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DESIGN AND DEVELOPMENT OF VERSATILE SALINE FLOW RATE MEASURING SYSTEM AND GSM BASED REMOTE MONITORING DEVICE

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ABSTRACT:

As the world population grows, the need for health care increases. In recent years, progress in medical care has been rapid due to the advancements in the field of sensors, microcontrollers and computers. A major reason for this is the combination of the two important disciplines namely medicine and engineering. This paper describes the development of an automatic saline monitoring system using a low cost indigenously developed sensor and GSM (Global system for mobile communication) modem. This enables the doctor or nurse on duty to monitor the saline flow rate from a distance. The 8051 microcontroller is used for providing co-ordination action. An IR sensor is used at the neck of the saline bottle to know the flow rate of the liquid. The detection of saline drop rate is quite faithful. The output obtained from the sensor is processed to check whether the flow rate is slow, medium or fast and the same is transmitted through GSM technology to a distant mobile cell for future actions.

Key words : Microcontroller, Saline, Intravenous, Sensor, Circuit

[1] INTRODUCTION

The lack of care persons with sufficient skill in hospitals and their heavy duty become a social problem in the modern world. We should develop low cost health monitoring systems available to every hospital in the days to come. Various engineering designs are carried for the benefit of hospital facility enhancement. A number of health monitoring sensors for humans in bed have been developed [1]-[5]. Monitoring heart rate by an air pressure with an air tube in mattress in bed is also developed [6]-[9]. System of systems using non- contact sensors is described by Yutaka HATA *et al* [10]. Heart attack symptoms are also detected using mobile phone and wearable sensors [11]. The objective of this work is to help the life of a patient by developing an automatic and cost effective saline monitoring system. The saline is injected into the blood stream based on physiological conditions like heart beat, temperature, pulse rate, body weight, blood pressure etc. of the patient. The technology is rather changing beyond ones imagination. The idea here is to develop an automatic saline flow monitor, which measures the saline drop rate and sends the information of flow rate to the remote cell phone. It is an advanced and automatic saline monitoring system helpful for the doctors to monitor the flow from a distance. This reduces the continuous on-site monitoring by the doctor or nurse. It also helps in indicating the saline level and gives the alarm when the bottle is about to empty. For this purpose the microcontroller technology can economically prove the best results and it is cost effective and easily implemented. The estimated cost of the product is a few thousand rupees. This makes the product easily affordable and would serve the society.

[2] MATERIALS AND METHOD

Normal saline (NS) is a general term referring to a sterile solution of sodium chloride (Nacl, known as common salt) in water but is only sterile when it is to be placed intravenously; otherwise, a normal saline solution is a 0.90%w/v solution. This sodium chloride sterile solution is typically used for intravenous infusion, rinsing contact lenses, nasal irritation and often used to clean a new piercing.

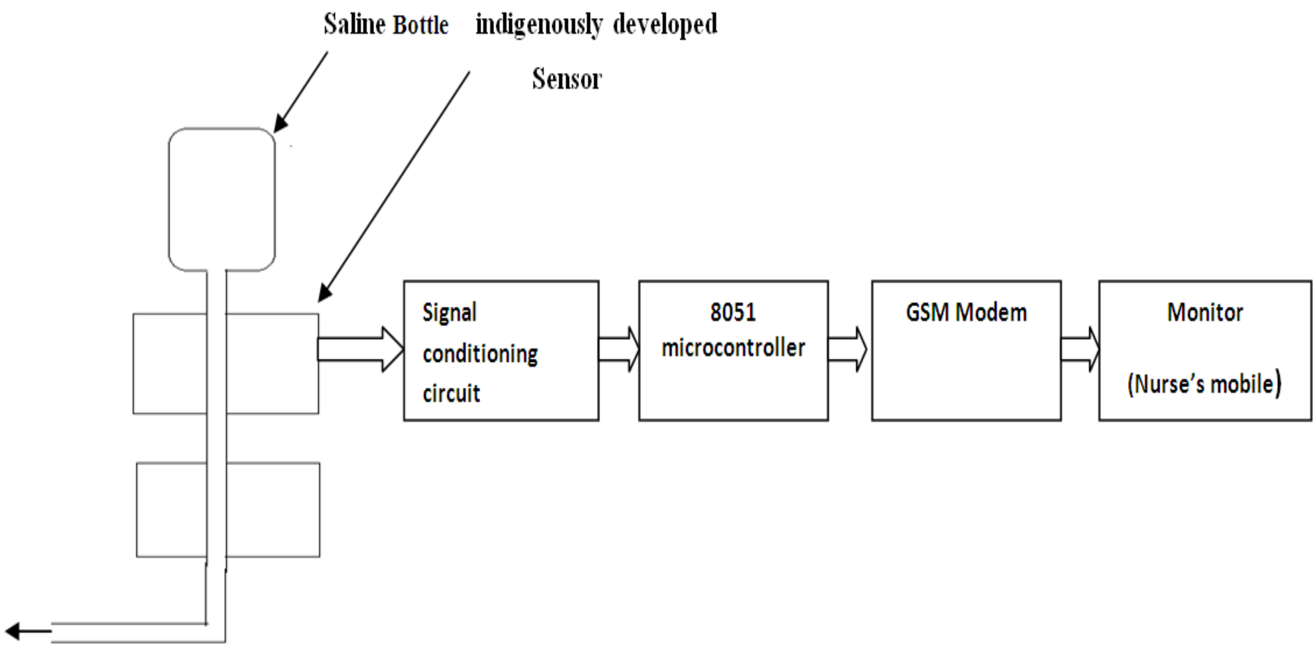

Fig. 1: Block diagram of the saline monitoring system

Normal saline solutions are available in various formulations used for different purposes. NS is used frequently in intravenous drips (IVs), for patients who cannot take fluids orally and have developed or are in danger of developing dehydration or hypovolemia. NS is typically the first fluid used when hypovolemia is severe enough to threaten the adequacy of blood circulation, and has long been believed to be the safest fluid to give quickly in large volumes. Normal saline contains 9 grams of Nacl, the concentration is 9 grams per liter divided by 58.5 grams per mole, or 0.154 moles per liter. Osmotic coefficient of Nacl is about 0.93. The amount of normal saline infused depends largely on the physiological condition of the patient but is typically between 1.5 to 3 liters a day for an adult. Other concentrations of saline are frequently used for some medical purposes, such as supplying extra water to the dehydrated patient or supplying daily water and salt needs of a patient who is unable to take them through mouth. The block diagram of saline monitoring system is as shown in Fig. 1. In the existing conventional arrangement, the saline monitoring system has no electronic detector or monitor. In this work an indigenous sensor, having a pair of IR LED and photo transistor, is developed to monitor the flow by faithfully detecting the saline drops at the neck of the bottle. The signal conditioning circuit consists of a multi-vibrator, a comparator along with phototransistor circuit. For each falling drop of saline the signal conditioning circuit produces one pulse. The 8051 microcontroller is used to count the pulses in unit time. Hence this count is proportional to flow rate. The 8051 sends a bit high to Global System for Mobile communication (GSM) modem for the corresponding flow rate. Four bits are used in different combination to represent different flow ranges. These four bits are sufficient to represent maximum of sixteen flow ranges. The range can be divided into still smaller intervals, but it is sufficient to monitor only very low, low, medium, high and very high levels in a practical situation. Here the saline drop rate of one drop per two seconds is taken as very low flow rate and ten or more drops per second are taken as very high flow rate. The signal flow from sensor to GSM block and GSM to any mobile phone (doctor's or nurse's cell phone) is shown in the transition diagram (Fig. 2 and Fig. 3) and the message is displayed at the destination cell phone. A code of four bit combination is sent to the GSM modem using RS232 and MAX 232 IC. The messages stored in the GSM modem are transmitted to a remote cell phone, say, the one with doctor or nurse.

Software description:

The software program for the microcontroller is written in C language and same is downloaded in the flash memory of the microcontroller [12] . The flow chart is shown in Fig. 4. Initially the timer module is configured as a counter

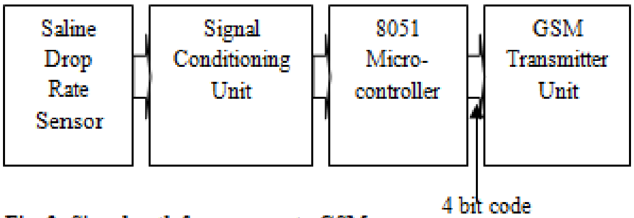

Fig. 2: Signal path from sensor to GSM

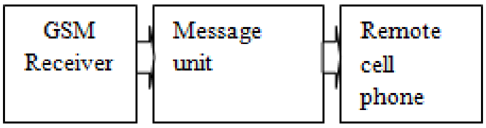

Fig. 3: Signal path from GSM to Mobile cell phone

The pulses obtained from the sensor and the signal conditioning circuit is counted. The counter register value is stored in random access memory. Then the count value obtained is compared with values already stored in memory to decide whether the saline flow is very low, low or high. Depending on the count value, the microcontroller displays the flow rate on the local liquid crystal display and also sends a four bit binary number to the GSM modem. The GSM sends the corresponding message to the doctor's/nurse's cell phone. Five ranges are used in this work they are very low, low, medium, high and very high. User can always change the number of ranges and their corresponding flow rate values for the better monitoring purpose.

[3] RESULTS AND DISCUSSION:

The performance of this work is evaluated for various flow ranges.

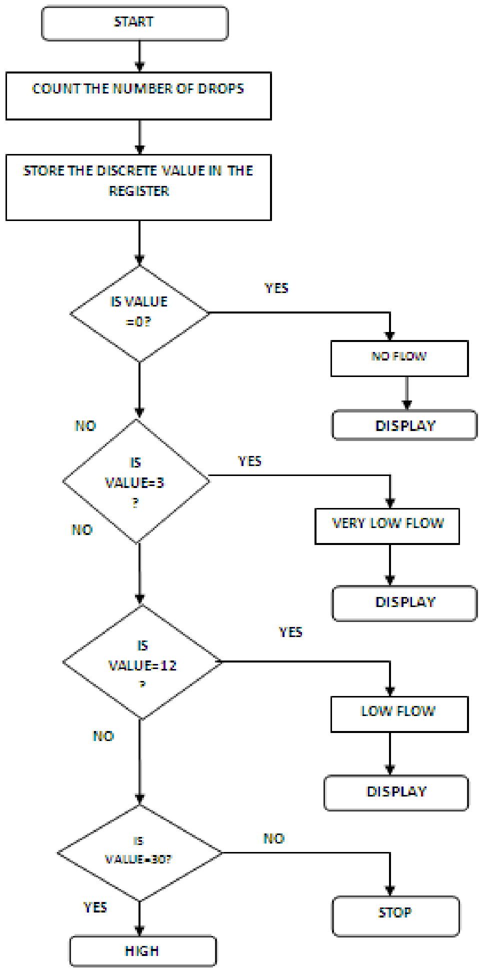

Fig. 4: The sample flow chart

The performance is checked by manually setting the flow for different ranges such as very low, low, high and very high. One can divide the flow range into still more ranges if required. The saline flow rate is quantified by counting the number of drops in a fixed time interval. It is observed that the sensor and the signal conditioning circuitry produce one pulse for every occurrence of a drop. The flow rate of one drop in every two seconds or more time is considered as very low range. Similarly, a flow rate of ten drops in every two seconds or less time is considered as very high range. Intermediate ranges are proportionally divided. Table 1 shows the actual data monitored on this system.

- Accurate and need based injection of saline to the patient.
- Useful in situation where patient is critically ill and needs continuous monitoring.
- The saline monitoring is automatic and notice of every level is intimated to the doctor/ nurse spontaneously for patient safety and easy access when required.
- Very high commercial value as the product can fit into any multi-specialty hospital systems.

Drop rate (Pulse rate)	Display on local LCD (Patient's side)	Display on the doctor's mobile
0.5	10 – 25 %	Flow Rate: 10 – 25% Patient No : 1 Low
2-4	25 – 50%	Flow Rate: 25 – 50% Patient No : 1 Medium
5.0	50%	Flow Rate: 50 % Patient No : 1 Half
6-7	50 – 75%	Flow Rate: 50 – 75% Patient No : 1 High
10 or more	More than 90 %	Flow Rate: More than 90% Patient No : 1 Very high

Table 1: The results and data displayed

Fig. 5 a) and b) show the whole set-up and the sensor. The saline drop rate sensor is fixed to the neck of the saline bottle. This sensor is connected to the signal conditioning circuit so that electronic pulse is generated for every drop occurrence. Microcontroller is used to count these pulses in unit time period and manipulates the flow rate. The flow rate is displayed on the LCD connected to the microcontroller and corresponding flow rate is sent as message to the remote mobile phone via GSM transmitter and receiver pair. The data displayed on the LCD connected to microcontroller and the information available on the cell phone is shown in Fig 6 a) and b).

Fig. 5a) The complete set-up b) The sensor

Fig. 6a) The local LCD b) The data on the mobile cell

[4] CONCLUSION

The automatic saline monitoring system provides more flexibility to the doctors; thereby the patient's caring is enhanced. The work presented here is a basis for the automatic injection system, where the patient's physiological conditions like heart rate, body temperature, rate of respiration, blood pressure are automatically checked and the saline flow rate is controlled and hence it saves lot of time for the doctor or nurse who is on duty.

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