom in the process of decay. With strong positive charge, the density of alpha precludes them from penetrating more than an inch of air or a sheet of paper. Alpha particles are not a serious health hazard except when they are emitted from within the body as a result of ingestion. Meanwhile, Beta radiation consists of negatively charged particles emitted from an atom in the process of decay. These particles are relatively light and can penetrate somewhat better than alpha particles which are through a few millimeters of Aluminum. If ingested, beta radiation can be hazardous to living cells. Gamma radiation represents one extreme of the electromagnetic spectrum, particularly that radiation with the highest frequency and shortest wavelength. Gamma rays can pass through virtually anything and are effectively shielded or absorbed only by materials of high atomic weight such as Lead. It is a very powerful and potentially very dangerous type of ionizing radiation detectable by all Geiger counters.

The component of a radiation counting system may include a radiation detector to detect radiation and a recorder to record the pulses detected by the detector. Geiger Muller sensor is widely used by researchers and university laboratories to detect radiation intensity. It is composed of a central anode and a shell which acts as a cathode while gaseous of usually Argon or Neon surrounds a region of anode to be ionized. In order to produce energetic accelerated ions between the electrodes, a high electric field is maintained across the pair. The Geiger Muller sensor will begin to emit pulses once the recorder indicates a certain threshold voltage. This happens when the tube experienced constant radiation intensity and the voltage applied on the sensor is slowly increased [8]. Geiger counter has moderately good gamma discrimination capability [9]. In our design, the Geiger Muller sensor was powered by an 11.1V lithium-polymer battery for the best performance, and later ZigBee transmitter device is utilized to send radiation data to laptop. Figure 1 shows the cross sectional view of a typical Geiger Muller detector.

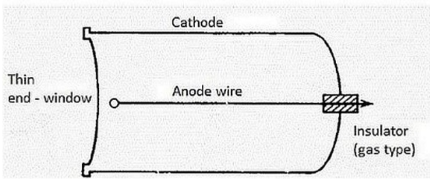

Fig. 1. Cross sectional view of a typical Geiger Muller Detector [8].

3. Mobile Robot Design

The mobile robot was design so that necessary components can fit onto one platform. The components will communicate wirelessly with a computer to send and receive data. Then, a spatial distribution map of radiation level will be generated based on the accumulated data.

The mobile robot platform was integrated with four main components which are the Arduino Mega 2560 board, Arduino Uno board, DC motor with encoder and the Geiger Muller sensor. The Geiger Muller sensor will read the radiation values on its surrounding through the designated waypoints. The data read was then transmitted to a laptop wirelessly. Figure 2 shows the complete platform model of the mobile robot.

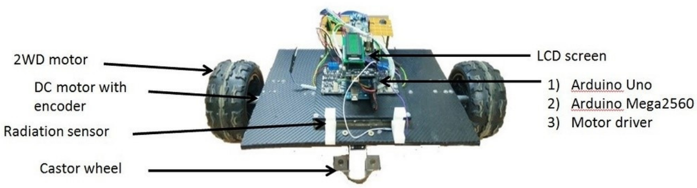

Fig. 2. Mobile robot platform.