Monitor and Remote Control of a Heating Cloth for the Aged

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***Abstract*-- In this paper we present a monitor and a remote control design of a heating cloth. This design uses an insulated heating resistance wire to warm up the cloth, which includes an application either on a phone or on a handheld controller. The built-in controller monitors and controls the temperature through Bluetooth transmission. The heating pad inside the heating cloth monitors both the heating pad temperature and the body temperature. The user can instantly know the body temperature and wear clothing which can be adjusted to retain body warmth.**

I. INTRODUCTION

Both the elderly and the children often may not wear enough clothing to keep warm in cold weather. To keep one's body at a normal temperature is important, and through intelligent control methods the body temperature can be accurately monitored. There is the danger of hypothermia. Some medical reports define a normal person's body temperature between 28-35°C as a loss of temperature. If this state continues for a certain time, depending on the severity of the hypothermia, a coma, reflex nerve damage or other conditions may occur. This happens mostly with the elderly or with children, and the reason is usually a lack of warm clothing and/or not taking in enough calories to allow the body to maintain its temperature [1]. Fig. 1 shows the body temperature gradually rising when one wakes up, followed by exercise for ten minutes and then rest. There are two points shown in Fig. 1. First, if one remains in a resting state, one has a lower body temperature. Second, exercise can increase the body temperature which will however decrease afterwards. If one is elderly, there is a good chance that the body temperature will be lower than average if one continues to rest for a long time.

Fig. 1. Temperature when resting-exercising-resting.

Warm "power" clothing, which uses a special knitting method that does not release any body temperature into the air, is now available on the market. In traditional electrical heating devices currently sold on the market, such as electric blankets, the basic circuit is usually directly connected to a power line for heating. Although an electric blanket adds a two-stage thermostat adjustment or temperature circuit, the user also still needs insulation products which consume a lot of energy [2-3].

In this paper we design an active heating cloth with both a wireless control and a display module by which the user can control the heating temperature of his clothing very simply. Fig. 2 shows the architecture of the heated clothing. Our design also includes a small-size thermo controller mechanism that can be put into a battery pack to prevent the clothing from overheating.

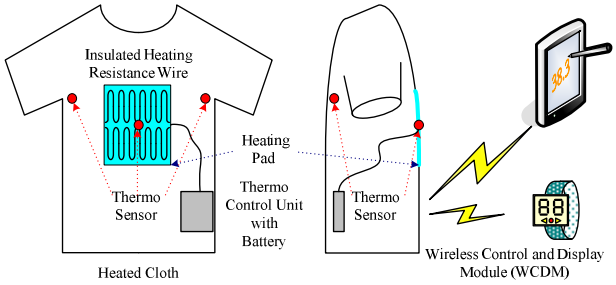

Fig. 2. Concept of the heated clothing

II. HARDWARE ARCHITECTURE

Fig. 3 shows the hardware architecture of the thermo control unit and the heating pad. The heating pad consists of one meter of insulated heating resistance wire. The right side of Fig. 3 presents the temperature sensing and control circuit.

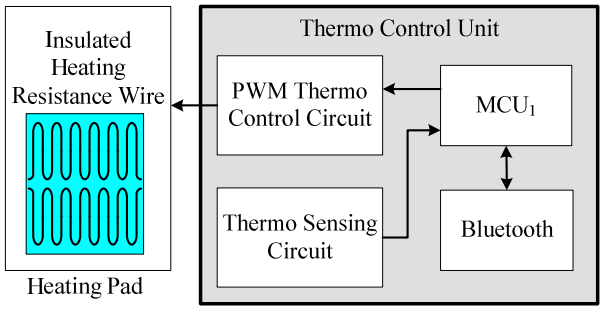

Fig. 3. Hardware architecture of thermo control unit and heating pad.

The sensing control circuit has three thermo sensors, placed respectively on both sides of the chest and on the center of the

heating pad. Two extra thermo sensors are used to detect the body temperature and compare it with the center heating pad for protection. When the temperature of those two extra sensors is lower than the set temperature of the central heating pad, the power to the heating pad is cut off and both the wireless control and the display module (WCDM) are notified. After several times of use, the system automatically remembers the tempaerature. Then, when the user turns on the power, the clothing will automatically rise to this preset temperature unless the user changes it.

Fig. 4 presents the block diagram of the wireless control and display module. The control buttons above the WCDM allow the user to select power on, urgent stop and adjustment of Max/Min temperature. The WCDM initiates an alarm notification when notified by the thermo control unit.

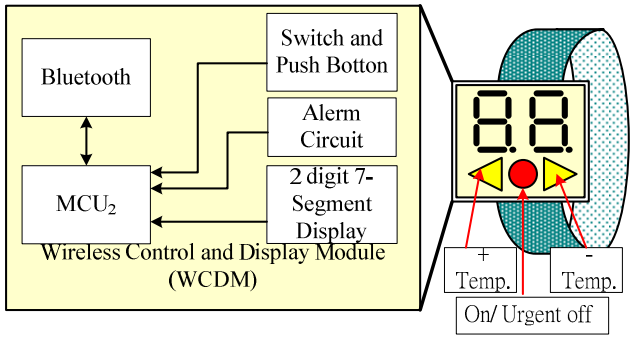

Fig. 4. Block diagram of WCDM

III. Software Design and Heating Control

In the software design we have selected an open platform with JAVA syntax to achieve the software requirements. Fig. 5 shows the screen of the smartphone.

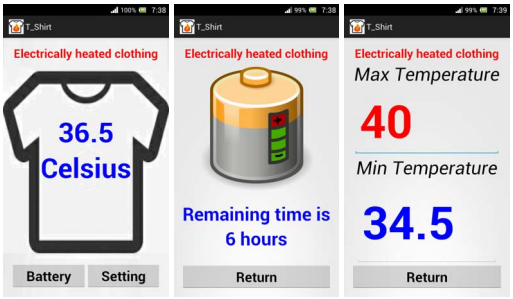

Fig. 5. Screen of smartphone

When the user activates the application, the Bluetooth function is automatically activated to complete the pair. The application reads the temperature data and displays the current temperature of the heated clothing on the screen, as shown in Fig. 5(a). When the user presses the battery button the system reads the battery information in order to display the remaining heating time of the clothing as shown in Fig. 5(b). When the user presses the setting button he enters the temperature setting screen to set both the minimum and maximum temperature, which is shown in Fig. 5(c). As for activating the heating of the clothing, we divide the process into four phases: the initial heating phase, the temperature holding phase, the re-heating phase and the excessive temperature protection phase.

IV. Experiment Results

Table I is a comparison of the various wearable heating products on the market. A single-use heat pad does not need power. However, people often forget to take it out of their clothes, thus causing injury. That situations happens particularly both with the elderly and with children. For the warm power clothing more specific weaving methods and materials have been used so that the warm air can be kept next to the body. Heated clothing is more heat-efficient than the single-use heat pad, and warm power clothing even has a temperature monitor with a control function. The one difference between an electric blanket and heated clothing is the requirement of AC power.

TABLE I
Comparison with Other Products

	Single-use Heat Pad	Warm Power Clothing	Heating Blanket	Our Design
Heating status	Active heating	Passive heating	Active heating	Active heating
Power consumption	None	None	40-180 W	15 W
Over-heating protection	None	None	Yes	Yes
Temperature monitor	None	None	Yes	Yes
Temperature control	None	None	Yes	Yes

V. Conclusion

The results of this experiment proved that our design required 30 minutes to produce heat from a room temperature below 28 degrees Celsius. To reduce the temperature takes more time because that procedure avoids any repetition of heating up and any waste of energy. As the response rate is not high, the system does not transmit data very often; the frequency is every 30 seconds. In this prototype we have used 8 rechargeable AA batteries as the main power supply to provide warmth for 8 hours. These batteries are both easy to carry and easy to buy in any convenience store.

References

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