Microprocessor based RAD LOG tracking system

ABSTRACT

A setup is introduced to monitor radiation in particular region using specialized tracking device through website. This specialized tracking device consists of SD card, GPS, Display, GPRS/GSM, Mother Board, Radiation measurement meter, keypad. Radiation measurement meter is used to measure the radiation in the environment where it is kept. Radiation value which is measured by the radiation measurement unit is given as input to the mother board. GPS data is also given as input to the mother board. GPS data gives information about the location (latitude and longitude). Mother board sends GPS data and radiation measurement to the server through GPRS. These data can be viewed by the user via website which collects this information from the server. To view the data in the website user, need to login using username and password. Username is nothing but the IMEI number. Password can set by the user (user defined). GPS data and radiation measurement data can also be stored in the SD card with the help of mother board. The data stored in the SD card can be viewed in excel sheet. If the user who carries the specialized tracking device needs to make a call to the person to inform about the condition/situation, then the user has to enter the number using the keypad in the specialized tracking device. Each number is linked with particular person's phone number. Thus pressing the number will make a call to the particular person. In order to indicate emergency situation without making a phone call, user need to press the emergency button in the keypad. Thus the emergency condition will be intimated to the user in the web view using alarm.

Index Terms – GM Tube, GPRS, IP address.

I. INTRODUCTION

In recent years, mobile and computer devices have experienced a rapid growth. Smart phones and tablets can now possess the computing power of a desktop computer. These advancements have also spread into the field of radiation technology. In this technology, radiation is energy given off by matter in the form of rays or high-speed particles. All matter is composed of atoms. Atoms are made up of various parts; the nucleus contains minute particles called protons and neutrons, and the atom's outer shell contains other particles called electrons. The nucleus carries a positive electrical charge, while the electrons carry a negative electrical charge. These forces within the atom work toward a strong, stable balance by discarding excess atomic energy (radioactivity).

In that process, unstable nuclei may emit a quantity of energy, and this spontaneous emission is called as radiation. Ionizing radiation is a type of energy released by atoms that travels in the form of electromagnetic waves (gamma or X-rays) or particles (neutrons, beta or alpha). The spontaneous disintegration of atoms is called radioactivity, and the spare energy emitted is a form of ionizing radiation. Unstable elements which disintegrate and emit ionizing radiation are called radio nuclides. All radio nuclides are uniquely identified by the type of radiation they emit, the energy of the radiation, and their half-life. This radiation can be emitted in the form of positively charged alpha particles, negatively charged beta particles, gamma rays, or x-rays.

Alpha radiation is a heavy, very short-range particle and is actually an emitted helium nucleus. Alpha radiation travels only a short distance (a few inches) in air, but is not an external hazard. Alpha-emitting materials can be injurious to humans if the materials are inhaled, engulfed, or absorbed through open wounds. Most alpha radiation is not able to penetrate human skin. Alpha radiation is not able to perforate clothing. Beta radiation is a light, short-range particle and is actually an ejected electron. Beta radiation may travel several feet in air and is passably penetrating. Beta radiation can perforate human skin to the "germinal layer," where new skin cells are produced. If high levels of beta-emitting contaminants are allowed to remain on the skin for a prolonged period of time, they may cause skin injury. Clothing provides some protection against beta radiation.

Gamma radiation containing no mass or charge can travel much faster through air than alpha or beta, losing (on average) half its energy for every 500 feet. Gamma radiation or x rays are highly penetrating electromagnetic radiation. Gamma radiation or x rays are able to travel many feet in air and many inches in human tissue. They are sometimes called "penetrating" radiation since they readily perforate most materials like X rays. Sealed radioactive sources and machines are mainly composed of gamma radiation which causes external hazard to humans. For this basis, disclosure to gamma radiation can cause a number of health effects to the human beings. While the body has the potential to repair damage, its ability to repair radiation-related damage can be overwhelmed at high doses.

Gamma ray exposure is measured by millirem, or mrem. One-time exposure on a daily basis for most people is 25 mrem at most, while people working in radioactive [5] environments with adequate protection may absorb up to 5,000 mrem at once. Anything more than 10,000 mrem is considered very dangerous even if exposure is short. Beyond this point, health concerns become immediate and the risk of illness is very high. Unlike other types of radiation, gamma rays travel so fast they pass through the entire body very quickly, infecting all organs and tissue. Their ionizing patterns mean exposed body parts can become ionized and their properties changed even after the gamma radiation itself has long evaporated. Gamma Radiation exposure can have varying effects, depending on the dose received, and what the exposure was. Certain elements, when the exposure is internal, it will deposit in various organs or bones. Radioactive Iodine gravitates to seek out the thyroid (making it useful in cancer treatment) whereas Strontium-90, which gravitates to seek out bone and bone marrow, and can lead to bone cancer and leukemia.

For acute exposures, the first physical effects can be seen at around 25-50 rem, and perceptible as a drop in a person's white blood cells. Acute Radiation Syndrome occurs at 150-350 rem, presenting nausea, fatigue, hair loss, and skin reddening. The LD 30/50, which is the point where 50 percent of the people exhibited will die within 30 days without medical care, is between 460 and 600 rem. At 1000 rem, 100% of those exhibited will die within 60 days. These are all very high levels analogized to typical exposure. In recent years a new technology was intended for the development of environmental monitoring systems, the wireless sensor networks ([13], [14], and [16]. A sensor network is composed by a set of geographically distributed autonomous sensors that monitor physical or environmental conditions and transmit the acquired data to a central location. The main components of a sensors network are the sensor nodes, the base stations and a server that centralize all the results of the network activity. The data transmission is usually made between the components of the network either via satellites or by wireless radio.

A microprocessor-based intelligent monitoring and warning system is proposed in [2] that were applied to environmental monitoring. The system was designed in a holonic view, and it can be used as an independent standalone system or it can be included as a part of a larger intelligent monitoring system. Also, the system is low cost and flexible, and can be adapted to various environmental monitoring applications for example air pollution monitoring, flood monitoring and alert [17], soil pollution monitoring, radiation monitoring etc. In this paper it is presented a microprocessor-based system designated for monitoring the release of subatomic high frequency particles in the gamma ray area. In addition to radiation monitoring, the system also shows the geo location details in the bhubi map. Emergency situation will be intimated in map view using an alarm. Radiation measurement along with location details will be stored in SD card. This system performs remote transmission of data together with the GPS coordinates and the appropriate warning calls to the user.

II. RELATED WORK

Radiation monitoring systems are being required to provide improved reliability, labor rescuing maintenance, inspections and enhanced monitoring functions. Radiation monitors may fall into the categories of environment radiation monitoring, personal dose monitoring, surface contamination monitoring, radioactive material monitoring and area process monitoring. In recent years, especially after the Chernobyl Accident, automated radiation monitoring systems increase its importance in the field of radiation protection. To realize such a system, Turkish Atomic Energy Authority, Çekmece Nuclear Research and Training Center initiated the "Early Warning Environmental Radiation Monitoring System Design and Development Project" in the year 1995. Developed system presently is operating successfully in 67 sites in Turkey. A radiation-monitoring system has been locally developed that continuously observes the environment for radiation activity. The system consists of intelligent remote probes and a server computer that communicates over public telephone lines. Special detector software has been written that handles the data obtained from the Geiger-Muller tubes. Measurement results are stored on the remote station until transferred to the server computer for later retrieval or analysis.

The system has been designed to minimize human interaction by means of programmable server software, which controls routine or periodic tasks such as retrieving data and maintaining detectors. In case of an abnormality in the detected radiation activity, the system automatically raises visual and audio alarms. Early Warning Environmental Radiation Monitoring System (RESA) consists of two main parts. REMOTE STATIONS for radiation detection and RESA CENTER with personal computer REMOTE STATIONS for radiation detection and RESA CENTER with personal computer running special software called RESA Server. The REMOTE STATION consists of a "smart probe" and an uninterruptible power supply unit (UPS) containing a modem which communicates with the remote stations through telephone lines. The micro controller 87C51FA from the MCS-51 family is used in the probe. The radiation dose rate is measured continuously through probes from background to 400 R/h by two Geiger Muller (GM) detectors sensitive to gamma and X-rays. If one of the detectors is defect the measurement is continued with the other detector. The pulses coming from the detectors are counted separately during one minute. Dead time corrections are made for these counts and radiation dose rates are calculated in µR/h.

Microprocessor-based radiation monitoring system which is developed around an environment without any possibility of remote data transmission while driving [6]. This issue is partially solved in [8] by using a desktop computer and an internet connection. The portable system presented in [15], which is based on microprocessor, is able to transmit the data remotely by interconnecting it through a serial line to a PC, PDA or a smart phone. In the last years, some radiation monitoring systems based on wireless sensor networks were reported in the literature. A review of some recent experiments with sensor networks for environmental and agricultural applications is presented in [4]. A mobile wireless sensor network for radiation levels monitoring around and inside a nuclear power plant is proposed in [1]. The design and implementation of a radiation dose monitoring system based on wireless sensor network was also described in [12]. An overview of sensor networks was made in [7], while detailed discussions on the importance of using sensor networks in earth system science and ecology were reported in several papers such as [8] and [11]. Sensor network based environmental and radiation monitoring systems were reported in the literatures [9], [18], [19] and [20]. In this paper we propose a mobile microprocessor [10] system with internet connection capability, which monitors increases in concentrations of gamma radiations along a preset geographical route. The warning signals, which are generated according to the received data, are sent together with the corresponding GPS coordinates to the Committee of Emergency Situations for taking the appropriate measures.

III. PROPOSED SYSTEM

The main objective of this project is to track the location of the person while driving and monitoring the gamma radiation in the environment. The Radiation Log Tracker detects the gamma radiations from the environment using GM tube. The measured radiation and the geo location will be stored in the memory card. After a specific time, samples, the location and radiation details will be send to the admin using M2M communication. And then the GRPS is connected to the admin computer, where the location can be viewed in the bhubi map.

The radiation value will be viewed in the map as we move the pointer and the vehicle’s travelled path will be shown in the map. The environmental radiation and the geo locations (latitude and longitude) [3] will be updated periodically for every 30 seconds. The admin initially sets the route of the vehicle in the map and if there is any deviation in the route the indication will be displayed in the map. Radiation is measured in dos rate (μSv/hr) and dos value (mSv). If the vehicles move in normal location green light indication will be shown in the display and for abnormal location red light indication is used.

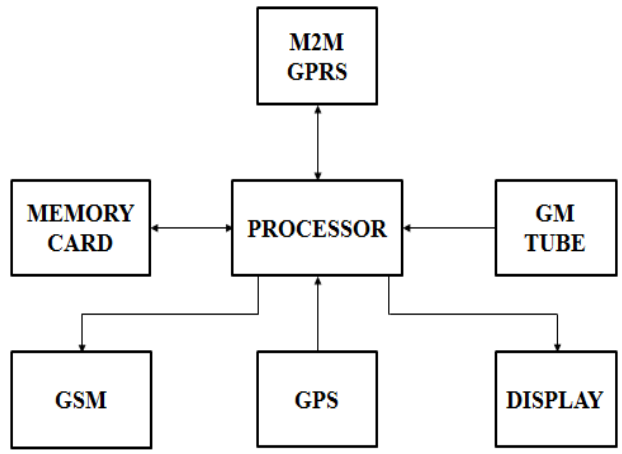

Fig 1. Proposed block diagram

Vehicle and admin constitutes a GRPS modem, where M2M communication takes place. Admin GRPS modem receives all the data's using a specific IMEI (International Mobile Equipment Identity) number for each user. Under emergency condition, the GSM modem makes a call to the predefined number and enables the speaker and mike. The call is received by the admin automatically. The block diagram of the proposed system is shown in figure 1.

3.1 GM TUBE

The Geiger–Muller tube or GM tube shown in figure 2 is the sensing element used for the purpose of detecting ionizing radiation. It is a gaseous ionization detector and uses the Townsend avalanche phenomenon to produce an easily detectable electronic pulse as little as a single ionizing event due to a radiation particle. It is used for the detection of gamma radiation, X-rays, and alpha and beta particles. It can also be adapted to detect neutrons. The tube operates in the ion pair generation of the "Geiger" region.

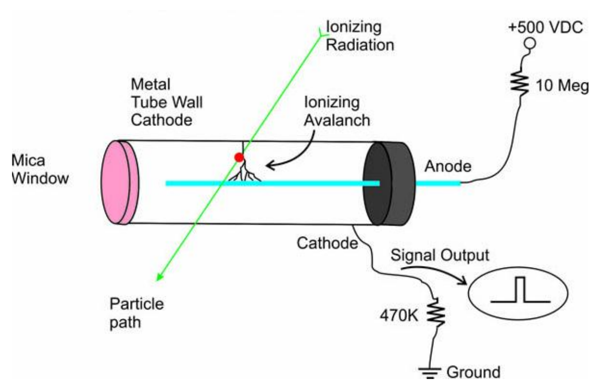

Fig 2. GM Tube

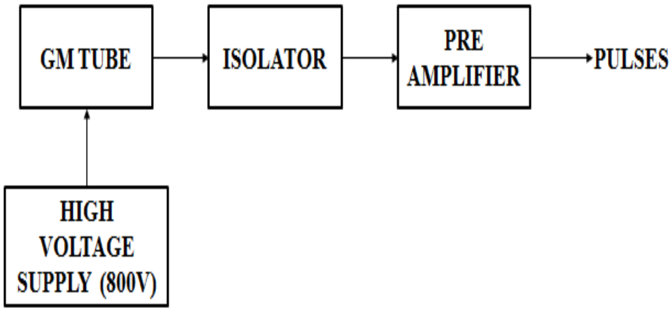

Fig 3. Block Diagram of GM Tube

Basically GM Tube consists of a pair of electrodes surrounded by a gas. The electrodes have a high voltage across them. The gas used is usually Helium or Argon. When radiation enters the tube it can ionize the gas. The ions (and electrons) are attracted to the electrodes and an electric current is produced. A scalar counts the current pulses, and one obtains a "count" whenever radiation ionizes the gas.

The equipment contains two parts, the tube and the (counter + power supply). The Geiger-Mueller tube is regularly cylindrical, with a wire down the center. The (counter + power supply) have voltage controls and timer options. A high voltage is confirmed across the cylinder when ionizing radiation such as an alpha, beta or gamma particle enters the tube, it can ionize some of the gas molecules in the tube. From these ionized atoms, an electron is knocked out of the atom, and the remaining atom is positively charged. The high voltage in the tube produces an electric field inside the tube. The electrons that were knocked out of the atom are attracted to the positive electrode, and the positively charged ions are attracted to the negative electrode. This creates a pulse of current in the wires connecting the electrodes, and this pulse is counted.

The charged ions become neutralized after the pulse is counted, and the Geiger counter is ready to record another pulse. In order to restore the Geiger miler tube quickly to its original state after radiation has entered, a gas is added to the tube. The output of the GM Tube pulse goes to the oscillator. Oscillator which generate the output signal pulse with constant amplitude and constant desired frequency and convert DC power into a periodic signal or AC signal at a very high frequency. A preamplifier boosts the signal strength and converts a weak electrical signal (Oscillated output signal pulse) into an output signal strong enough to be noise-tolerant and strong enough for further processing as shown in Figure 3.

3.2 GPRS

GPRS is a packet-based data bearer service that is delivered as a network overlay for existing GSM networks. GPRS is often described as 2.5G cellular technology that lies between second (2G) and third (3G) generation and has primarily evolved because of increased demand of data service over GSM network which otherwise was primarily for voice communication. Because GPRS is backward compatible with GSM, it has provided an easy migration path for 2G to 2.5G GSM operators compared to 3G. GPRS utilizes a packet radio principle to convey user data packets in an efficient way between GSM mobile stations and also to external packet data networks. This makes GPRS network compatible to leading packet-based internet communication protocols like IP and X.25.

3.3 CONSIDERATIONS FOR USING GPRS FOR M2M APPLICATIONS

GPRS are designed to offer better network architecture for data communications. Required characteristics of a data network are always on connection, billing based on the volume of data sent, not on time spent and faster data transfer. GPRS provides quick session setup and fast data transmission speed [2]. GPRS base stations and support nodes use Internet Protocol for relaying messages. In order to use the GPRS network for data communication in M2M application one requires a GPRS enabled device (generally a modem) with support for TCP/IP. Because M2M device does not limit devices to physical locations. This gives more flexibility to move them or support remote locations without cables running for environmental measuring, even to places without power supply. And to hook into an existing wireless network (e.g. GSM/GPRS) can be done easily and without complex integration efforts.

Typical system architecture for this is shown in Figure 2. To create a successful communications system using GPRS special considerations are required [9]. Depending on M2M application two types of GPRS communication can be set up viz. static IP, dynamic IP.

3.4 STATIC IP ADDRESS

Static IP addresses are useful for the purpose of gaming, website hosting or Voice over Internet Protocol (VoIP) services. Speed and reliability are key advantages. Because a static address is constant, systems with static IP addresses are vulnerable to data mining and increased security risks.
Other name of the static address is known as fixed address. This means that a computer with an assigned static IP address uses the same IP address when connecting to the Internet. An ISP is allocated a range of IP addresses. The ISP delegates each address to its networked computers via the Dynamic Host Configuration Protocol (DHCP) server, which is configured to allocate static IP addresses to the specific computers. The addresses are used for network identification and communication. Allocation mechanisms vary, depending on platform.

Unlimited IP address requirements were not considered when the Internet was first conceptualized. At that time, Internet Protocol version 4, based on 32-bit addressing (IPv4) allowed for 4.2 billion unique addresses. Even then, ISPs approached static addressing conservatively by limiting static addresses to unused IP addresses to facilitate temporary IP, or dynamic IP, addressing to requesting DHCP servers. With the rapidly expanding use of IP-addressable devices, IPv4's limitations became more apparent. The IPv6 protocol followed IPv4 and provided for 128-bit addressing for virtually unlimited IP addresses. Following steps describe setting up of the connection between the client and the server as shown in figure 4.

Step 1: The client connected to the server through IP address (192.168.1.1) which is already fetched from TTPS.

Step 2: If the client is connected to the server, then it sends the information to the server with IMEI number.

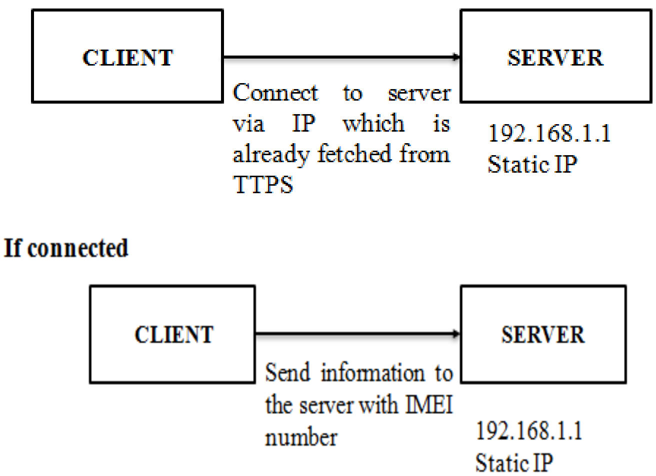

Fig 4. Static IP address

3.5 DYNAMIC IP BASED CONNECTION

When the connection is established in the network, an IP address is assigned to it. However, when the machine disconnects, it loses the IP address. The next time the machine connects, it will pick up a new IP address. In this paper, if the application requires that the client (remote device connected to the modem) reports the host (central monitoring server) periodically about status updates or report by exception, the dynamic IP service can be used. In this scenario, a host may only receive the data from the client or at the most respond to client requests, but will not initiate communication with the client. The client is assigned a dynamic IP address on the internet by the GPRS service provider. This is said to be dynamic IP because it may change each time it contacts the host or tries to be online. The host must have a fixed IP address (or domain name), so that client knows where to find it. Following steps describe setting up of the connection between the client and the host as shown in figure 5.

Step 1: From the admin side, the server request for IP address to the TTPS (Trusted Third Party Server) and the server get the Dynamic IP address (192.168.1.1)

Step 2: From the client side, Client request GPRS network for server IP address to TTPS.

Step 3: Trusted Third Party Server provides IMIE and IP address response to client.

Step 4: Client connects to server via IP address. For this it is necessary for the server to have live connection to internet and with application port opened and ready to communicate.

Step 5: If the server is connected strongly to the client, then the information is sent through the server with IMEI number. These connections remain till the time data flow exist and connection has to be reinitialized whenever required again.

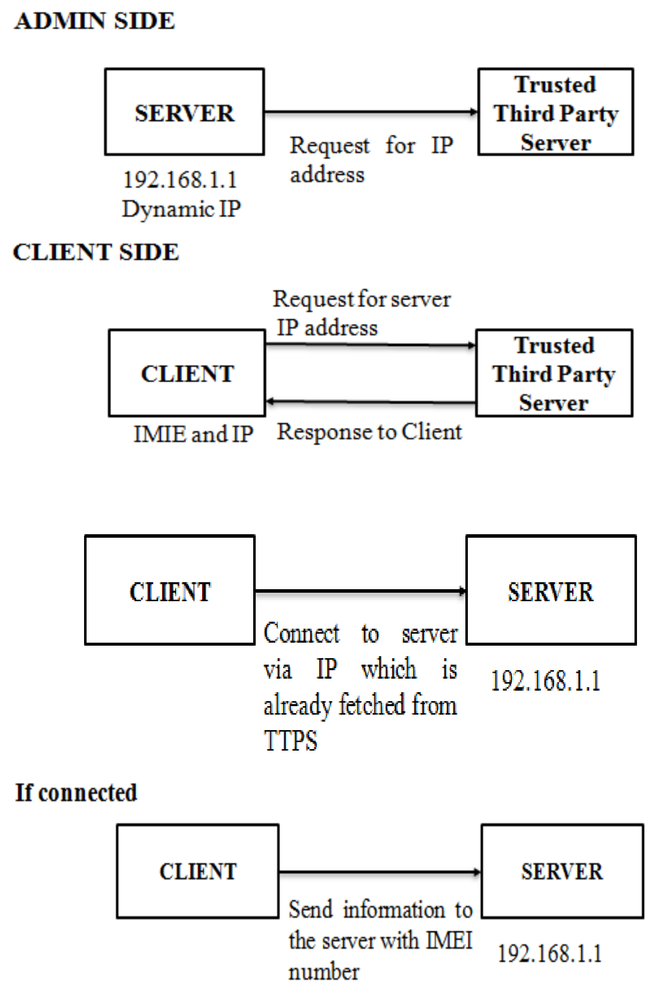

Fig 5. Dynamic IP address connection

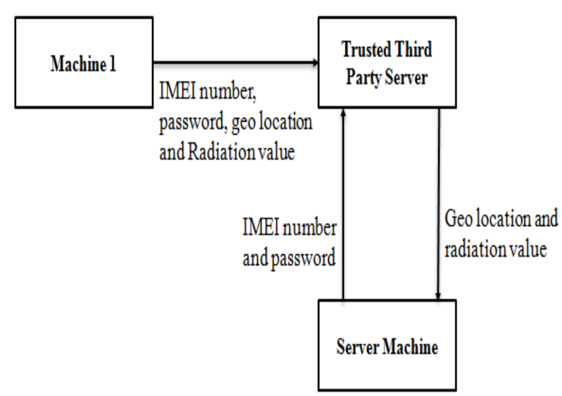

Fig 6. M2M Connection

Here the Machine 1 sends the IMEI number, password, radiation value and the geo location to the third party server. The third party server has a temporary storage of 1Kb size. So it can store new values and delete previous values. The server machine requests the third party server by sending the IMEI number and the password. The Third party server in turn sends the geo location and radiation value as response. Thus the connection is established as shown in Figure 6.

IV. RESULTS

In this section, result is given to verify that the proposed Rad Log Tracker.

Fig 7.1 Software overview- Login result

Fig 7.2 Map view

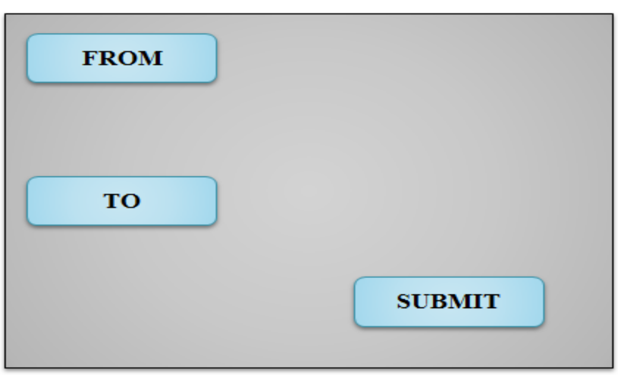

Fig 7.3 Location Update

V. CONCLUSION

Microprocessor-based radiation monitoring and warning system with wireless data transmission is presented. The performances of the system were tested in selected areas. In the Rad Log Tracker, the gamma radiation from the environment is measured and the geo location of the vehicle is viewed in the bhubi map. The geo location (latitude and longitude) will be updated periodically for every 30 seconds. Rad Log Tracker is very useful for environmental protection. The tracker is designed and tested successfully. It tracks the radiation and locates very efficiently. It can also be extended for monitoring other fields and protect the environment from measuring the air quality and toxic gases pollution, with minimum changes in our design.

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