A low cost 15-day body temperature monitoring device

A Low Cost 15-day Body Temperature Monitoring Device

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***Abstract*— This paper describes a low cost 24-hour body temperature monitoring device. Experimental results from a prototype device are presented, and the anticipated applications discussed.**

I. Introduction

Body temperature is one of the vital parts of homeostasis and it can provide an insight of what is happening in the human body. Hospital devices for monitoring patient temperature 24 hours a day exist, but there are few commercial systems which can provide prolonged monitoring at a reasonable price. This paper describes how a suitable low-cost device was designed using off-the-shelf components and briefly discusses the possible applications of the device.

II. Methods and Materials

The clinical method for measuring the core temperature is to take rectal temperatures, but due to their invasive nature they are not suitable for continuous monitoring. The probe of the thermometer was designed to attach to the axilla as it provides a point on the body which is easy to access and non-invasive to allow quick attachment. This position is known to reflect rectal temperature to within 1°C [1].

Temperature sensor – medical grade thermometers have an accuracy of ±0.1°C and resolution of 0.1°C. For this project 4 different sensors were considered based on their accuracy, resolution and price. MCP9808 is most suitable as it has the best benefit-cost ratio despite having an accuracy of ± 0.25°C. The accuracy of the sensor can be improved using a calibration procedure if necessary.

Microcontroller – ATtiny85 on a Digispark PCB was selected as it has enough non-volatile memory, low power consumption and Universal Serial Library which can be used create a simple USB user interface to extract the information from the non-volatile memory.

III. Results and Discussion

The device (Fig. 1) samples the temperature every 5 minutes and this can be adjusted to provide higher temporal resolution/longer monitoring. By powering down the sensor probe between measurements an average self-heating of 10μW was achieved (important for battery life and reducing measurement error). The prototype has compact dimensions and can run for 15 days on a single CR2032 battery.

Fig. 1 shows the typical operation of the device over a period of 12 hours. This shows that it can accurately measure the body temperature (blue line). Nevertheless, also apparent are sharp drops in the measured temperature. These are not due to physiological changes but because of environmental factors such as going outside or having a cold drink. These spikes can be filtered by a moving average with interval 6 (red line).

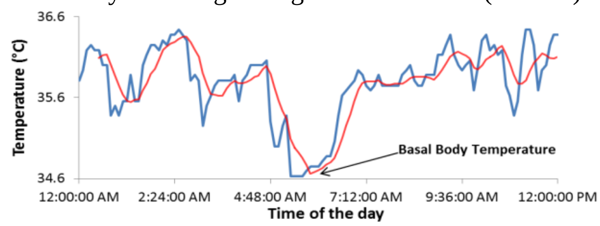

Figure 2. 12-hour body temperature recording

Despite this it can provide useful information to clinicians as it reflects the changes in the body temperature linearly, it is non-invasive and has long term stability.

We anticipate using our new sensor for as an index of the circadian rhythm [2]. Disruptions in the circadian rhythm can hint to hormonal dysfunction and sleep disorders. Several research papers suggest that body temperature is directly linked the menstruation cycle [3]. By measuring the Basal Body Temperature a woman can determine if she is in ovulation and thus increase her chances of conceiving.

IV. Conclusion

The device has good performance, energy efficiency and low cost (less than $5) and it can be used to accurately monitor the changes of the body temperature throughout the day and also over longer time periods. This system can be improved by using a Bluetooth Low Energy microcontroller such as the TI CC2640, the main advantages of this will be real-time information available to the patients and physicians.

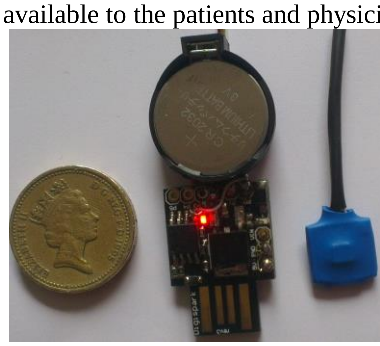

Figure 1. Picture of the thermometer

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