International Journal of Engineering Research and Science & Technology

www.ijerst.org

ISSN : 2319-5991

Vol. 22 No. 3 (2026)

ijerst.editor@gmail.com

editor@ijerst.com

ISSN 2319-5991 www.ijerst.com

Peer Reviewed, Referred & Indexed Journal

Research Paper

Smart Heat Stroke Detection and Prevention System Using Vital Signs Monitoring

Ms. N.Revathi, Dr.R.vasuki
Department of Biomedical Engineering, Bharat Institute of Higher Education and Research, India
hod.bme@bharathuniv.ac.in

ABSTRACT

Heat stroke is a serious, heat-inducing disease that may have fatal consequences if it is not identified in time and treated. This paper proposes a solution for an IoT-based Heat Stroke Detection and Prevention System that continuously detects vital signs and environmental conditions. The heart rate sensor, respiration sensor, and DHT11 sensor are combined with an Arduino Uno microcontroller in the system to detect body parameters and ambient factors. Information can be presented on an LCD and sent over IoT to be remotely monitored. With the detection of abnormalities, alerts are issued so that, as soon as possible, some preventive measures are taken to avoid loss of safety and minimize the risk of heat stroke.

Index Terms: *Arduino Uno, Heat stroke detection, IoT healthcare, LCD display, Physiological monitoring, Respiration sensor, Wearable sensors*

INTRODUCTION

One of the most serious heat illnesses is heat stroke, which in many cases is caused by long-lasting exposure to high ambient temperatures and insufficient fluid drinking. It is defined by a potentially mortal elevation of body temperature, most frequently over 40°C, and it can also be accompanied by confusion, dizziness, fast pulse rate, and even organ failure unless treated quickly. Therefore, early detection and timely intervention are required to avoid fatal outcomes [1]. Conventional approaches toward the detection of heat stroke are rooted in manual monitoring and subsequent clinical detection, which do not necessarily work effectively in high-threat settings such as outdoor workplaces, sports, and military operations. A Smart Heat Stroke Detection and Prevention System based on vital signs monitoring is proposed to meet these challenges. Wearable sensors constantly monitor important signs such as body temperature, heart rate, blood pressure, and hydration of the body. There is real-time processing of data and detection of abnormal patterns that can show the development of heat stroke [2].

The system has the capability of alerting both the individual and caregivers when critical thresholds are detected, therefore facilitating prompt interventions. The combination of smart analysis and health monitoring is a proactive approach that intensifies individual safety and prevents dangerous health complications by detecting them in advance.

Heat stroke can be life-threatening with a mortality rate up to 70 percent, though by far slightly sooner than 100 percent when treated promptly. This emphasizes the necessity to have a wearable device that is able to recognize a possible heat stroke at an early phase. As technology explodes, the Internet of Things is an emerging capability that has played a critical role in the field of healthcare and enables the use of personal healthcare devices and E-Health systems. The older heat stroke detection devices were, however, limited. The other used costly sensors and transmission modules, and failed to take into consideration the effects of the Thermal Heat Stroke Risk Coefficient (THSRC), and also lacked an end-user monitoring system [3].

Global warming has also seen an unending increase in the temperature of the Earth's atmosphere, resulting in a lot of heat waves. A heat wave can be defined as a prolonged duration of elevated temperature, growing in most cases above 32 degrees Celsius or more 4 days in a row. This climate threat is extremely hazardous to human life and environmental processes, and its effects keep getting worse every year. The most frequent health problems are heat stress and heat exhaustion, particularly among outdoor workers, the elderly with circulatory illness, and children. The necessity of effective monitoring and prevention systems of heat stroke day by day [4].

RELATED WORKS

Lim et al. [5], the combination of IoT with Machine Learning (ML) is vital in predicting and preventing heat-related illness, especially when it relates to early detection. Wearable devices with IoT capabilities, using sensors, can monitor changes in the environment, including temperature and humidity. A few important signs, such as body temperature, heart rate, and sweat level, are also taken into consideration. The collected real-time data can then be processed with ML algorithms to detect hidden patterns and correlations that can point to the predisposition to heat stroke or other diseases. Predictive models are used to make early warnings and alerts, and people can avoid by taking precautions, such as hydrating, seeking shade, and cooling. The proactive intervention minimizes cases of heat-related illnesses and

minimizes hospital admissions. Hence, the present work relates to making a heat stroke detection system using IoT and augmenting it with ML algorithms to predict it precisely.

Shimazaki et al. [6], thermoregulation aids in maintaining the level of homeostasis of body temperature by balancing the production of heat and dissipating heat. When this balance is not maintained, the body cannot keep its core temperature safe, causing heat stroke. The condition usually starts by showing mild symptoms such as weakness, light-headedness, and headache, but when not treated, it may lead to serious central nervous disorders such as convulsions, coma, and even death. The issue of heat stroke is a main focus of people who are exposed to high-temperature scenarios, especially those working in warehouses, boiler rooms, and construction sites. Garcia et al. [7], even though direct evidence cannot prove that dehydration is one of the causative factors of exertion heat stroke (EHS), it is logical to think of it as a major risk factor for EHS based on its physiological consequences. Blood plasma is nearly 90 percent water, and plasma volume is depleted during exercise due to the escalation of metabolism and the production of sweat. This increases plasma osmolality and blood viscosity, which are associated with increased synthesis of reactive oxygen species. An increased osmolality results in a shift of water between the intracellular and extracellular spaces, and elevated viscosity leads to a degree of cardiac drift and increased cardiac strain. Massive plasma volume depletion can cause orthostatic hypotension, sequelae effects, reduced cerebral blood circulation, and syncope. Additionally, exercising in hot conditions increases the rate of sweating and thereby increases fluid loss, increasing the risk of heat stroke.

Sorensen and Hess [8] state that heat illnesses are possible even without a heat wave and high levels of suspicion are required in the presence of suggestive symptoms. A quick appraisal of the recent exposure to heat and effort by the patient must be performed in the earliest assessment, and this can be done by taking into consideration the details provided by the emergency medical providers, the patient himself, or any other sources possible. Core body temperature measurement is critical, and it should be remembered that the temperature can drop even prior to the moment of clinical assessment.

PROPOSED WORKS

The suggested project is devoted to the creation of a smart heat stroke sensor and prevention system based on the usage of IoT-enabled sensors and embedded program code. The hardware architecture has been created so that important elements such as a stable power supply, Arduino

Uno microprocessor, LCD screen, and IoT connectivity are incorporated to guarantee real-time monitoring and data transmission. Vital signs are continuously monitored with the help of a heart rate sensor, a DHT11 sensor of temperature and humidity, and a respiration sensor that records the breathing mode as shown in Figure 1. A combination of these inputs results in precise physiological and environmental data that can be used to detect heat stroke early on. This implementation is enabled by the Arduino IDE, and the programming is done in Embedded C language to ensure the software is effective in processing the information, integrating the sensors, and controlling the system. The suggested system maintains a critical data point on the LCD and sends it through IoT to remote access to monitor the condition of individuals, to preemptively act towards preventing heat-related illnesses.

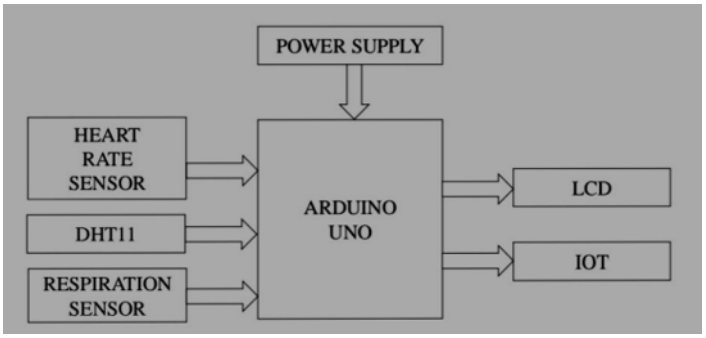

Figure 1: Block Diagram of Proposed Work

HEALTH MONITORING MODULE

The Health Monitoring Module is developed to enable the continuous monitoring of important physiological and environmental data with the aid of onboard sensors. A stable power supply also provides power to the system, and hence the Arduino Uno microcontroller operates continuously. Arduino Uno is used as a central processing unit, which communicates with three sensors. The Heart Rate Sensor detects the cardiovascular status of the individual by recording real-time pulse information, which is also important in detecting the initial stages of heat stress. DHT11 Sensor can measure temperature and humidity of the environment and provide crucial environmental information that could be used to determine the level of heat exposure. Also, the Respiration Sensor monitors breathing rate, which can also vary during a state of heat stress. All the received data is sent to Arduino Uno to process and compare with the set thresholds. In case of patterns that are abnormal, it can be sent to the alerts and display modules, where some pre-emptive measures can be taken. A block diagram is shown in Figure 2 of all components.

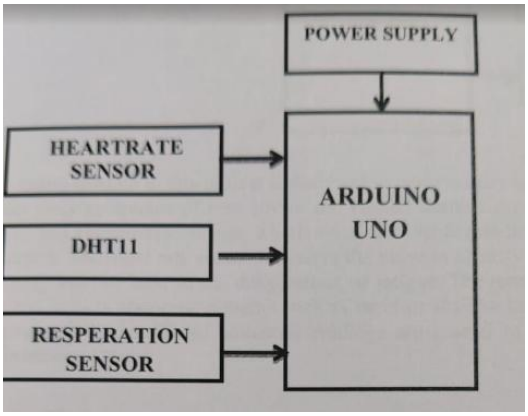

Figure 2. Block Diagram of Health Module

ALERT AND NOTIFICATION MODULE

The Alert and Notification Module is a fundamental feature of the suggested heat stroke detection system, as it is imperative that once abnormal physiological or environmental values are sensed, it is effectively relayed. The health module provides ongoing monitoring of critical parameters such as the heart rate and the respiration rate, the alert module becomes the second line of defense as it gives timely warning to the user when there is a critical overrun. Instead, when the irregularities such as abnormalities in heart rate, odd breathing patterns, or other precursors to the heat-related illnesses are caught, the Arduino Uno can analyze this data and trigger the alarming mechanism accordingly. The alerts can be created both locally, by means of a buzzer or a vibration motor to alert the person directly, and remotely, with IoT integration that can relay the data in mobile apps or cloud-based systems to caregivers, medical experts, or monitoring systems. Such a two-level monitoring and alertness guarantees the safety on their own as well as outside monitoring, permitting an instant reaction before the situation gets out of control and turns into a critical medical condition. All the configurations of alert and notification module are shown in Figure 3.

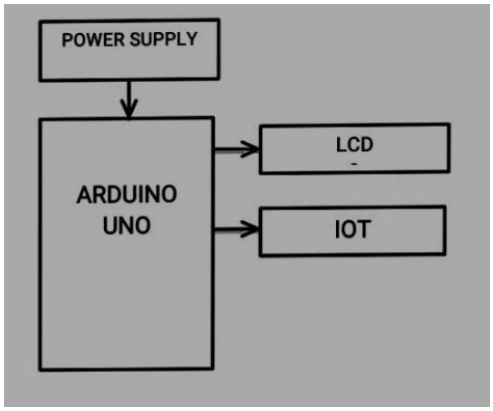

Figure 3. Block Diagram of Alert Module

DISPLAY AND USER INTERFACE MODULE

The Display and User Interface Module is an essential feature that displays the current data about the health and the physical environment in a concise, easily readable format to the user. In this set up, an LCD has been interfaced with the Arduino Uno to follow up the readings that were recorded with the help of the heart rate sensor, respiration sensor, and DHT 11 sensor (figure 4). Body temperature, heart rate, respiration rate, and humidity levels are displayed on the screen thus allowing the user the opportunity to instantaneously monitor their health status. In this module, a clear indication of normal and abnormal conditions is made. As an example, when sensor values grow above the preset limits, warning states can be displayed on the LCD, indicating to them that they must take action to prevent the situation without hesitation. It has such a structure that the interface is easy, user-friendly, and effective enough that even ordinary people can effortlessly analyze the information listed on its screen.

Besides the local display, this module can supplement IoT-based monitoring to provide real-time data visualization to remote users. Both the interface and the display can easily grant individuals the opportunity to self-monitor themselves as well as improve the reliability of the system, since timely access to important information is possible on site and has a beneficial outcome in terms of decreasing the amount of time before the individuals face the risk of heat stroke, and can be addressed.

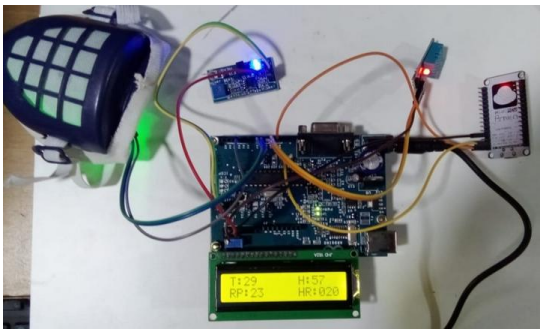

Figure 4. Prototype of IoT-Based Heat Stroke Detection System

RESULTS AND DISCUSSION

The functional prototype of the Physiological and Environmental Monitoring IoT-Based Heat Stroke Detection and Prevention System was developed and tested. The Arduino Uno was

combined with a heart rate sensor, respiration sensor, and DHT11 sensor, and real-time values were presented on the LCD module [9]. Testing was conducted at ambient temperature values of 28-35 degree Celsius, and ambient humidity of 45-70%. These values were useful in having insights into environmental heat index. The respiration sensor was accurate to within 2 breaths per minute, and the actual respiration levels were generally between 18-26 breaths per minute in the regular state. On the same note, the heart rate sensor gave results of true pulse levels as pulses were recorded, ranging between 65 and 120 pulses per minute regarding the level of activities of a user.

Some of the sample readings recorded through the system were temperature 29ºC, humidity 57%, respiration 23 resp per minute, and Heart rate 80 beats per minute. The values were normal and are shown clearly on the LCD. But, once the environmental temperature surpassed 32ºC, the humidity level crossed 65%. These were identified by the system as risk factors. Upon that, the alert system was triggered, resulting in local alarms and IoT-sent out-of-band alerts to be monitored remotely. The final outcomes verified that the system was able to monitor critical health and environmental readings, signal the early onset of heat stress, and issue real-time warnings to forestall its progression to serious heat stroke.

The proposed IoT Heat Stroke Detection and Prevention System proves that a combination of wearable sensors and real-time monitoring can help mitigate the dangers posed by illnesses related to the heat [10]. The findings showed that there was potential for the system to be used in order to measure and present the important parameters of temperature, humidity, respiration rate, and heart rate with acceptable accuracy. Among the principal advantages of this type of system, the combinatorial use of environmental information and physiological indicators has to be mentioned, which allows us to get a complex general analysis of the level of risk of this or that user. As an example, a high heart rate or frequent breathing in a hot and humid environment was a good proxy of possible heat stress, making a good reason to consider multi-sensor fusion. The presence of the alert and notification system further enhanced the reliability of the system, as users know about it instantly, and it can be remotely monitored using IoT. This is a very useful feature, especially in the industrial and outdoor workplace environment where workers might be receiving harsh conditions throughout. Nonetheless, it was found to have certain limitations, including the reliance on the low-cost sensors, which can somewhat impact accuracy, and the system not being able to work without a constant supply of power. Although these limitations exist, the system offers a cost-effective scalable

application to prevent heat stroke in a practical manner that is consistent with the rising need of IoT-based health care applications. The findings confirm the ability of the system in identifying risk conditions and readings that distinguish between alert and normal statuses.

CONCLUSION

The Heat Stroke Detection and Prevention System, designed and built on the framework of the Internet of Things, effectively proves the potential of smart technology in achieving the health benefits of wearable monitoring devices by assisting in the early detection of heat-related illnesses to prevent life-threatening complications such as heat stroke. This integration of sensors, including the heart rate sensor, respiration sensor, and DHT11 to monitor the temperature and humidity, allows the system to have constant monitoring of the physiological and environmental parameters. The Arduino Uno functions as the heart of the system where various data are collected, calculated, and shown on LCD. Once unusual conditions are identified, the alert and notification module sends immediate warnings, both on a local and a remote scale, enabling an immediate intervention.

The findings confirm the ability of the system in identifying risk conditions and readings distinguish between alert and normal statuses. This is an affordable, scalable solution, despite the fact that accuracy depends on the quality of sensors and the necessity to provide stable power supply. In general, this project demonstrates the possibilities of IoT in health areas and provides a proactive user-friendly way of minimizing cases of heat stroke and maximizing individual safety in a place of high risk.

REFERENCES

[1] Shimazaki, T., Anzai, D., Watanabe, K., Nakajima, A., Fukuda, M. and Ata, S., 2022. Heat stroke prevention in hot specific occupational environment enhanced by supervised machine learning with personalized vital signs. *Sensors*, *22*(1), p.395.

[2] Shimazaki, T., Anzai, D., Watanabe, K., Nakajima, A., Fukuda, M. and Ata, S., 2022. Heat stroke prevention in hot specific occupational environment enhanced by supervised machine learning with personalized vital signs. *Sensors*, *22*(1), p.395.

[3] Son, T.W., Ramli, D.A. and Abd Aziz, A., 2021. Wearable heat stroke detection system in IoT-based environment. *Procedia Computer Science*, *192*, pp.3686-3695.

[4] Javed, S., Ghazala, S. and Faseeha, U., 2020. Perspectives of heat stroke shield: an IoT based solution for the detection and preliminary treatment of heat stroke. *Engineering, Technology & Applied Science Research*, *10*(2), pp.5576-5580.

[5] Lim, C.W., Yogarayan, S., Abdul Razak, S.F., Ali Bukar, U. and Sayeed, M.S., 2024. Heat stroke prediction: a perspective from the internet of things and machine learning approach. *International Journal of Electrical and Computer Engineering (IJECE)*, *14*(3), pp.3427-3433.

[6] Shimazaki, T., Anzai, D., Watanabe, K., Nakajima, A., Fukuda, M. and Ata, S., 2022. Heat stroke prevention in hot specific occupational environment enhanced by supervised machine learning with personalized vital signs. *Sensors*, *22*(1), p.395.

[7] Garcia, C.K., Renteria, L.I., Leite-Santos, G., Leon, L.R. and Laitano, O., 2022. Exertional heat stroke: pathophysiology and risk factors. *BMJ medicine*, *1*(1), p.e000239.

[8] Sorensen, C. and Hess, J., 2022. Treatment and prevention of heat-related illness. *New England Journal of Medicine*, *387*(15), pp.1404-1413.

[9] Debele, G.M. and Qian, X., 2020, December. Automatic room temperature control system using Arduino Uno R3 and DHT11 sensor. In *2020 17th International Computer Conference on Wavelet Active Media Technology and Information Processing (ICCWAMTIP)* (pp. 428-432). IEEE.

[10] Tamura, T., Huang, M., Yoshimura, T., Umezu, S. and Ogata, T., 2022. An Advanced internet of things system for heatstroke prevention with a noninvasive dual-heat-flux thermometer. *Sensors*, *22*(24), p.9985.