Proposal of System to Prevent Heat Stroke Using Acceleration Sensor and Smartphone

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Abstract

In recent years, people who fall or die by heat stroke has increased. In particular, about 80 percent of deaths from heat stroke are elderly people over the age of 65. One factor of heat stroke is that people do not know limit point of the activities in bad environment. Therefore, we propose a new system to prevent heat stroke using acceleration sensor and smartphone. By using this system, everyone will be able to make moderate outdoor activities. By measuring temperature, humidity, and momentum, this system estimates the risk of heat stroke using the fuzzy reasoning.

Keywords: heat stroke, smart phone, fuzzy reasoning.

1. Introduction

By global environmental change such as global warming, abnormal weather events are occurring and there has been an increase in boiling hot day in the summer in Japan^(1,2). According to the “Climate Statistics” of “Japan Meteorological Agency”, the global annual average temperature is rising at a rate of about 0.68 degree per century⁽³⁾. In the scorching heat, heatstroke patients have been increase and they often become heat stroke when put up with hot weather^(4,5). According to the “Bulletin Report on Heatstroke Patients” of the “National Institute for Environmental Studies”, the number of patients with heat stroke in Tokyo in 2011 was 2,712 people⁽⁶⁾. There are cases of death by heat stroke⁽⁷⁾. The prevention of heat stroke is very important⁽⁸⁾.

Therefore, we propose alert system for prevention of heat stroke. We decided on use of the smartphones as to conform to this system because smartphones can be carried

at all times and easily incorporated into this system. Furthermore, since smartphones have spread rapidly in recent years, it is easier to spread this system⁽⁹⁾.

In this time, the external measuring equipment is used in measure of humidity and temperature. However, we assume that the smartphones of Android spread in the future will be able to measure humidity and temperature because temperature and humidity API has been added in Android⁽¹⁰⁾. We had been estimated from the pressure and temperature and humidity the risk of heat stroke. In this study, we estimates that are specific to personal data of the usual and momentum obtained from the acceleration sensor.

2. System to Prevent Heat Stroke Using Acceleration Sensor and Smartphone

2.1 Summary

In this system, by using the smartphone, and inform the risk of heat stroke to the user. Therefore, we measured momentum, temperature-humidity, and atmospheric pressure, is calculated by using a fuzzy inference the risk of heat stroke. By managing a server environment data obtained, it is possible to display the map information obtained elsewhere in the same time zone. The structure of this system is shown in Fig. 1.

2.2 Structure

This system is made up smartphone, the sensor unit, from the server. Smartphone operating systems is Android 2.3.3. Sensor unit, ADK board and various sensors (Arduino, ADK R3). Sensor unit to measure temperature and humidity, barometric pressure, momentum, the radiation dose. Longitude and incorporation of these data, to measure the time and latitude, smartphones, and displays

Fig. 1. Structure of this system.

Fig. 2. Prototype of the sensor Unit.

Fig. 3. Digital humidity sensor.

Fig. 4. Acceleration sensor.

Fig. 5. Atmospheric pressure sensor.

them. Humidity and temperature are measured by Digital Humidity Sensor (Sensirion, SHT11). Fig.3 shows the picture of Digital Humidity Sensor. Measurement of momentum, use the acceleration sensor (KXM52-1050). To obtain the acceleration in three directions, to calculate the momentum. Fig.4 shows the picture of Acceleration Sensor. Atmospheric pressure is measured by Miniature I2C Digital Barometer (Freescale Semiconductor, MPL115A2). Fig.5

shows the picture of Atmospheric pressure Sensor. Latitude and longitude are measured by the GPS that is built into the smartphone. Latitude and longitude are measured by the GPS that is built into the smartphone. In recent years, smartphone is developed an internal radiation dose sensor or humidity sensor and temperature. By using them, it is possible for the user without external sensor unit, to use this system. Since we do not use the smartphone built their

Fig. 6. Membership function.

sensor unit is mounted outside the smartphone in this paper.

2.3 Momentum

The amplified by the operational amplifier output X-axis of the acceleration sensor, Y-axis and Z-axis, through a filter of 0.1 ~ 30 Hz, then rectified, is synthesized. Set the threshold value and to output 0 or 1. The momentum of the current was measured by 1 second for 50 seconds, the closer to the current time, and multiplied by 0.02 fold increments coefficient As away and added. As a result, the range of values of the momentum of current is 0 ~ 25.5. The momentum of usual is to get in the cousin that takes a

value of the day each, to the average of daily results.

2.4 Display of Environmental Data

This system can display on a smartphone environmental data measured by the sensor unit. Environmental data is the radiation dose and the momentum and pressure and temperature and humidity. And this system can also display the history of environmental data. In addition, the system also can display the location of any environmental data via a server. Thus, users can use this system in accordance with the purpose such as moving to a cool place. This system uses Google

Table 1. The rules for fuzzy.

Not higher the degree of risk		WBGT	High			Low		
Momentum of usual	Motion state of current	AGE	High	Slightly higher	Low	High	Slightly higher	Low
High	Intense		Very increasing	Very increasing	Very increasing	Increasing	Little increasing	Keep
	Not violently		Increasing	Little increasing	Little increasing	Keep	Keep	Keep
Low	Intense		Very increasing	Very increasing	Very increasing	Little decreasing	Keep	Keep
	Not violently		Increasing	Increasing	Little increasing	Keep	Keep	Keep

Higher the degree of risk		WBGT	High			Low		
Momentum of usual	Motion state of current	AGE	High	Slightly higher	Low	High	Slightly higher	Low
High	Intense		Increasing	Increasing	Increasing	Little increasing	Keep	Keep
	Not violently		Increasing	Little increasing	Little increasing	Decreasing	Decreasing	Very decreasing
Low	Intense		Very increasing	Very increasing	Very increasing	Keep	Keep	Keep
	Not violently		Increasing	Increasing	Little increasing	Little decreasing	Little decreasing	Decreasing

Maps.

2.5 Degree of Risk

This system estimates the degree of risk of heat stroke and advises the user depending on the risk. From temperature and humidity measured by the sensor unit, the system calculates WBGT. WBGT is an index to evaluate heat stroke^(11,12). In order to calculate degree of risk of heat stroke, the relationship of temperature, humidity, Motion state of current, Momentum of usual, AGE, and WBGT is used⁽¹³⁾. This system estimates the current degree of risk of heat stroke from the previous degree of risk and WBGT and the relationship of temperature, humidity, Motion state of current, Momentum of usual by the fuzzy reasoning. By using the fuzzy inference, the system can estimate the changes similar to human senses⁽¹⁴⁾. The membership function is shown in Fig. 6. The rules for fuzzy reasoning are shown in Table 1.

3. Experiment

This measurement of the data used is carried out at the premises of Kitakyushu National College of Technology in

Fig. 7. Display of status.

Japan. The subjects to obtain data with a measurement apparatus have a move 20 minutes school. The granularity of temperature is ± 0.5 degree, and the granularity of humidity is ± 3.5 %. The measured values were used value to first place of decimals. In this experiment, the sending

Fig. 8. Display of status on map.

Fig. 9. Display of degree of risk.

the data of environmental status to the server be omitted. Threshold value of the acceleration sensor is 2 volts. The display screen of the environmental data is shown in Fig. 7. The information acquired on the map is shown in Fig. 8. In addition, red dot positions indicate high degree of risk as shown in Fig. 9.

4. Conclusions

The results of this experiment, it is possible to use this system, to prevent heat stroke. However, in the experiment, since carried out in Table measuring device, it is considered that when it is used, to be used to put the like in a bag probably. Therefore, there is a possibility that measurement errors may occur. The system can improve the accuracy of the measurement result by taking environmental data more.

Further, by having to keep data from the momentum

daily, it is possible to calculate the risk had the individual. It was possible by the calculation of the momentum by the acceleration sensor, the difference in momentum of the person, making the system that is specific to individual.

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