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A STUDY ON THE EFFECT OFAIR FLOW IN RADON DETECTOR MODULE

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ABSTRACT

Radon is an invisible, odorless and chemically inactive radioactive gas that is produced by the decay of uranium ore. Various types of equipment and components have been proposed to date for radon detection. In this paper, a radon detector using PIN photodiode radon sensor module is implemented. In order to improve air flow in high voltage chamber, we set a fan on the top or the bottom of the chamber. Through some experimental studies, we found that the fan could improve air flow in the high voltage chamber, resulting in high sensitivity.

Keywords: *radon, radon detector, PIN photodiode sensor, air flow, sensitivity.*

I. INTRODUCTION

Radon is a natural, inert, invisible, odorless and chemically inactive radioactive gas emitted from the earth. It is produced by the decay of uranium ore, such as radium, actinium, or thorium. Because it is inert and does not chemically bond to elements, it is released from soil into the atmosphere. Radon is emitted almost everywhere on earth, but some geographical regions have higher concentrations than others. When radon decays, it released alpha particles with energy of 5.5 MeV. 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. It has been reported that the US. Environmental Protection Agency estimates exposure to naturally occurring radon leads to 21,000 lung cancer deaths nationwide each year, making radon the nation's primary environmental health threat and second only to cigarette smoking as a cause of fatal lung 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-2l8 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 α 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], the system is developed 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. In [7], 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 this paper, a radon detector using PIN photodiode radon sensor module is implemented. In order to improve air flow in high voltage chamber, we set a fan on the top or the bottom of the chamber. Through some experimental studies, we found that the fan could improve air flow in the high voltage chamber, resulting in high sensitivity.

II. IMPLEMENTATION OF RADON DETECTOR MODULE

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. Recently a PIN photodiode is more widely used than a conventional PMT, because it requires less bias to operate it and it is very compact. A PIN photodiode sensor

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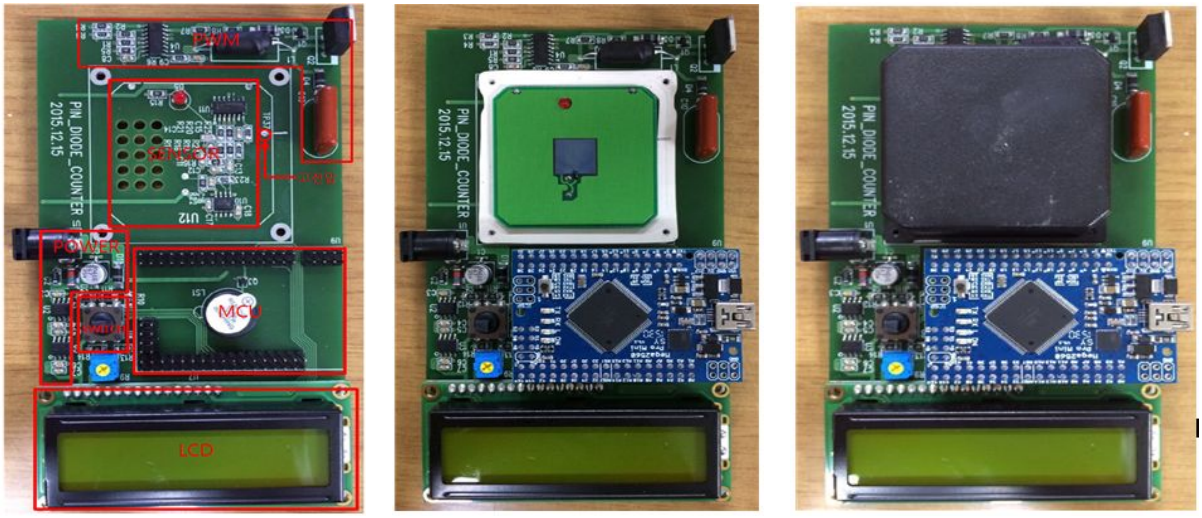
module was used for detecting of radon gas in this paper. The LCD display shows the level of radon gas in Pico Curies per liter (pCi/L). The display range is 0.0 to 999.9. The radon counter developed in this paper is designed to notify the user of the level of radon gas on either a short-term or long-term basis, and is updated every hour if there is a change in the level of radon gas. When a radon particle hits the PIN photodiode sensor, the output voltage level of the sensor will be slightly changed. In order to detect this voltage change for MCU, a pulse converting circuit is needed. The PIN photodiode radon detector is implemented as Fig. 1.

Figure:



(a)assembled LCD display (b)assembled radon sensor and MCU (c)assembled radon chamber

Figure 1. Implemented PIN photodiode radon detector

Figure:

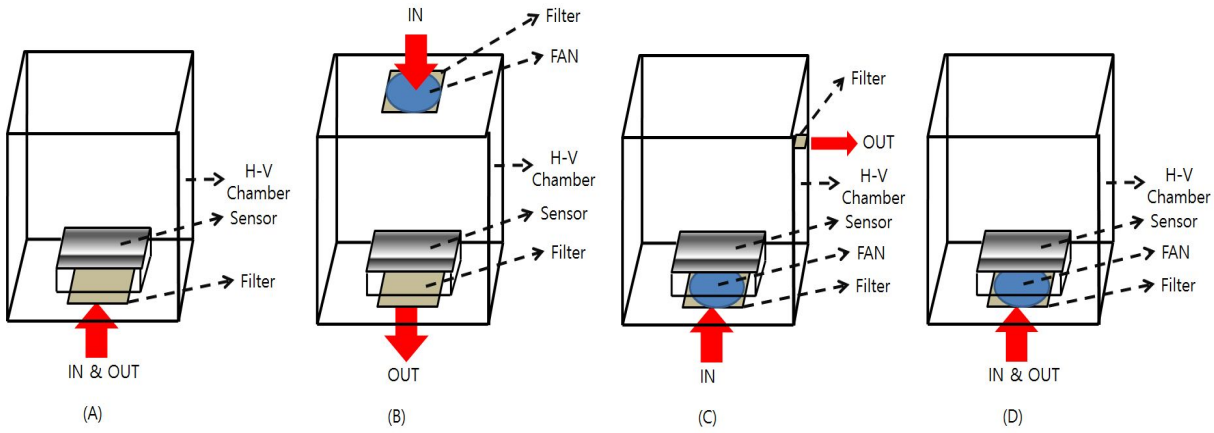


Figure 2. Air flow improvement using a fan

In this paper, we attempt to improve air flow in high voltage chamber, resulting in more radon counts per hour. For this purpose, we installed a fan on the top or bottom of the high voltage chamber as shown in Fig. 2. In Fig. 2, IN or OUT means the air flow direction. Fig. 3 shows the installation of a fan on the top of chamber as illustrated in Fig. 2 (B). On the other hand, Fig. 4 shows the installation of a fan on the bottom of chamber as illustrated in Fig. 2 (C),

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and (D). Fig. 5 shows the fan speed control using arduino PWM control program. As another attempt for air flow improvement, we used an air pump as illustrated in Fig. 6. Fig. 7 shows the experimental study of air flow improvement using a fan pump.

Figure:

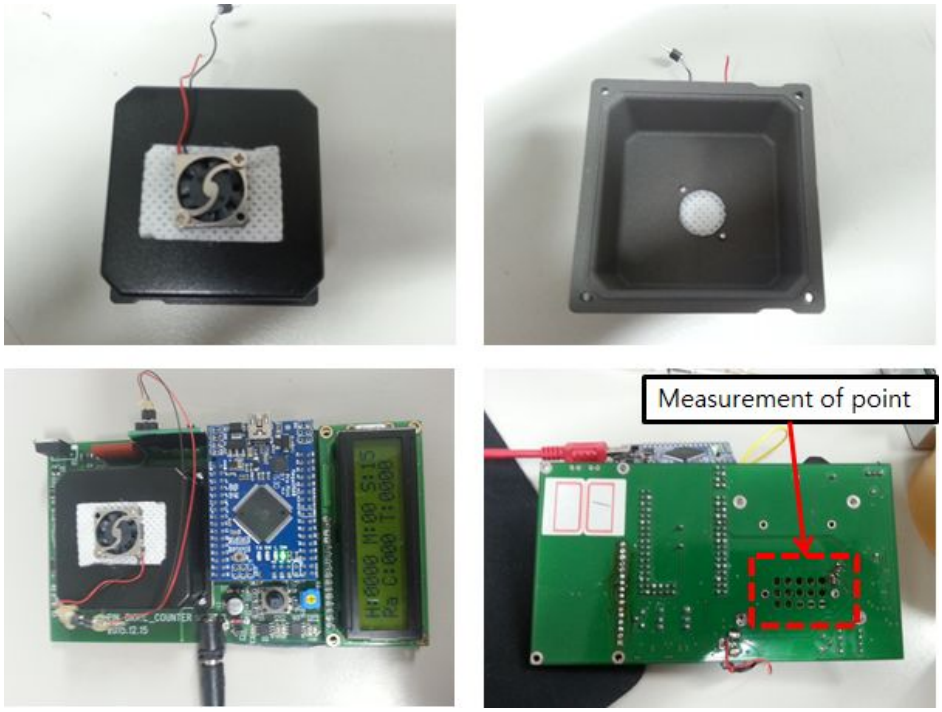

Figure 3. Installation of a fan on the top of chamber

Figure:

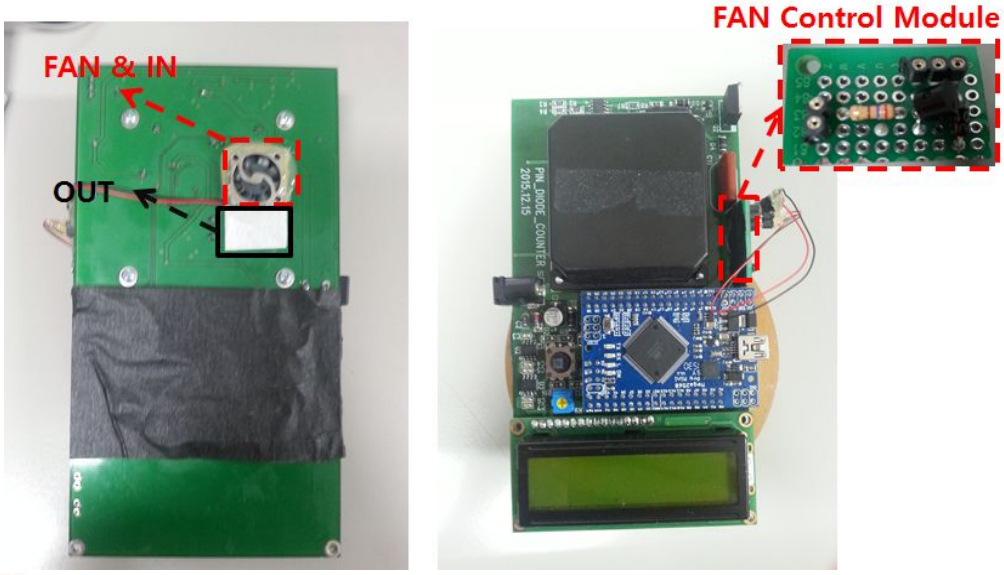

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Figure 4. Installation of a fan on the bottom of chamber

Figure:

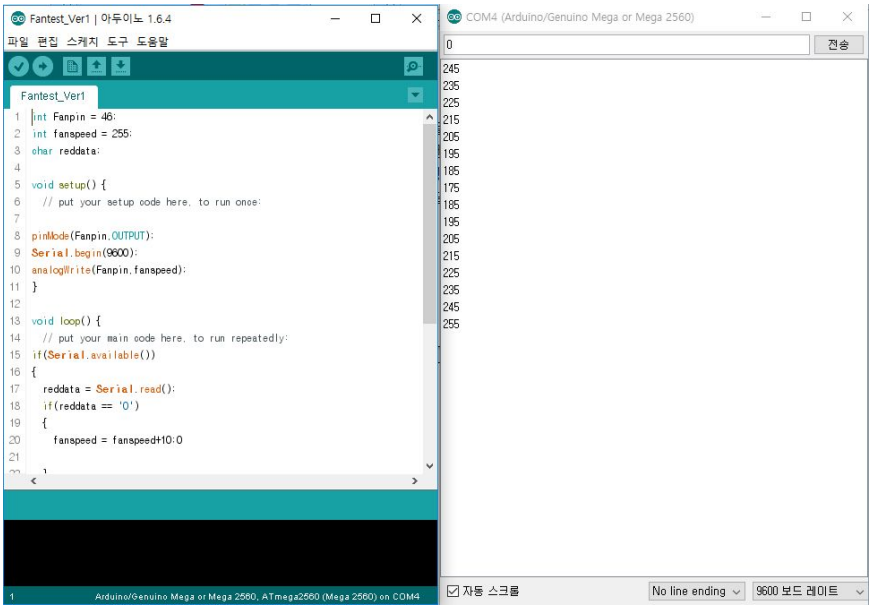

Figure 5. Fan speed control using arduino PWM control program

Figure:

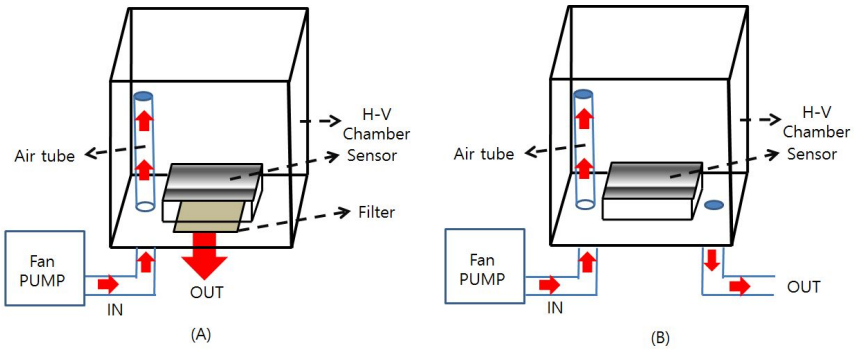

Figure 6. Air flow improvement using a fan pump

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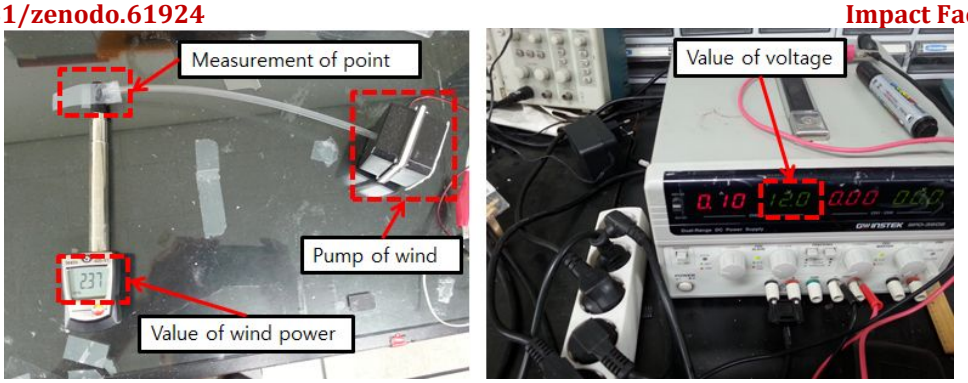

Figure 7. Experimental study of air flow improvement using a fan pump

This experiment was done for 10 days. In the case of the fan installed on top of chamber, the sensitivity of radon detection was improved about 30% better than the case of no fan. On the other hand, in the case of the fan installed on bottom of chamber, the sensitivity of radon detection was improved about 50% better than the case of no fan. Finally, in the case of the fan pump, the sensitivity of radon detection was improved about 80% better than the case of no fan.

III. CONCLUSION

In this paper, a radon detector using PIN photodiode radon sensor module is implemented. The LCD display shows the level of radon gas in Pico Curies per liter (pCi/L). The display range is 0.0 to 999.9. The radon counter developed in this paper 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. When a radon particle hits the PIN photodiode sensor, the output voltage level of the sensor will be slightly changed. In order to detect this voltage change for MCU, a pulse converting circuit is needed. In order to improve air flow in high voltage chamber, we set a fan on the top or the bottom of the chamber. Through some experimental studies, we found that the fan could improve air flow in the high voltage chamber, resulting in high sensitivity.

IV. ACKNOWLEDGEMENTS

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