The application of GPS, GIS and GPRS in Environmental Radiation Survey

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Abstract: Institute of Nuclear Energy Research, Taiwan, has developed a mobile environmental radiation survey system that incorporated with the application of GPS, GIS and GPRS. Global Positioning System, GPS, can provide accurate positioning and timing in the environmental radiation survey. Geography Information System, GIS, integrates GPS data and survey data into the electric map and displays them immediately. General Packet Radio Service, GPRS, enables the mobile network which can real time transfer the mobile survey results. In this paper, two kinds of ?ray dose rate monitoring instruments are tested. One is a High Pressure Ionization Chamber (HPIC, GE Reuter-Stokes Inc.) and another is a GM tube (GammaTRACER, Genitron Instruments GmbH). Both of them can be equipped in a monitoring car and used as a mobile radiation measurement instrument. However, the stability and sensitivity of HPIC are better than GammaTRACER. The cycle time of GammaTRACER is more than 1 minute, but HPIC may get one monitoring data per second. The system can take data every 10 seconds if HPIC was used as the monitoring instrument. In another word, the system would get survey results every 100 meters if the monitoring car at the speed of 36 km/h. GIS can show the survey result immediately in the electric map. A dose rate distribution map will also easily be made by this system and displayed in 3D mode. We can know the radiation condition well form the system. The system will be helpful to the works such as routine patrols, nuclear terrorisms and nuclear accidents.

Key words: GPS, GIS, GPRS, Environmental Radiation Survey

1. Foreword

Institute of Nuclear Energy Research (INER), Taiwan, has developed a mobile radiation monitoring system for environmental radiation survey. The system is useful to the works such as routine patrols, nuclear terrorism, radioactive pollution accident and nuclear accident. The system is based on the integration of global positioning system (GPS), geographic information system (GIS) and General packet radio service (GPRS) to connect with radiation monitoring instrument, HPIC and GammaTracer. These modern techniques, GPS, GIS and GPRS have been applied to the environmental pollution investigation, the management of ambulance, the disaster management and the management of land-use [1-3]. GPS can provide a way of accurately determining positions where the mobile environmental radiation survey system is on the surface of the earth. GIS is a tool that can capture data, store it, analyze it, retrieve it, and make maps from it. A GIS is a “graphic database,” or an “intelligent map,” that stores and displays the environmental radiation survey results and the relative
points of GPS data. GPRS technology enables wireless access to data networks like Internet and allows mobile phone to be used for sending and receiving data over an Internet protocol-based network. GPS, GPRS and radiation monitoring instruments are connected by personal digital assistant (PDA). In this paper, two kinds of γ-ray dose rate monitoring instruments are tested and assessed. One is a High Pressure Ionization Chamber (HPIC, GE Reuter-Stokes Inc.) and another is a GM tube (GammaTRACER, Genitron Instrument GmbH). Both of them can be equipped in a monitoring car and used as mobile radiation measurement instruments. However, the detection efficiency and sensitivity of HPIC are better than GammaTRACER. The system can take one monitoring datum every ten seconds if HPIC was used as the monitoring instrument. In another word, the system would get survey results every 100 meters if the monitoring car is moving at the speed of 36 km/h. The GIS is installed in the monitoring center that can show the survey result immediately in the electric map. The dose rate can be classified into different levels and be displayed by different colors that make the monitoring results easy to be observed.

2. The descriptions of the system

The system could be divided into two major parts; one is the mobile devices controlled by PDA and the monitoring center operated by personal computer. The major functions of the system are as follows:

(1) Connecting of radiation monitoring instrument;
(2) Connecting of GPS;
(3) Integration of monitoring data and GPS data;
(4) Communication by GPRS;
(5) Displaying and analyzing by GIS in monitoring center.

Figure 1 shows the connecting scheme of the system. GPS, radiation monitoring instrument and GPRS are integrated by a PDA and these devices are shown in figure 2. There are some benefits for using PDA in the mobile system. PDA has the advantages of compact size, quick start and easy to be operated. GPRS enables the mobile network, which can real time send the monitoring results back to monitoring center. The PDA and the monitoring center also can be communicated with each other by sending short message. The radiation monitoring data can be displayed and analyzed by GIS in the monitoring.
HPIC and GammaTRACER

Both HPIC and GammaTRACER are used commonly in Taiwan. GammaTRACER is a Geiger-Mueller tube type of radiation monitoring instrument with a long life battery. GammaTRACER has the advantages of low cost, low weight, and no need of power supply. The mobile radiation monitoring system coupled with GammaTRACER can be handled by an individual easily. HPIC has better linearity, energy response, internal background, detection efficiency and sensitivity. The system can take one monitoring datum every ten seconds if HPIC was used as the monitoring instrument. In another word, the system would get survey results every 100 meters if the monitoring car is moving at the speed of 36 km/h. According to our experience, the mobile radiation monitoring system still worked well when the speed the car was over 100 km/h.
GPS

A CF interface GPS is adopted to connect with the PDA. The GPS can provide the accurate position with an error below 10 meters.

GPRS

A SM interface GPRS is adopted to connect with the PDA. GPRS technology enables wireless access to data networks like Internet and allows mobile phone to be used for sending and receiving data over an Internet protocol-based network. The cost of sending data for GPRS is much lower than GSM.

PDA

The application program of PDA is developed by the Embedded language. The PDA can integrate the operations of GPS, GPRS and monitoring instruments and communicate with the monitoring center. The start procedures of PDA are shown in Figure 3.

The monitoring center

The monitoring center is located in the INER. It receives the radiation monitoring data and communicates with the mobile system by Internet. The following shows the functions of the GIS based monitoring center.

1. Collecting GPS and radiation monitoring data;
2. Displaying electric map;
3. Showing the radiation monitoring result on the electric map;
4. Sending message to the mobile system;
5. Analyzing the results of the radiation monitoring;
6. Information management.

Fig. 3. The start procedures of PDA
The view of the GIS based monitoring center is shown in Figure 4. The black line is the track of the radiation monitoring car and the black word along with the track is the radiation monitoring result. The GIS based monitoring center allow users to modify the track line that control the color range of data as shown in Figure 5.

3. Discussion

With the modern technologies integration of GPS, GIS and GPS, we established a mobile radiation monitoring system. The system can give environmental radiation survey some promotions. The promotions include reliability of data management, analyzing ability, efficiency and mobility.

The error of positioning by GPS is below 10 meters, and we can see that the tracks of the mobile system can be always displayed on the road of the electric map. GPS can provide not only precise latitude and longitude data, but also can provide very accurate time data by the satellites. The time of the computers and PDAs can be corrected by GPS before a start of the mobile radiation survey.

GammaTRACER and HPIC were adopted to connect the mobile radiation monitoring system because that they are normally used in Taiwan. GammaTracer is light and easy to handle with the
mobile system. HPIC is sensitive and can be taken one datum every 10 seconds with the mobile system. GammaTRACER is suitable to be handled by individual and HPIC is suitable to be equipped with vehicle for the mobile radiation monitoring system.

GPRS technology allows mobile phone to be used for sending and receiving data over an Internet protocol based network and the mobile system can keep communication with the monitoring center when the vehicle is at the speed over 100 km/h. So we can do real-time radiation survey in large area. The system is useful to the works such as routine patrols, nuclear terrorism, radioactive pollution accident and nuclear accident.

4. Conclusion

Institute of Nuclear Energy Research (INER), Taiwan, has developed a mobile radiation monitoring system for environmental radiation survey. The development of the system is based on modern technologies and the current condition of environmental radiation monitoring in Taiwan. The system is ready to be used in environmental radiation

References