

Design of a Smart Shirt to Monitor Human Body Temperature Using the Internet of Things

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Abstract—Health care systems were greatly affected by the COVID-19 pandemic. Everyone was feeling insecure, whether infected. Among the symptoms identified by the virus, body-temperature was the most prominent sign. This research proposes accurate body temperature monitoring without requiring close contact or affecting one’s normal business operations. This study presents a smart shirt design based on the Internet of Things applications. The proposed shirt will allow the wearer to monitor their body temperature. This is achieved using an Arduino microcontroller with a temperature sensor, a display screen, and a battery as a power source. In this system, the temperature sensor measures the body temperature and transmits the information to the microcontroller, which is displayed on the screen. This study identifies the most appropriate location for placing the smart components in shirt, considering the comfort and style of the wearer.

Keywords—*Internet-of-Things(IoT), Wearable Technology, Smart Clothing, , Microcontroller.*

I. INTRODUCTION

Clothing is one of our most basic needs. It serves a variety of purposes, from aesthetics to weather protection. In addition, clothing can also be used for health monitoring when the latest technologies are applied. Considering the recent COVID-19 pandemic, the importance of protective clothing, such as coveralls, and health monitoring cannot be overstated. There was a global health care crisis caused by the COVID-19 outbreak that overwhelmed the most advanced health care systems. A lack of access to health care, coupled with an overburdened healthcare system, everyone was in a vulnerable position, which sometime even lead to critical health conditions. As body temperature was the one of the basic symptoms of COVID-19, this study aims to develop a smart shirt that can be used for monitoring human body temperature.

There has been a wealth of literature reviewed during this study, some of which is presented here. Throughout human history, clothing has served a variety of purposes along with protection. Clothing plays a significant role in determining the wearer’s perception of comfort status because it connects the wearer’s body and the environment. Often, it is described as a ‘second skin’[1]. It is relatively new for functional clothing to be considered a segment of technical textiles. A functional piece of clothing is one that is specifically designed in order to fulfill a specific purpose beyond their normal design and use. A garment that adds value or function may be made from innovative materials or have innovative functionality [2]. In addition, the clothing can be embedded with electronic functions, such as wireless

transmitters and sensors, to facilitate the delivery of telemedicine services [3]. The recent COVID-19 outbreak impacted not only health care, but society, culture, and the economy as well. The suppression of viral transmission was significantly enhanced by non-pharmaceutical measures, even though advanced medical treatments failed. Personal protective equipment (PPE) and telemedicine have been made more effective by the use of functional and smart textiles [4]. In another study the authors developed a glove to measure vital signs of human body. Additionally, the incorporated system will notify the user if any vital signs indicate a life-threatening condition. The authors claim that the glove can be adapted to meet the needs of a variety of patients in a hospital environment [5]. Using design details and key technologies, the authors describe an implementation method for smart clothing systems. They discussed a variety of clothing applications, including medical emergency response, emotion-based care, disease diagnosis, and real-time tactile interaction. As a part of this study electrocardiogram signals are collected by smart clothing to monitor mood and detect emotions. Additionally, a number of challenges and issues related to implementing smart clothing in a broad range of contexts have been discussed [6]. Another study suggests that smart clothing can be used to monitor health. A smart clothing system, a sensing device, and a mobile device are included in the system design. The smart clothing collects electrocardiographic signals and heart rates. The system is evaluated in Taiwan for the use of elderly residents in a long-term care facility. The proposed system was found to be acceptable to both elders and caregivers [7]. Using advances in mobile communication, artificial intelligence, the Internet of Things (IoT), and big data, wearable technologies are transforming people’s lives. In addition to design specifications, textile materials, and suitable sensors, the authors present a framework for the development of smart clothing. A seamless sensor integration strategy for diagnostic and prognostic purposes is also suggested by the framework [8]. Clothing serves as a fashion statement as well as a form of protection, functionality, and comfort. All of these requirements must be met for a garment to be functional. Through the application of new technologies, clothing design can be improved to meet the needs of individuals, according to the study. Taking measurements and simulating wearable garments is crucial due to the adaptation of cuts to sitting positions [9].

The literature reviewed and presented as a part of this study indicates that no study has been conducted regarding the design of design of a smart shirt to monitor human body

temperature using the IoT applications. Hence, the proposed design can be considered novel with respect to its application with the following key contributions.

- The study will enable the wearer to be more confidently carry the dress in workplaces as well. As the integrated system will not affect the aesthetic of the dress.
- The designed dress will enable the wearer to monitor the body temperature anytime while wearing the dress and will reduce the unnecessary/excessive travelling to health care centers.
- The wearer will be able to monitor body temperature without holding a device all the time such as electronic forehead thermometer, electronic ear thermometer etc.

II. OVERVIEW OF TECHNOLOGY

Key technologies used in the design of the smart shirt include:

A. Internet of Things

A concept commonly referred to as Internet of Things (IoT) is the general concept of connecting objects to the internet. It automates things and minimizes human intervention. Humans and other objects are connected to the internet through the Internet of Things applications in order to acquire and analyze various types of data [10]. As a concept, the Internet of things may also be referred to as connected devices that transmit data from the real world to the digital one. Through this project, we have integrated a microcontroller with a human body temperature sensor to provide real-time data to a liquid crystal display (LCD) screen.

B. Wearable Technology

The term wearable technology refers to a category of electronic and mobile devices that are integrated into implants, accessories, or outfits and can serve as portable measurement devices on the body [11]. By using communications interfaces, smart wearables provide intelligent services by being positioned near, on, or in the body [12]. Throughout the course of this study the authors have used wearable devices to measure human body temperature that are smart and wearable. This study uses wearable components considering the comfort of the wearer. The details are presented in the next section of this paper.

III. SYSTEM COMPONENTS

A. Arduino uno

As a part of this project we have used arduino UNO microcontroller as an IoT device. Figure 1 shows arduino UNO. We have used this microcontroller in regards to its compact size and low-cost. Among its many features, Arduino UNO is a compact board based on the ATmega328P. As part of its design, it is equipped with a ceramic resonator operating at 16 MHz, 14 digital input/output pins, a power jack, six analog inputs, a reset button, an ICSP header, and a USB connection. Featuring everything we need for this study, it can be connected to a computer via a USB cable or powered by an AC-to-DC adapter or battery [13].



Figure 1 Arduino UNO Microcontroller.

B. LM35

A linear relationship exists between the output voltage and the Centigrade temperature on the LM35 series of precision integrated-circuit temperature sensors. It is advantageous to use the LM35 over linear temperature sensors calibrated in Kelvin, since it does not require a large constant voltage to be subtracted from the output to obtain convenient Centigrade scaling. The device can be used with a single power supply adapter or with a positive and negative source. Due to its low current requirements, self-heating is extremely low with statistics under 0.1°C in the presence of still air. Figure 2 represents LM35 sensor [14].

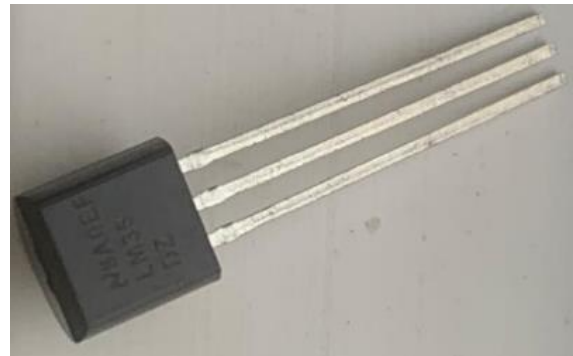


Figure 2 Temperature sensor, LM35

To display the temperature and power the components, we have used an LCD display screen and a battery throughout this study.

IV. DESIGN DESCRIPTION

A smart shirt has been designed for human body temperature monitoring. The authors focused to add the functionality to an everyday lifestyle. In contrast to prior research, this study presents more innovative concepts in terms of the power, degree of tailoring, and functionality of the device. Despite being near the body, wearable electronics are not supposed to touch the body constantly. In order to maintain this point of view, the armhole seam of the LM35 has been adjusted, and a small classic pocket has been added to the bicep. The pocket's main purpose is to hold the microcontroller without affecting the dress's aesthetics. An LCD display screen is also accommodated at the top of the pocket and the proposed wired connection are concealed beneath the sleeve.

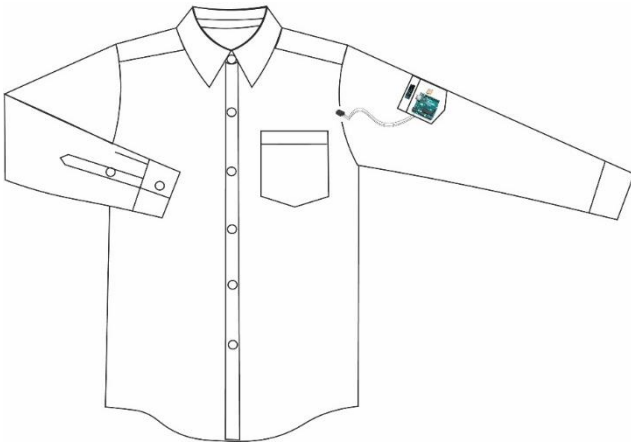


Figure 3. Wearable technology integrated smart shirt

As a part of the designing process of the smart shirt the authors propose that some fundamental points that are carefully considered such as while integrating the electronic devices body ergonomics are focused. The authors aim to make the design suitable for holding and maintaining integrated devices, regardless of their size, weight, or shape. To add to this durability of the dress and the protection of the wearer are also carefully considered in designing the dress.

V. CONCLUSION

Covid-19 opened many doors of the research gap in clothing and health monitoring. The wardrobe needs to be updated with the latest technology. The project will enable wearer to be psychologically and physically satisfied while wearing this dress. The dress will let him continue working and daily life activities without any trouble. The use of smart clothing will reduce the burden on health care systems and, alternatively, it will increase the work efficiency of first line health care worker. The design proposed as a part of this study will enable the wearer to monitor body temperature while keep social distancing in practice.

VI. FUTURE WORK

As a part of future research direction, the authors would like to add more functionalities to the smart shirt that can hold smart components to save and track the history of human body temperature.

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