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Full Length Research Paper

Development of a realtime microcomputer-based logging system for diagnosis and research

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In this research, a realtime temperature logging system that logs human temperature into the computer over a period was developed and the temperature chart produced is useful for diagnosis and research purposes. The graphical representation within the threshold temperature (36°C) depicts normal body temperature of a healthy person. An upshot beyond this temperature makes the logger to signal an audible alarm for medical attention. It consists of hardware and software units. The hardware consists of sensor NTC (negative coefficient of temperature) thermistor, pre-amp; analog to digital converter, buffer between analog to digital converter and computer interface port. The software was developed in Visual Basic 6.0 for interfacing through the parallel port of the computer and the program designed to provide a user-friendly environment where the measurement can be read. There is high correlation between the approach developed by this study and other standard measuring equipments — correlation of 0.994574 with standard thermistor, and correlation of 0.997785 with standard thermocouple. The temperature logged to the PC can also be viewed from another PC remotely located over a network thus providing a good framework for telemedicine.

Key words: Diagnosis, remote logging, temperature measurement, thermistor, thermocouple.

INTRODUCTION

A realtime system is "any system where a timely response by the computer to external stimuli is vital"; it is a system in which the total correctness of an operation depends not only upon its logical correctness, but also upon the time in which it is performed. In other words, the completion of an operation after its deadline is considered useless - ultimately, this may cause a critical failure of the complete system (Ben-Ari, 1990). It can be hard realtime or soft realtime and has its application in different fields including manufacturing, process controls, high-speed data acquisition devices, medical monitoring equipment, aircraft "fly-by-wire" controls to mention a few (Juvva, 1998). In this work, the monitoring of human temperature is considered. Temperature is one of the parameters used to determine the health status of an individual (Medline, 2008). It is regarded as one of the vital signs. Vital signs include the heartbeat, pulse rate, temperature, and blood pressure. These signs are measured and monitored to check an individual's level of physical functioning (Gao et al., 2005; Medline, 2009). In Medicare, temperature is important and it is often one of the first examinations carried out on a patient. Most ailments common to mammals are accompanied by temperature increase. A normal human temperature is between 36 and 37.4°C; body temperature rising above this range indicates fever.

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REALTIME TEMPERATURE LOGGING SYSTEM

The developed Realtime Logging System is portable and battery powered. It is used to monitor the human temperature for a period of time. It has a user-friendly computer program that facilitates the viewing, digital recording and plotting of the logged temperature. The plot within the threshold temperature (36°C for a healthy person) depicts normal body temperature. An upshot beyond this temperature makes the logger to signal an audible alarm to alert the medical personnel. The recording and graphical representations are done per second and in realtime.

HARDWARE DESIGN AND SOFTWARE DEVELOPMENT

The device developed contains a temperature sensor – negative temperature coefficient (NTC) thermistor, which transduced the temperature measured into electronic analog signal. The analog signal was then passed into an analog-to-digital converter (ADC).

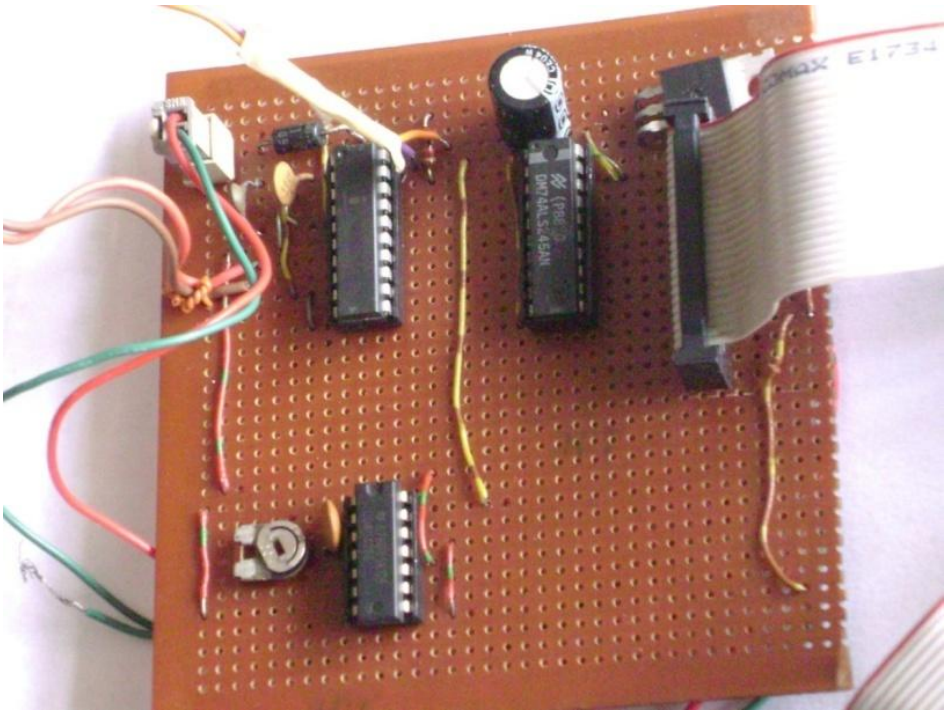

Figure 1. Circuit under construction.

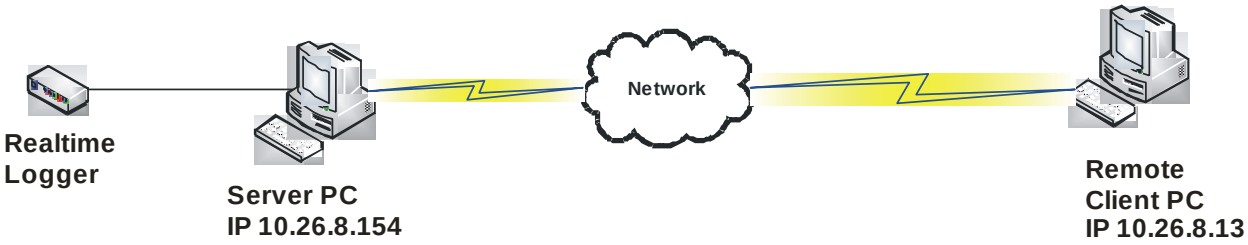

Figure 2. Diagram of developed logger measurement being accessed remotely over a network.

The converted signal was received and transmitted (using a transceiver) to the microcomputer through the parallel port (Axelson, 2000). In the laboratory setting, a personal computer (server PC) was used (Intel™ i3 CPU, 3.06 GHz processor, 2 GB RAM, 160 GB HDD, Windows Xp professional service pack 3 OS). A computer program in Visual Basic 6.0 was then written to address the parallel port and to log the measured temperature into a user-friendly interface where the temperature was both interpreted and analyzed. The program was written to be able to:

(a) measure and log human temperature into the computer in realtime;
(b) start and stop logging automatically and
(c) raise an audible alarm or give a visual message when the reading is beyond a pre-set (threshold) value.

Figure 1 shows the logger during construction. The server PC was networked to a client PC (Genuine Intel (R) CPU, 1.2 GHz Intel Processor, 2 GB RAM, 80 GB HDD, Windows7 OS) using the University Intranet (Figure 2).

PERFORMANCE TESTING AND ANALYSIS

After the individual circuit stages and the software were tested; the assembly was then tested connecting to a human being. The temperature was logged into the computer over a period of time. This was done also with a mercury thermometer and the readings were found to be almost exactly the same with a difference of 0.02°C. The software was tested and found to be able to

i) measure and log human temperature into the computer in realtime;
ii) start and stop logging automatically and
iii) raise an audible alarm or give a visual message when the reading is beyond a pre-set (threshold) value.
iv) give the temperature reading as well as details of the date, time (minute, second)
v) log temperature over the network into a remote client

Table 1. Measurement of temperature of the atmosphere. Table of data recorded every 30 s using standard thermistor, standard thermocouple and developed datalogger.

Time (s)	Developed	Standard TH	Standard THC
30	25.42	25.53	25.51
60	25.62	25.69	25.65
90	25.64	25.67	25.65
120	25.62	25.69	25.67
150	25.66	25.65	25.51
180	25.62	25.65	25.65
210	25.64	25.67	25.65
240	27.54	27.58	27.55
270	27.56	27.61	27.58
300	27.62	27.6	27.64
330	27.62	27.68	27.72
360	27.6	27.64	27.55
Correlation with developed thermometer		0.9945748	0.997785

PC (in realtime) using the remote desktop connection in windows operating system.

In order to validate the developed logger measurement, it was used (at room temperature) to measure atmospheric temperature alongside standard temperature sensors (thermistor and thermocouple) for about one hour.

It must be noted however that the temperature sensor would have to be attached to the patient being monitored in order to take the reading for a period of time. In this paper, the temperature measurement device was used (at room temperature) to measure atmospheric temperature alongside standard temperature sensors (thermistor and thermocouple) for about one hour. Table 1 shows the table of data recorded every 30 s and the graphs of the comparison are shown in Figure 4.

DISCUSSION

The human body temperature measured was logged into a user-friendly interface that facilitates the viewing, digital recording plotting of the measured temperature. The graph within the threshold temperature (36°C) depicts normal body temperature of a healthy person with the plotting in colour blue. An upshot beyond this temperature makes the logger to signal an audible alarm thus alerting the medical personnel. The colour of the graph also changes from blue to red colour (Figure 3). The alarm and change of plotting colour depends on the threshold monitor temperature set by the user as seen in Figure 3. Using the Windows operating system Remote Desktop Connection (RDC) to access the server PC with Internet Protocol (IP) address 10.26.8.154 located at the Department of Electrical CPUT (Figure 2), the measured temperature logging could be viewed from client PC with IP address 10.26.8.13 located at the PG residence, CPUT over the Intranet. The remote user is able to operate (start/stop) the logger, however, the alarm system was not audible from the remote PC (Figures 2 and 5).

Figure 4 shows the graph of the comparison results of the developed logger having a correlation of 0.9945 with standard thermistor and 0.9977 with thermocouple. In both cases the correlation tends towards unity (Jain RK 2004). This indicates a high degree of measurement closeness/reliability.

Conclusion

This work has developed a Realtime microcomputer-based logging system for diagnosis and research purposes that successfully logs human temperature into a remote PC over a network (Intranet).The result obtained was compared with that of the standard digital thermometers and found to extremely close with a difference of 0.02. It compares favourably with standard thermistor and standard thermocouple with a correlation of 0.9945 and 0.9977 respectively. It would be very useful to medical personnel in gathering data to be used in diagnosis and research and offers a high potential for telemedicine. It would be of immense importance to pediatricians who have to treat children, many of whom cannot talk, the dumb or even animals (mammals) in veterinary medicine. The device is capable of raising audible alarm and as such, it would be very useful in Intensive Care Unit (ICU) of the hospital where prompt responses are needed to save lives of patients under critical conditions. The device is portable and compatible with most computers (laptop and desktop) running windows. This makes it useful not only in the hospital but in the homes and offices thus bringing Medicare to your door. However it could be improved in future to transmit

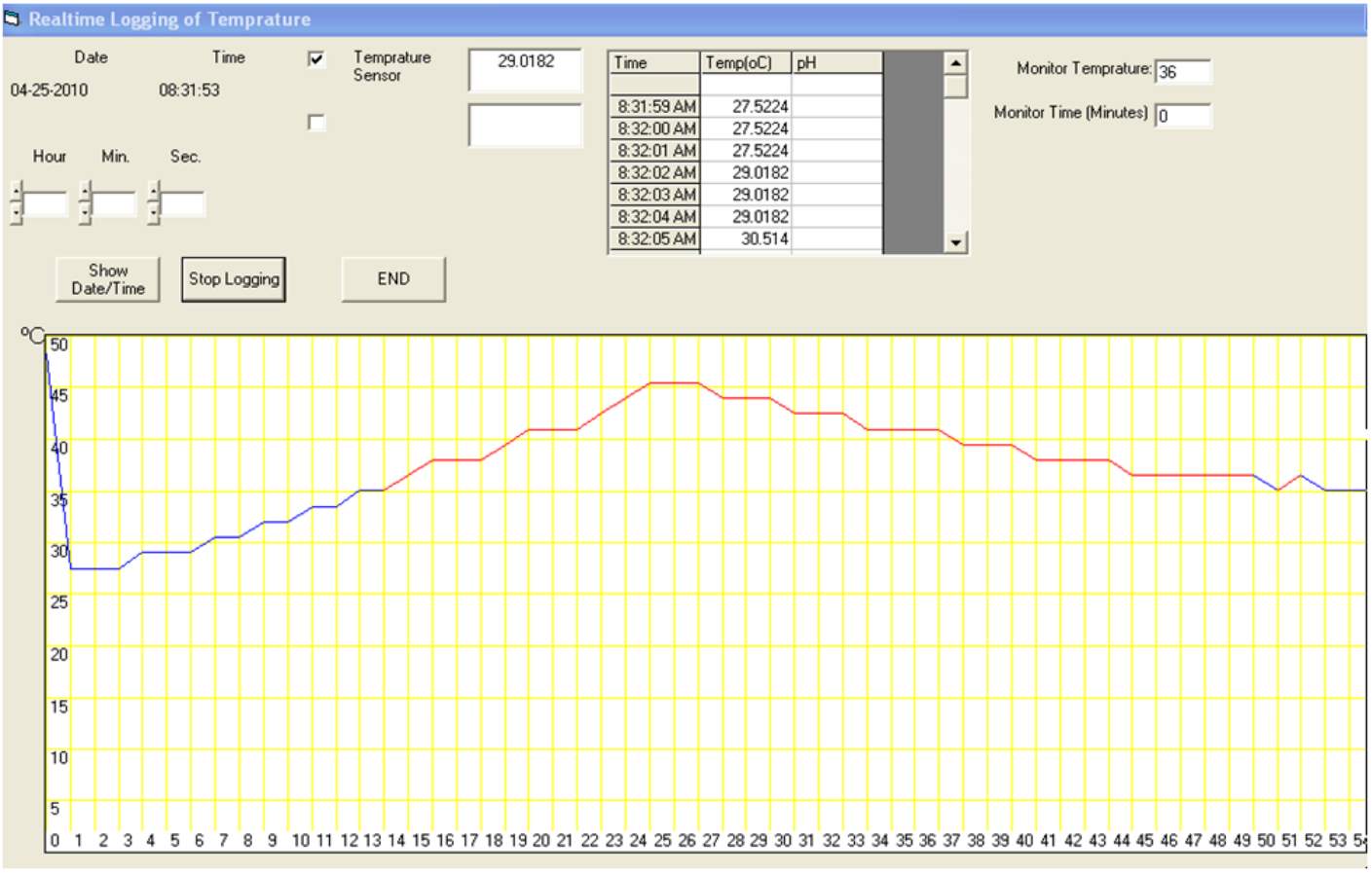

Figure 3. User-friendly interface on server PC showing plotting of temperature measured by the logger with (threshold temperature set at 36°C).

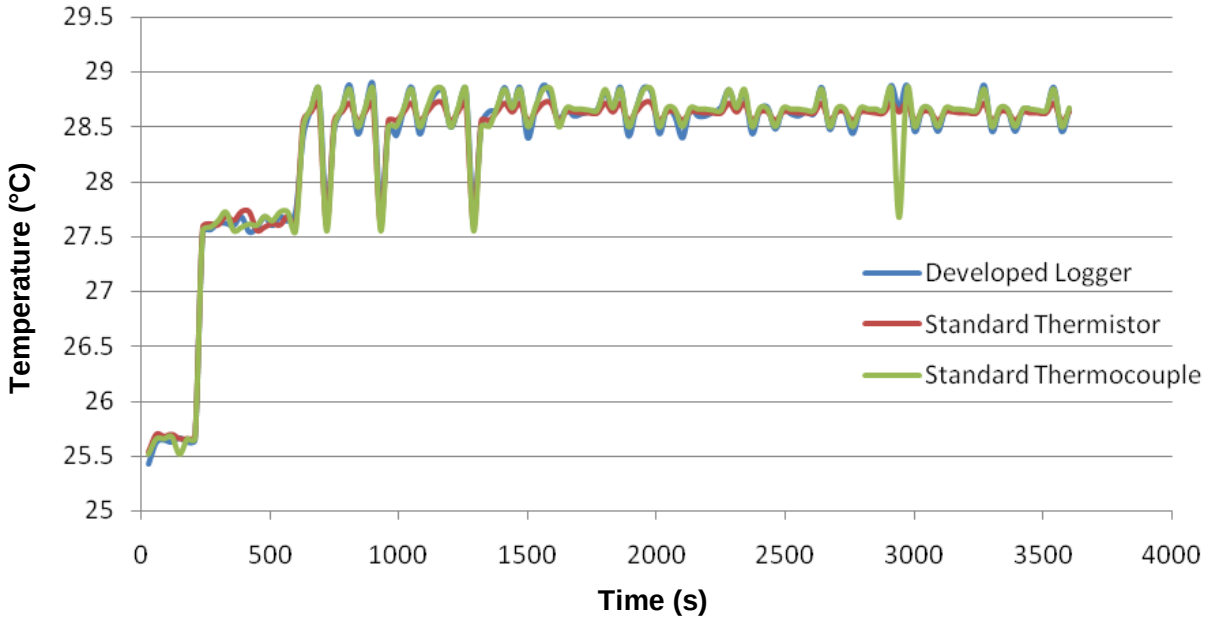

Figure 4. Graph of developed logger compared with standard thermistor and thermocouple when used to measure atmospheric temperature.

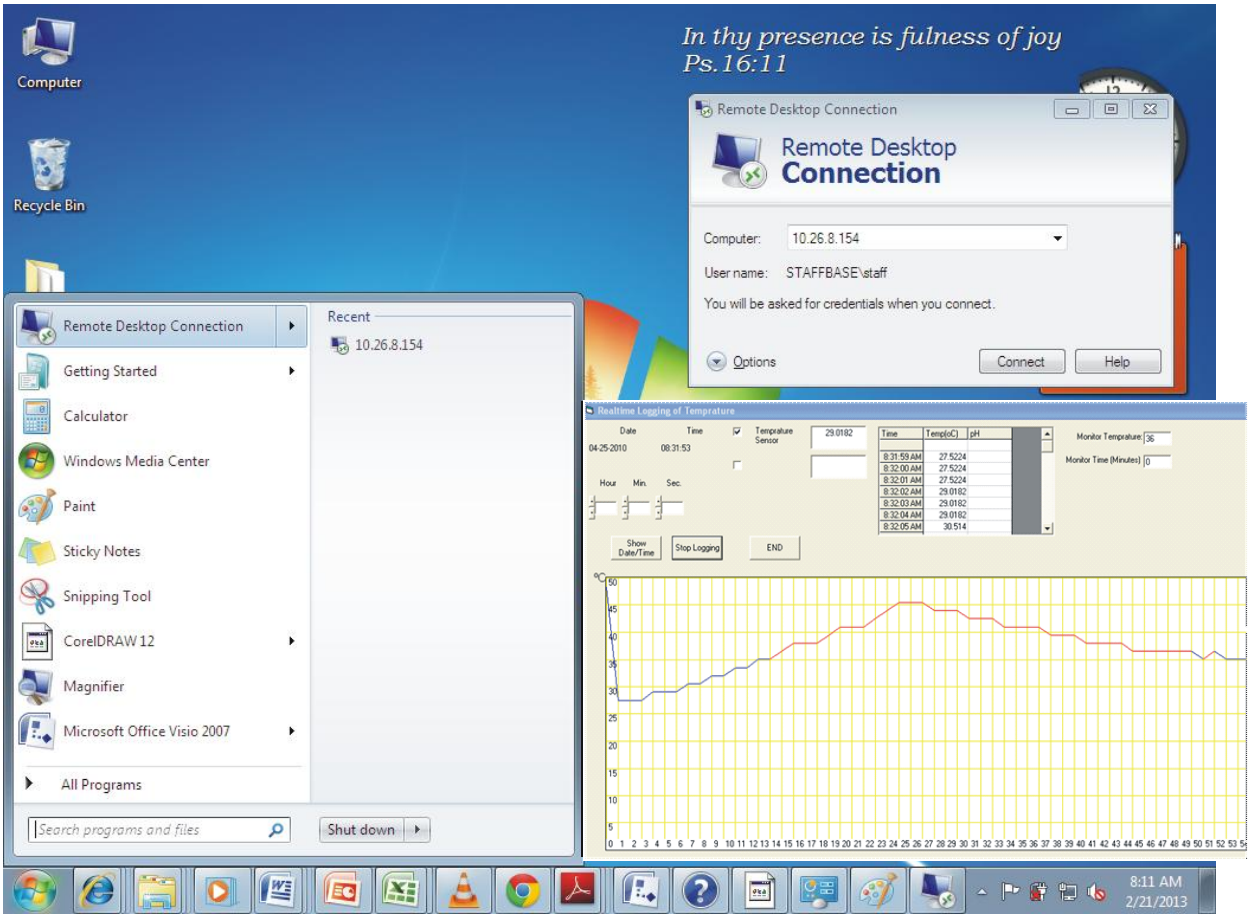

Figure 5. Diagram showing Remote Desktop Connection and user-friendly interface accessed on remote client PC.

measured temperature wirelessly to the PC instead of cable thus making it more convenient for users.

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