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## RADON MONITORING SYSTEM USING WCDMA WIRELESS COMMUNICATION

Gyu-Sik Kim<sup>\*1</sup>, Seong-Kon Choi<sup>2</sup> and Bum-Kyu Lee<sup>2</sup>

<sup>\*1</sup> Department of Electrical Engineering, The Univ. of Seoul, Seoul, Korea

<sup>2</sup> R&D Center, GaboTech. Co. Ltd, Seongnam City, Gyeonggi-do, Korea

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### ABSTRACT

This paper presents the development of a radon concentration monitoring system, which uses the Safety Siren Pro Series 3 Radon Detector for detecting the radon particles and a data processing module with WCDMA communication capabilities for measurement results transmission and management. This solution represents an inexpensive, easy to use, portable Safety Siren Pro Series 3 radon detector and a radon monitoring system which can be used for monitoring the radon level in a specific location or for being a part of a distributed monitoring system. The WCDMA wireless communication module can send radon level measurements to a computer or a smart-phone.

*Keywords: radon monitoring, WCDMA, wireless communication, smart-phone*

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### I. INTRODUCTION

Radon is an invisible, odorless and chemically inactive radioactive gas that is produced by the decay of uranium ore, such as radium, actinium, or thorium. Because inhaling radon and its radioactive decay products causes irradiation of lung tissue, prolonged exposure to high concentrations of radon significantly increases the risk of developing cancer

Various types of equipment and components have been proposed to date for radon detection. In [1], highly sensitive, electrostatic collection chambers have been developed for low-level radon measurements using CR-39 plastic track detectors. In [2], a radon detector employs an electrically charged pressed, porous metal filter that allows radon gas diffusion, while blocking ambient light, so that it readily traps both attached and unattached Po-214 and Po-218 ions, that may be present in gas passing through the filter, the filter being charged positively relative to an unbiased PN junction of a photo diode detector within a detection chamber. In [3], a passive direct-reading radon monitor utilizing a custom  $\alpha$  particle detecting MOS integrated circuit and electrostatic radon progeny concentrator has been designed. In [4], a silicon PIN photodiode was designed and fabricated in consideration of low-leakage-current and high-bias-voltage application. In [5], a fast-responding passive radon detector using electrostatic concentration and enhanced readout electronics has been designed. In [6], an electrostatic concentrator constructed by metalizing a plastic funnel is used to focus charged radon progeny onto the exposed surface of an optical image sensor from a webcam. Alpha particles emitted by the collected progeny strike the image sensor, generating sufficient charge to completely saturate one or more pixels. In [8], this work presents the development of a system which monitors the radon level, using a PIN diode for detecting the radon particles and a data processing module with Wi-Fi communication capabilities for the transmission and management of measurement results

This paper presents the development of a radon concentration monitoring system, which uses the Safety Siren Pro Series 3 Radon Detector for detecting the radon particles and a data processing module with WCDMA communication capabilities for measurement results transmission and management.

### II. WCDMA WIRELESS COMMUNICATION

Radon is a radioactive gas that is colorless, odorless, and tasteless and is impossible to detect without the use of sensitive test equipment. Radon is a naturally occurring gas produced by the breakdown of uranium in soil, rock, and water. The EPA presently suggests that corrective action be taken to reduce the radon levels in your home if measured over the long term at 4 pCi/L or greater. Safety Siren PRO 3 radon gas counter shown in Fig.1 (a) was used for experimental studies in this paper. The numeric LED display shows the level of radon gas in Pico Curies per liter (pCi/L). The display range is 0.0 to 999.9. The Safety Siren Pro Series 3 Radon Detector display is designed to notify the user of the level of radon gas on either a short-term or long-term basis, and is updated every hour if there is a change in the level of radon gas.

Figure:



Figure 1. Safety Siren PRO 3 radon gas detector and WCDMA(KEM-W320)

This paper presents the development of a radon concentration monitoring system, which uses the Safety Siren Pro Series 3 Radon Detector for detecting the radon particles and a data processing module with WCDMA communication capabilities for measurement results transmission and management as shown in Fig. 1 (b). The protocol is 3G WCDMA. The frequency is about 2GHz. The interface is 24pin receptacle type (UART/USB/power) and 40pin board-to-board connector. The connection of Siren Pro 3 and WCDMA module is shown in Fig. 2.

Figure:



Figure 2. Connection of Siren Pro 3 and WCDMA module

### III. IMPLEMENTATION OF RADON MONITORING SYSTEM

Fig. 3 shows the home page of the radon monitoring system implemented in this paper. The map of South Korea is located in the center of home page. There are total 9 states in South Korea. One of them is Gyeonggi-do. It is of dark yellow color and the display is of 30/1.4. The dark yellow color means the radon concentration of 1.0 to 2.0 pCi/L. The display of 30/1.4 means that the total number of 30 radon gas detectors are installed and their average value is 1.4 pCi/L. The right column designates the average value of radon concentration for 9 states and 7 major big cities of our country.

Figure:

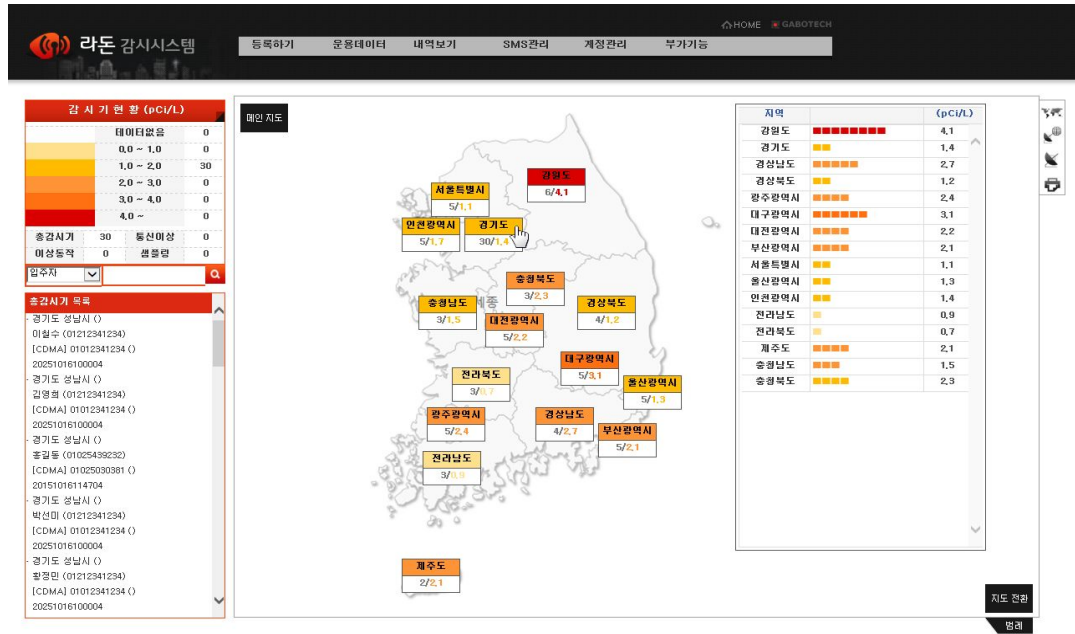


Figure 3. Home page of the radon monitoring system

Figure:

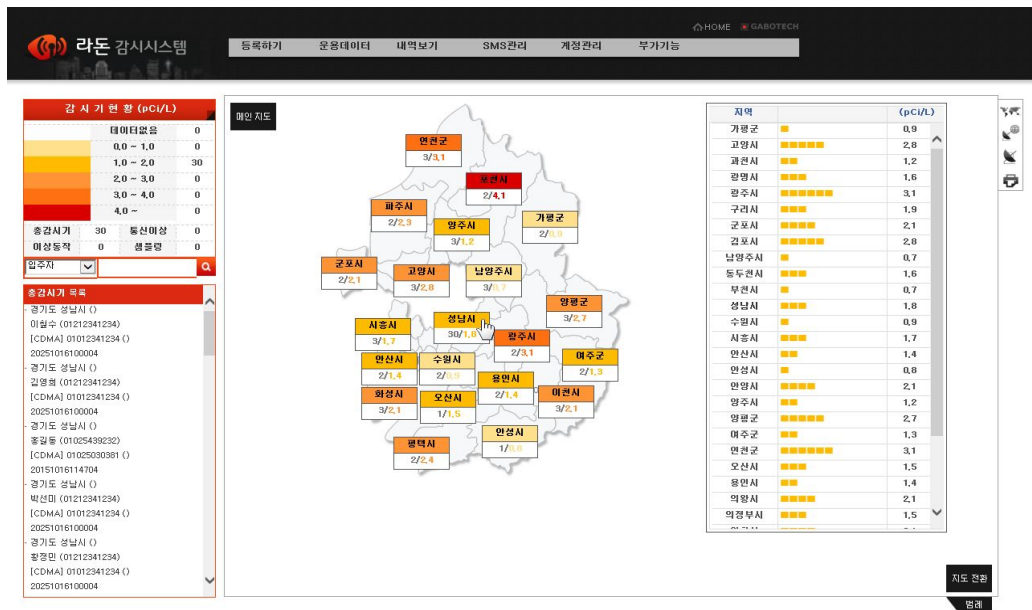


Figure 4. Radon data of Gyeonggi-do

If we click “Gyeonggi-do” at the home page of the radon monitoring system, several counties and small cities of Gyeonggi-do will show up. Similarly, the total number of radon detectors and their average value of radon concentration would be displayed. Fig. 4 shows the radon data of Gyeonggi-do. Next, assume that we clicked “Seongnam city” which is one of cities of Gyeonggi-do. Then, the street view of Seongnam city will show up in the monitor screen as Fig. 5. Also, many small circles with various colors are on it. Each circle designates the individual

radon detector installed in a house. If its color is red, the radon concentration is over 4.0 pCi/L, which is in dangerous status.

Figure:

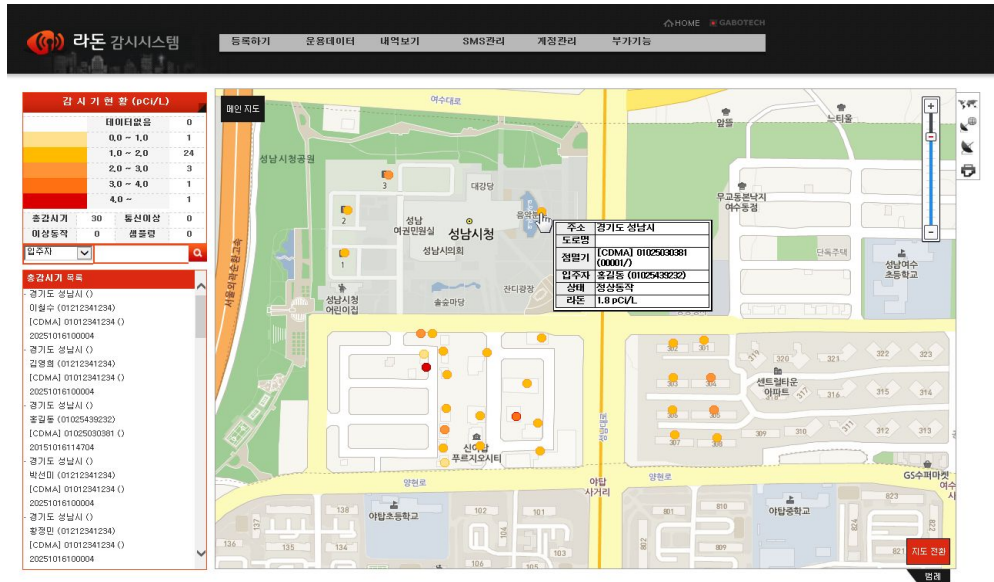


Figure 5. Street view of Seongnam city

Figure:

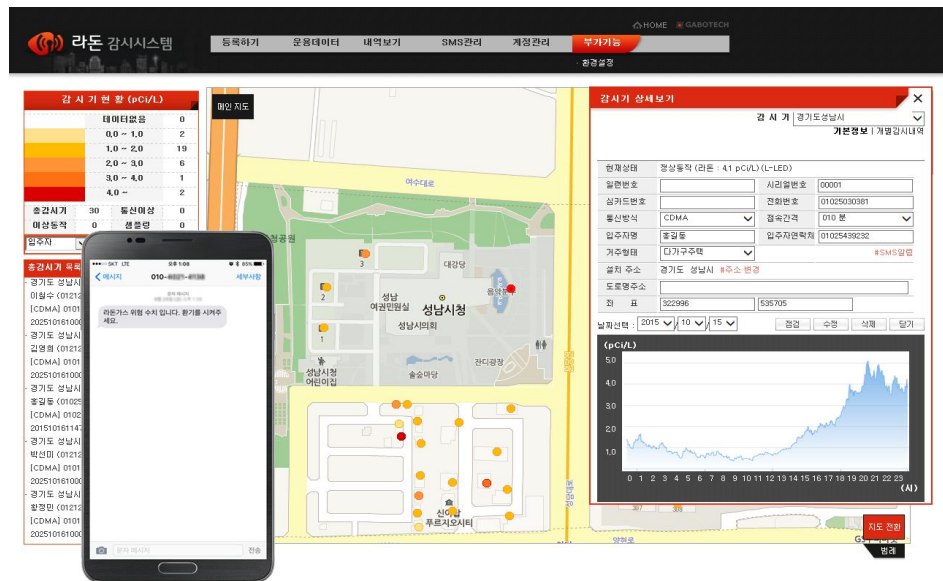


Figure 6. Radon graph and smart phone alarm message

Finally, if we click one of houses in the street view of Seongnam city, then the information of radon detector serial number, address, personal name, mobile phone number and radon real-time graph will show up. If the radon concentration is over 4.0 pCi/L for long time, an alarm text message will be sent to the resident as shown in Fig. 6.

#### IV. CONCLUSION

This paper presents the development of a radon concentration monitoring system. This solution represents an inexpensive, easy to use, portable Safety Siren Pro Series 3 radon detector and a radon monitoring system which can be used for monitoring the radon level in a specific location or for being a part of a distributed monitoring system. The WCDMA wireless communication module can send radon level measurements to a computer or a smart-phone.

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