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Wearable Computer with Temperature Distance Sensor

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Abstract:

In today's world, computers are an absolute need for everyone. Computers are electronic tools that facilitate human activity. Everyone, whether young or old, is given a task that requires the use of a computer, such as creating an application or a paper. Similar to how a computer makes work simpler, a mobile device similarly makes work easier, but no one are permitted to utilize or access any of the software a computer provides. No one can use every piece of software on a mobile device to finish a task or any work, thus a computer is also required. Computers have developed into a crucial component of the human environment. Over time, mobile phones have grown to offer more computer capability and apps. All are also in the era of the smart watch, where timepieces are evolving to display time and other information along with fitness data. As a proof of concept for possible wearable applications, a wireless temperature sensor based on a nematic liquid crystal as variable capacitance is presented. After conducting a performance analysis of the wireless temperature sensor, a straightforward comparable circuit has been suggested. Special sensors, accelerometers, thermometers, and heart rate monitors, are included into wearable computers to offer real-time data for health monitoring. This paper discusses about wearable computers with temperature distance sensors.

Keywords — **Wearable Computer, Temperature Distance Sensor, Computer, Mobile Phones, Heart Rate, Battery, Touch Screen Display, Lidar Sensor, Thermocouples, Thermopiles, Metabolic Process, Commercial Sensors, Temperature Detector, Integrated Circuit, Semiconductor Temperature Sensors.**

INTRODUCTION:

Today's dramatic shrinking of computer hardware has paved the way for the wearable computer to become a reality. The efficacy of outdoor information display systems has drawn a lot of attention to it. However, because they tightly suit the human body at all times, wearable computers also have significant promise for sensing and capturing real-time data about the immediate surroundings and ambiance around the user.

The Raspberry Pi controller is used to create the wearable computer, which also includes a battery, touch screen display, LIDAR sensor, and temperature sensor installed in a small package over a wrist strap. This creates a clever, portable wearable computer. [1]

One form of sensor that is especially made to measure a person's body temperature is a temperature sensor. The two most popular methods are to either directly detect the skin's temperature when the sensor is worn or to utilize infrared rays to monitor the temperature remotely. There are many thermocouples, thermopiles, and other temperature sensors available that are used in industrial processes because they are more durable, can withstand high environmental temperatures, and are highly stable. It should be noted that these temperature sensors are specifically made for medical and fitness applications. There are three basic types of temperature sensors, all of which are flexible and wearable. These include thermistors, resistive temperature detectors (RTDs), and pyroelectric detectors. The most popular method among them is the use of thermistors, which usually have a quick reaction time, ease of manufacture, and a broad temperature detecting range. [2]

On a Raspberry Pi controller, the Linux operating system is installed. This enables anybody to utilize all Linux functions on the Raspberry Pi, including file storage and retrieval, tools, and the browser. To make it simple for everybody to interact with the

Windows system, it is possible to use integrated touch screen display. To access the internet, it is possible to use the inbuilt WiFi module in the Raspberry Pi**.**

An essential physiological indicator is body temperature. Temperature has a significant impact on the stability of the human body's internal environment and metabolic process.

Vital signs often decline with a drop in body temperature, whereas an increase in body temperature is likely indicative of an illness or fever. As a result, body temperature can be used as a sign of aberrant physiological conditions.

According to a measuring principle based on a certain physical phenomenon, temperature is measured. A measurement model based on a measurement principle, or a mathematical connection between the data gathered in a measurement, is where the measurement result is formed. Any conductor might theoretically be utilized as a temperature detector.

The wide range of commercial temperature sensors demonstrates how crucial it is to measure this factor. Biological activities, manufacturing operations, and biomedical applications, among others, all depend on temperature variations. Commercial sensors should therefore be able to operate in a variety of operational circumstances and temperature ranges. This is made feasible by building these sensors on a variety of physical and/or chemical processes and materials. A resistor temperature detector (RTD) is based on a metallic wire's temperature-dependent resistivity, whereas thermocouples employ the thermo-electric effect at a metal-metal junction. According to the black-body radiation concept, an optical-fiber temperature sensor measures the spectral emission of an item as a function of its temperature. Thermistors, integrated circuit (IC) temperature sensors, and other devices provide more examples. These are only a few of the several commercially available gadgets. [3]

Specifications of a wearable computer: The key components of this innovative human-computer interface that stand out and make it great are:

Consistency: The computer is user-friendly and always on. It doesn't require opening and turning on as a hand-held device like a tablet or laptop does.

Enhancement: The idea that computation is the main work is the foundation of conventional computing archetypes. Wearable computing, however, does not adhere to the aforementioned idea.

Mediation: In contrast to traditional computing, wearable computing functions as a mediator by assisting anyone it uses via the myriad applications it offers in the fields of healthcare, domestic usage, businesss, the military, etc.

Privacy: Because wearable computing is considerably more intimate as it is worn, it may be utilized to provide a new degree of privacy. This fosters a tight relationship between humans and computers.

Convenient: Because the correct person may utilize wearable technology at the proper time and location, which provides a wonderful comfort zone and contributes to increasing its overall utility, it is of the highest convenience to anyone it uses.

Unrestrictive: Wearable technology frees anyone it uses from being forced to concentrate on just one item at a time and allows them to multitask. [4]

Benefits of Wearable Temperature Sensors:

On the patient's skin, temperature sensors that are worn are applied. Once in place, the sensor can continuously monitor the patient's temperature or notify the carers when it rises over a set point. To make the patch as small and flexible as feasible, these devices frequently use flexible printed electronics.

Numerous medical applications, such as patient monitoring (both in- and out-patient), postoperative care, and fever monitoring, can make use of wearable temperature sensors. Wearable temperature sensors have a number of distinctive benefits over conventional thermometers:

- A patient's core body temperature may be continuously and precisely measured using temperature sensors.
- A patient can have a single sensor on them from preoperative to postoperatively.
- Wearable sensors are simple to use and non-intrusive.
- An adhesive that is kind to the skin increases comfort, promotes improved patient compliance, and extends wear times.
- Wearable sensors can be made to link to patient monitoring equipment and retain patient data. [5]

Temperature Sensor Types:

1. Temperature sensors generally fall into one of these primary types:
2. Thermocouples
3. RTDs (Resistance Temperature Detectors)
4. Thermistor Temperature Sensors
5. Semiconductor Temperature Sensors
6. Thermometers
7. Vibrating Wire Temperature Sensors [6]

REVIEW OF LITERATURE:

Stefan-Boltzmann's law states that an object's temperature may be inferred from the knowledge of its emissive power. Although radiation can occur at a variety of wavelengths, the infrared region of the spectrum corresponds to the highest value of the most often sought temperature ranges. This property of infrared thermography may be utilized for a variety of tasks, such as problem identification in mechanical or electrical maintenance or as a health indicator in medical applications. One of the most widely used non-contact body temperature sensors now on the market is an infrared thermometer which has a compact size, low price, and good accuracy. [7]

It is anticipated that soon there will be roughly 50 billion additional gadgets introduced globally due to the proliferation of various technologies. Due to the enormous volume of data and the problematic integration of diverse devices, this poses two significant problems. These questions still apply to wearable technologies. In most wearable body sensor networks, small, intelligent, low-power, and self-organized sensors are used to monitor physiological signals coming from a human body. To enable end-to-end network routing and communication among wearables and external devices, standardization, compliance, successful coexistence, and compatibility across diverse technologies are necessary. Studies have done for evaluating the wearable wireless computer based on several standards and technologies for inter-device communication [8]. The issues of coexistence and interoperability as well as the use of potential technologies for on-body, body-to-body, and off-body communications are examined.

It investigates several methods for ensuring efficient coexistence between various technologies as well as problems with interoperability. [8]

In order to assess the newborns' heart rate (HR) and respiration rate (RR) concurrently during the perioperative phase, [9] a novel form of fiber optic sensor was created that makes use of a mesh microbeam. The mesh microband fiber sensor's viability was assessed, and the sensor was positioned beneath the patient. The study's findings demonstrated that the suggested microlending optical fiber sensor had good agreement with the results of physiological monitoring that are already utilized in the medical field to measure HR and RR. [9]

Objectives:

- Ability to get the power of a personal computer right on your hand.
- Touch display for easy interaction.
- Internet connectivity on Smart watch.
- Ability to google search from anywhere.
- Contactless temperature sensing anywhere.

- Contactless and Accurate distance measurement using Lidar.

RESEARCH METHODOLOGY:

This study's general structure was exploratory. Significant new research opportunities in interface, artificial intelligence, and perception are made possible by wearable computing. New intelligent interfaces will emerge as research into user modeling and perception through bodily-worn gadgets advances, which will cut down on effort and complexity and open up new possibilities. Traditional macroscopic electrical equipment can no longer be designed to meet the needs of intelligent wearable technology. The design of micro-nano structured materials in electronic devices is essential for the precise real-time capture of signals from human physiological movements and environmental changes in order to accomplish the effective application of intelligent wearable devices. [10]

RESULT AND DISCUSSION:

An experimental prototype was built in the University of Calabria's Microwave Laboratory in order to completely test the suggested multisensory platform in terms of the improved correction algorithm for the precise detection of body temperature.

Human body temperature data collected with the suggested platform was compared with values obtained by using a standard reference thermometer as a first step to show the accuracy increase in the infrared readings gained from the adoption of ambient humidity and temperature. Repeated measurements were made at various levels of relative humidity and ambient temperature, yielding average errors (differences between infrared and conventional thermometer readings) of 3 to 7. Table 1 reports a sample dataset that was taken from the aforementioned collection.

Comparison of body temperature readings from infrared and conventional thermometers before calibration with environmental conditions is shown in Table 1 of the measurement results.

Table1: Sample dataset.

Implemented System			Traditional Thermometer	Body Temperature Difference
Ambient Temperature (°C)	Relative Humidity (%)	Body Temperature (°C)	-	-
29	67	31.11	36.6	5.49
29	67	31.1	36.5	5.4
29	67	31.13	36.4	5.27
29	67	31.13	36.7	5.27
29	67	31.12	36.3	5.18
Average		31.12	36.5	5.32

The fiber optic sensor was precisely calibrated using the data from the aforementioned measurement effort, resulting in a temperature compensation that guarantees incredibly accurate readings.

From the aforementioned data, the following polynomial correction formula was derived, and by utilizing the knowledge regarding the ambient temperature, it was able to produce the real body temperature:

$$T_{b=}a_1 + a_2T_S + a_3T_a + a_4T_S^2 + a_5T_S + T_a + a_6T_a^2 \quad (1)$$

Parameters appearing in Equation (1) have the following meaning:

Tb = the correct body temperature;

TS = the measured system temperature;

Ta = the ambient temperature.

Correction coefficients have the following values: a1 = 9.25, a2 = 4.08, a3 = −2.65, a4 = −0.16, a5 = 0.2, a6 = −0.06.

Creating human-interaction apps for personal fitness and healthcare requires automatic human activity identification. Step counts, distance travelled, climbed altitudes, and pace of walking/running are all helpful fitness monitoring metrics that are now well incorporated into cellphones. Position sensing is particularly helpful because inactive time is a strong indicator of future health issues. Movement sensors can also be used for sleep detection. Sports professionals today often use Inertial Measurement Unit (IMU) sensors, which offer a variety of particular sensor-based uses for athletes.

Figure 1 shows the common sensors for sensing human activity. A smartwatch's accelerometer can monitor activity and sleeping patterns. Data about the head and upper body's range of motion (ROM) may be gathered using sensors positioned on the neck and lower back. Sensors are frequently used in athletics to measure analytics such as speed, velocity, and long-term fitness growth. They may be placed to the leg following surgical treatment to help with rehabilitation. Data on head and neck mobility is collected using headbands.

The ability of data gloves to record information on finger motions, tremors, and restrictions of the finger joint is being studied at the research level. These devices are readily accessible on the market and are often used in healthcare and fitness monitoring.

Figure 1 sensors Smart Shoes, Pressure Mats, Leg Sensors, Smartwatches, Head Sensors, Data Gloves, Biometric Goniometers, Torsiometers on Toe and Arm.

Our wearable computer, the e-Button, has a diameter and thickness of around 62mm and 11mm, respectively, and can be worn comfortably and organically like a chest button as in Figure 2. In addition to the CPU and storage components, the e-Button has a wide-angle digital camera module, a light sensor, an accelerometer for measuring motion, a gyroscope for measuring orientation, and a GPS receiver.

The e-Button is made to capture the wearer's bodily movement, orientation, and position as well as practically every event that takes place in front of him or her. Researchers save and replay the recorded data to assess lifestyle without relying on self-reports from participants.

Figure 2: (a) e-Button is worn by a subject. (b) size of e-Button comparing to a U.S. quarter.

The wearable computer must automatically and methodically gather data from all sensors. To fulfill this demand the selected CPU is the ARM-based CPU, which is strong, energy-efficient, and can be extensively utilized in portable and mobile devices. To integrate these sensors into e-Button [16], numerous layers of printed circuit board (PCB), which comprised sensor package packages and intricate connections are utilized.

Forms of Wearable Computers:

The majority of tier systems for services or quality may be condensed into three levels: low, medium, and high. For instance, the three fundamental service classes are first class, business, and economy, while the fundamental sizes are large, medium, and tiny. Even while many designs may start out with intricate levels of service, they frequently degenerate into a straightforward three-tier plan. A three-level scale that differentiates between wearable computers based on processor performance and function flexibility (PPaFF) can be used to map out this market.

Table 2 contrasts the wearable computer PPaFF stages and links them to Weiser's initial prototypes. The processing intelligence for embedded tab-like computers is provided by small, low-power microcontrollers, while 'poly-functional' pad-like computers are supported by medium-range processors like the Intel Strongarm, and multifunctional boards are supported by small, high-end desktop equivalents.

Table 2 - PPaFF-scaled forms of wearable computer

PPaFF Scale Processor Performance and Function Flexibility	Low	Medium	High
Weiser's equivalent prototype	Tab	Pad	Board
Processor performance (capacity)	Low	Medium	High
Flexibility of function	Low "Mono-functional" Limited function usually task-specific	Medium "Poly-functional" More flexible, serially replaceable set of functions.	High "Multifunctional" Multiple functions available in parallel.
Microprocessor type	Single chip microcontroller e.g. Microchip 8-bit PIC microcontroller or 16-bit Mitsubishi M16C microcontroller	Mid-range microprocessor e.g. Intel StrongARM as used in PDAs	Higher-end microprocessor e.g. Pentium equivalent PC104-format motherboards (as developed for instrumentation applications).
Typical attention demands made on user	Low May not require a display or just a simple LED or LCD numeric display	Medium Larger graphical display able to display limited information	High Still larger graphical display often requiring a tablet or a head mounted display
Typical power consumption	Low UW (10-6 Watts)	Medium MW (10-3 Watts)	High Several Watts
Operating system	None	Embedded e.g. PocketPC™, Linux™	Full desktop equivalent, e.g. x86 Linux or Microsoft Windows™
Examples of current non-wearable commercial mobile equivalent	Pagers	PDAs, mobile telephones, MP3 players	Laptops, palmtops

Additionally, Table 2 provides approximations for each category's usual form factors, operating systems, user interface requirements, power consumption, and commercial devices.

Temperature is measured using a measurement methodology that is based on a specific physical phenomenon. The measurement result is produced from a measurement model based on a measurement principle, i.e., from a mathematical relationship between data obtained in a measurement. A temperature detector can theoretically be made out of any conductor. However, factors such as cost sensitivity and manufacturing constraints limit the options. Because of their ease of touch with humans, wearable sensors have sparked tremendous attention. Textiles are preferred for wearable sensors because they are soft, highly flexible, and porous, in addition to their protective and esthetic purposes.

It is proposed to use CNT-based wearable temperature sensors made by inkjet printing on taffeta fabric. A commercial desktop inkjet printer is used to deposit prepared CNT-based ink on the substrate. The performance of the developed temperature sensor was investigated by subjecting it to temperatures ranging from ambient temperature to 50 °C.

CONCLUSION:

Temperature sensing and monitoring play a crucial part in healthcare, disease prevention, and prosthetic skin applications since body temperature acts as a mirror of many aberrant biological situations. In conclusion, it is shown how sensitive and reliable carbon nanotube (CNT) temperature sensors may be made and characterized on fabric. Through the use of a straightforward inkjet printing technique, a conductive CNT ink was created and applied on taffeta fabric. This study presents an integrated platform incorporating various sensors for the non-contact simultaneous measurement of relative humidity, ambient temperature, and body temperature. The whole hardware design as well as the operational concept have been correctly detailed.

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