Automatic Intravenous Fluid Heating System for Babies in Intensive Care Unit

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Abstract: **During prolonged infusion the core body temperature of the babies under IV administration in intensive care unit drops below normal temperature which leads to hypothermia of the patient. The babies are more prone to fall under hypothermia than the adults. The body temperature of the babies may vary due to temperature changes surrounding them like room temperature of the baby. There are lot of intravenous fluid heating system which maintains the intravenous fluid at normal temperature i.e room temperature. But those methods don't take any feedback from the patient's body. Hypothermic conditions cause serious illness to the babies who are having epileptic problem and the babies under postoperative care. So there is a need to design a system which would address this problem. This paper addresses an automatic system which senses the body temperature of the baby and controls the flow of intravenous fluid inside the IV tube. A temperature sensor measures the body temperature of the baby and gives it to the controller. Controller stops the infusion when the temperature goes below normal and the heater and alarm goes on. Once the required temperature is reached in the IV bag the controller again turns on the motor of the infusion pump and turns off the heater and alarm. This automated infusion of warmed fluids helps in bringing back the normal body temperature of the babies, thus avoiding emergencies.**

Keywords: Infusion, body temperature, babies, IV fluid, temperature sensor, hypothermia, Intensive Care Unit.

I INTRODUCTION

Infusion pump systems are mostly used in the hospitals to give fluids, medications or nutrients to the patient. The fluids or medications are mostly given intravenously but it can also be given by subcutaneously. Many types of infusion pumps are there which can be operated automatic or semiautomatic. Automatic systems are used for better precision [1]. The infant's body temperature plunges in the Intensive Care Unit when they are under IV administration. It gives a route to hypothermia of the patient. The condition when the body temperature goes below normal body temperature (i.e 35 °C) then it is called hypothermia. Hypothermia can be classified as three types which are mild, moderate and severe hypothermia. Each type of hypothermia has its own symptoms which are given in the table 1. The hypothermia can be caused by two ways which are continuous exposure to cold and the metabolic activities which causes the heat loss of the body [2] [3].

Infants are having larger surface area than their body weight. So there are more chances to get hypothermia because they lose their body heat faster than the children and adults. Hypothermia is not a fatal condition. But it becomes fatal condition when the infant goes under critical conditions. The infant goes under critical condition when the infant is already affected or has epileptic problems or if the baby is in the postoperative care unit then it is more prone to get hypothermia. Mostly Intensive Care Unit of all the hospitals are built with Air conditioner. So the chance for the decrease in temperature of the IV fluid in the IV tube is more. The existing systems are used to maintain the normal temperature of the fluid or room temperature. The human body temperature also will vary depends on the time of the day. It may be different in day and night times. The body temperature of the human will slightly be higher in day time than the body temperature at night time.

There are several methods to treat hypothermia.
Those methods are covering the baby with hot blankets, wrapping the legs and palms of the baby and infusing warmed fluids to the patient's body. Mostly the last method which is infusing the warmed fluids to the patient is used to treat hypothermia. All these methods are manual methods. These methods cannot be used in the emergency condition which happens at late night in the Intensive Care Unit for a baby who cannot speak is under IV administration. There are various methods to warm the IV fluids like conventional water bath warmer system, heat plate warmer system and IV tube warmer system. Those are different warming methods to warm the intravenous fluids up to 45°C. But these methods are manual methods and someone has to come and do all this system once the hypothermia condition is occurred [4][5][6][11]. But these methods don't take any feedback from the patient's body.

So if there is any temperature change in the patient's body due to external exposure to cold the also the temperature of the fluid is maintained in the normal fluid temperature[15]. But that temperature is not sufficient for the patient to get back its body temperature to normal condition. These changes in the temperatures might cause serious illness to the patient. It may lead to death of the patient[11][13]. So this paper describes an automatic system which controls this problem during such critical conditions.

Table 1
Hypothermia classification

Types	Symptoms	Temperature
Mild	Shivering and muscle Stiffness	32-35 °C
Moderate	Drowsiness , No shivering , shallow breathing & No response to painful stimuli	28-32°C
Severe	Unconscious & No shivering	20-28°C

II. *MATERIALS AND METHODS*

This system contains two different main modules. One is infusion motor controlling module and the other one is heating module. The
motor of the infusion pump is used to control the speed of the infusion which is given to thepatient and the heating module contains heater
which is used to warm the intravenous fluid which is infused to the patient through IV. All these modules are controlled by the controller. This system also contains some sub modules which are temperature sensing module, alarm controlling module and display system.

A. TEMPERATURE SENSING MODULE

The temperature sensing module contains a temperature sensor which senses the body temperature of the patient. There are many sensors available to measure the body temperature of the patient which are LM35, thermostat, thermistor. But LM35 is mostly used to measure the body temperature of the patient. To measure the core body temperature of the patient the temperature should be placed in few of the places on the body[14]. Those places are armpit, anus, tympanic membrane, mouth (oral) and forehead [7] [11]. But studies say that armpit or anus placement of the temperature sensor will give the most accurate measurement [8].

B. *INFUSION MOTOR CONTROL*

The motor of the infusion pump controls the speed of the IV fluid in to the patient's body. Stepper motor is used to infuse the fluid into the patient in more precious manner. The motor is controlled by the controller. The flow rate of the infusion pump is controlled by flow rate sensor. The motor of the infusion pump has to be stopped when the temperature of the patient goes below normal temperature and it has to be turned on once the required temperature is achieved in the heater.

C. *LCD & ALARM SYSTEM*

The LCD (Liquid Crystal Display) is used to display the body temperature of the patient which is measured by the temperature sensor and given through the controller to it. 16X2 LCD is used.

D. *CONTROLLING OF THE SYSTEM*

The whole system is controlled by the controller which is programmed by the user to control the body temperature. The microcontroller's I/O pins are used by other elements of the system. This controller can control many modules at a time [9]. The development board can be handled easily. The user controls this controller by programming it using software to control the infusion and heater. The programs are written in C, C++, Java. The block diagram of the whole system is given in figure 1.

E. *WORKING*

The body temperature of the infant is measured by placing the temperature sensor on the armpit of the infant. The sensor measures the temperature and gives it to the controller. The controller displays it in the LCD. The controller is programmed by the user. It is programmed in such a way that it controls the motor of the infusion pump and the heater of the IV fluid. if the temperature of the infant is normal then there won't be any changes in the system. If the temperature of the infant's body goes below normal then the controller stops the motor of the

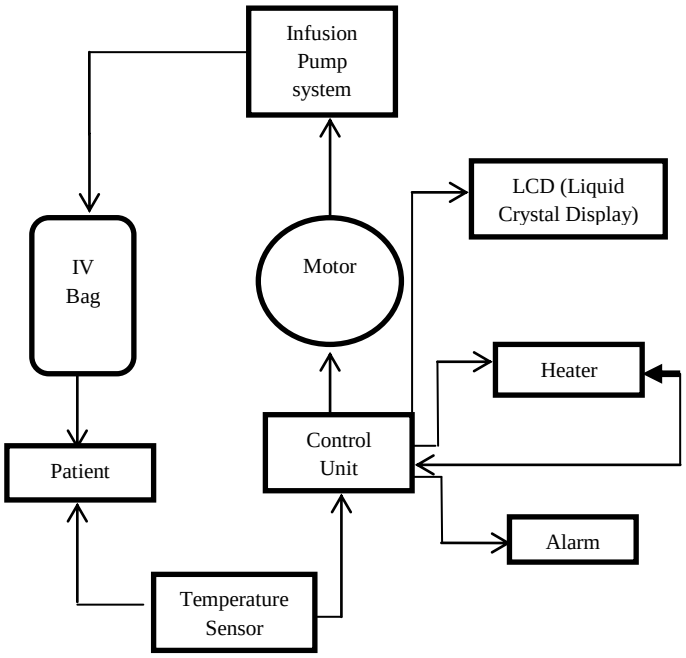

Figure 1: Block diagram of the system.

infusion. At the same time it triggers the alarm and turns on the heater to warm the infusion fluid. The heater starts to warm the fluid which is there inside the IV tube. The controller stops the heater once the required temperature is achieved
in the IV tube. The alarm is turned off once body temperature comes back to normal temperature. The complete block diagram of the system is given in the figure 1.

III. RESULTS

The temperature sensor is placed on the armpit of the infant and the core body temperature is measured. The temperature varies 10mv/per degree. This temperature variation is given in the table 2. Once the temperature goes below normal temperature (i.e<37°C) the motor is stopped and the alarm is triggered. The alarm is turned off once the body temperature becomes normal i.e. 37°C. Still the whole system is not yet completed. The analysis on the heater part is going on. The IV fluid which is inside the IV bag should be warmed without any direct contact. So we are finding a system by which the fluid can be warmed in convection method. The heater part has to be designed.

Table 2
Temperature Variation

Voltage	Temperature
100 mv	10 °C
300 mv	30 °C
370 mv	37 °C

IV .CONCLUSIONS

In this paper we have presented an automatic system which doesn't need any nurses or doctors attention and the nurses need not to be near the patient always. This system contains temperature sensor, motor, heater, controller, LCD, Buzzer. The body temperature of the patient is measured and it is displayed on the Liquid Crystal Display (LCD) through controller. The controller stops the motor when the body temperature of the patient goes below normal temperature (<37°C). At the same time the alarm is triggered and the heater is turned on. The heater starts to warm the fluid. Once the optimum temperature 38-45°C is reached in the fluid of the IV bag the heater is turned off. At the same time the motor is turned on. It starts to infuse the warmed fluid into the patient. The alarm is turned off once the body temperature of the infant becomes normal. This system is fully automated. Because of the feedback from the patient's body to the controller unit it is used to maintain the body temperature in more precise manner and the unexpected critical situations and deaths can be avoided.

V. REFERENCES

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