

Development of IOT-based smart hazard condition sharing system

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Abstract- This paper introduces the development of smart hazard condition sharing system for saving lives in the event of danger for the workers who perform underground work in tunnels, communication work sites and manhole, etc, using IoT technology in order evacuate from dangerous conditions such as toxic gases in the underground environment and to monitor the conditions of other workers. Through this technology, working conditions of workers can be perceived by using images and sensing data, hazards to workers can be identified and the safety of workers can be ensured by providing reasonable measures on various risk factors that are scattered throughout the industry in a variety of fields. In addition, by providing a real-time work support information and by developing a smart hazard condition sharing system that can provide smart safety control and remote work support resulting in increased productivity, it will help to reduce the damage on industrial accidents of workers.

Keywords- IOT, sensor fusion, risk sharing, risk detection

1 Introduction

In recent years, the disaster in the industry has occurred in a variety of ways due to a diversity of equipment, the complexity of the human configuration and change of the working environment, etc. Especially to the SME's who are vulnerable to economic independence, organization, management and education of safety are emerging as a major problem due to the lack of management skills. In Korea, an entire industrial accidents since 1960s have shown a steady increase and according to the industrial accident statistics by the Ministry of Labor, since 1964 when the Workers' Compensation Insurance was introduced, the number of death, injuries and diseased workers due to industrial accidents have exceeded 5 million people resulting in a direct and indirect losses of 150 trillion won. In 2012, according to the industrial accident analysis data published by the Ministry of Employment and Labor, the number of victims in mining and manufacturing industries in 2011 accounted for approximately 92,256 people with death of 1,864 people. Among them, the number of accidents occurred in the manufacturing, construction and mining accounted for about 70%. As seen in Figure 1 and 2, most of fatalities and industrial accidents have occurred in mining, manufacturing and construction industries and especially in mining sector, it

has show highest ratio of fatalities compared to entire industrial accidents. This shows that the cause of fatalities to the workers in mining and construction industries occur from dust, gases and fall, etc, and especially it is believed that the damage is more severe since the workers cannot detect the hazard conditions of work sites in advance.

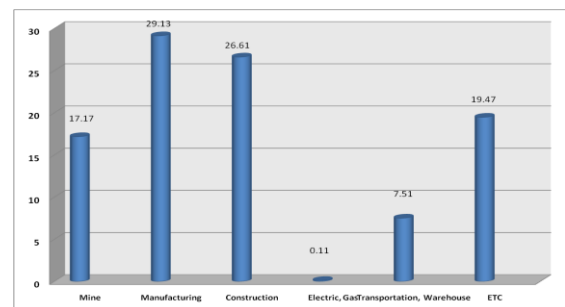


Fig. 1. 2012 Distribution of fatalities per industry

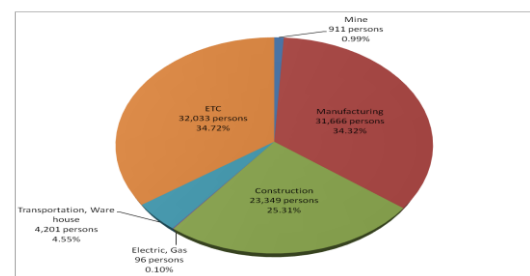


Fig. 2. 2012 Distribution of industrial accidents by industry

Therefore in this paper, by collecting work environment information through intelligent safety management equipment and by combining the information related to pre-defined work and perceiving various risk factors at work sites that require safety, a real-time work support information and hazard factors can be provided in order to propose a smart hazard condition sharing system that can enhance the safety of workers with additional system that can support remote operations. This system consists of intelligent safety management equipment where workers can detect hazard factors at work sites, application software

which processes detection of hazard conditions and sharing in real-time basis and smart work management software that controls and monitors the entire work site.

2 Methodology

2.1 Environmental data sensor module

Environmental data sensing is one of the biggest hazards among the risk factors of workers and requires a sensing data for gases such as oxygen, carbon monoxide and methane, etc according to the work environment. In order to process the sensing data, the values coming from the sensors are filtered according to its characteristics using PIC16F676 made by Microchips. It is a passive sensor module that quantifies using the ADC. A passive sensor module refers to the module having the function of measuring the sensor values when the main module commands the sensor values to be sent. This module has a calibration function for the zero point adjustment. In addition, it can be interlocked with oxygen, carbon monoxide and methane sensors to fit the working environment.

2.2 Hazard detection algorithm

Hazard detection technology provides independent detection of hazards from harmful environment in industrial work sites using the intelligent safety management equipment(worker). By collecting surrounding environmental values of workers, the sensor of intelligent safety management equipment detects the hazard conditions.

Technology that recognize the environmental sensing information from industrial safety sensors of intelligent safety management equipment, current location information and the hazards from behavioral information.

Technology that immediately operates the response module in order to inform the workers wearing the intelligent safety management equipment of detected hazards.

Hazard element detection at work sites can create effects that can reduce the impact of accidents by mapping the map information of the site with the location of objects to pre-inform the intelligent safety management equipment(workers) when they are entering hazardous areas in the work site and provides safety precautions. In addition, by inferring the condition of the intelligent safety management equipment through moving/behavioral detection, it can help in faster, more accurate accident response. The Figure 3 is a behavioral detection block diagram of intelligent safety management equipment.

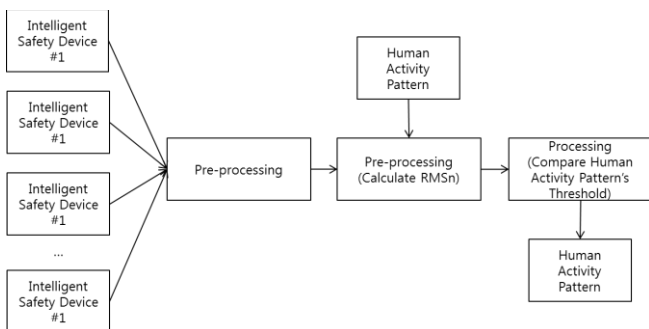


Fig. 3. Behavioral detection block diagram of intelligent safety management equipment

2.3 Hazard element sharing algorithm

Hazard alarm sharing function is required between the objects in order to share the hazards between the workers at the site and this function is made through a dynamic virtual sharing network(WBAN). Sharing network has the concept of virtual reserved network.

It holds local sink node of each WBAN as a member. For this reason, the local sink node of each WBAN must be able to support the WBAN model for communicating with the sensor node of WBAN and the sharing network mode for communicating with the local sink node of other WBAN on the shared network. In WBAN mode, it collects the environmental sensing data from each WBAN's configuration sensor node and determines the hazard. The Figure 4 explains the alarm sharing protocol for spreading the hazard conditions.

3 Smart hazard condition sharing system

The system proposed in this paper consists of intelligent safety management equipment where workers can detect hazard factors at work sites, application software which processes detection of hazard conditions and sharing in real-time basis and smart work management software that controls and monitors the entire work site. The Figure 4 is a target configuration of IOT-based smart hazard condition share system.

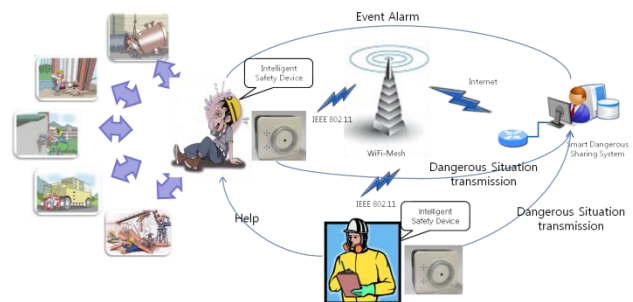


Fig. 4. Target configuration of IOT-based smart hazard condition share system

3.1 Intelligent safety management equipment

Intelligent safety management equipment is a module which contains environmental data sensor for sensing the environment, communication module and image sensing module for collecting image data in the occurrence of hazardous conditions and obtaining a variety of environmental information. It also has immediate alarm function for hazard recognition. Intelligent safety management equipment includes profile management DB of workers and environmental information management DB. When recognizing the hazard, it has the alarm function to warn the corresponding and surrounding workers of hazardous conditions.

3.2 Smart Hazard condition share application software

Industrial safety smart hazard condition share application is a software that operates under embedded Linux ported to smart safety management equipment which operates in a form of thread and plays the role of collecting sensor data, sharing and detecting hazard conditions along with collection of images and transmission.

Hazard condition share application software largely consists of sensor data and image data collection block and hazard condition detection/sharing block. The Figure 5 is a block diagram of sensor and image data collection block. Smart safety management equipment completes the communication module settings as the power turns on and prepares for the transmission of the sensor data and image data. In addition, it prepares to communicate with the smart hazard condition share server and when the hazard condition is detected it immediately sounds the alarm and transmits the event information to the operation software in the server. Smart hazard condition share server operates with the process of commanding the support and informing the hazard conditions to the surrounding workers based on the location of the workers.

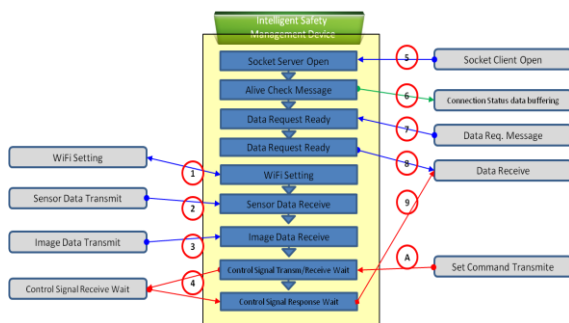


Fig. 5. Block diagram of sensor and image data collection and communication settings

4 Conclusion

This paper has proposed the IOT-based smart hazard condition share system for minimizing the personal injuries due to industrial accidents by detecting hazard conditions of workers in inferior sites using the sensor fusion and hazard condition share technology and by sharing the hazard conditions with the operation center and surrounding workers. The smart hazard condition share system consists of intelligent safety management equipment that can identify the conditions of workers with the detection of surroundings at the same time, application program having sharing function on hazard conditions and the smart hazard condition share server program.

The existing safety management system in industrial sites were operated in the method of preparing for safety by the workers themselves causing much accidents due to carelessness and leading to astronomical direct and indirect social costs. When using the smart hazard condition sharing system proposed in this paper, it can detect the hazard conditions at the work sites in advance, When using the smart hazard condition share system proposed in this paper, it can detect the hazard conditions at the work sites in advance, and even if hazard conditions do occur to the workers, it can minimize the fatalities by sharing the information on hazard conditions and allowing the support from the surrounding workers and managers thus it is expected to minimize the enormous social cost.

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