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Conceptual design of intravenous fluids level monitoring system – a review

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Abstract: In today's world of automation, there are advancements going on in all the fields. Each work is being automated day by day. However, if we see our current medical care system, some areas require manual caretaker and are loaded with heavy jobs, which consumes a lot of time. Nevertheless, since the work is related to human health, it should be properly done and that too with accuracy. An example of such a particular work is injecting saline or Intravenous (IV) fluids in a patient. The monitoring of such fluids needs utter attention as if the bottle of the fluid is not changed on time, it may lead to various problems for the patients like backflow of blood, blood loss etc. Various researches have been performed to overcome such critical situation. Different monitoring and alerting techniques are described in different researches. So, in our study, we will go through the researches done in this particular field and will see how different ideas are implemented.

1. Introduction

Intravenous therapy is the infusion of liquid substances directly into the vein. These are often called drips. Many times, it is seen that the medical personnel do not monitor the flow rate or does not change the bottle of fluid on time due to burden of work or any other reason. However, such thing is not acceptable at all, as it may result in reduction of Hemoglobin level in a patient due to back flow of blood, which may result in several risks for patient. To avoid this situation, as a remedy, making this process as automated will take care of the system. This is what the following study is about i.e. how can the level monitoring system of such fluids be automated and even alert the medical personnel about changing the bottle on time, so that patient should not suffer any kind of risks. In this research, various ideas used are reviewed and a conceptual design is being proposed.

2. Literature review

While reviewing the literature, it is found that flow meters can be fitted into the flow line to regulate the flow. The doctor's opinion takes a vital role in deciding the flow rate. The varieties of literatures are found in the portion of regulation. However, the control aspects according to the method are varying from author to author. The various types of IV fluid regulating methods are listed below:



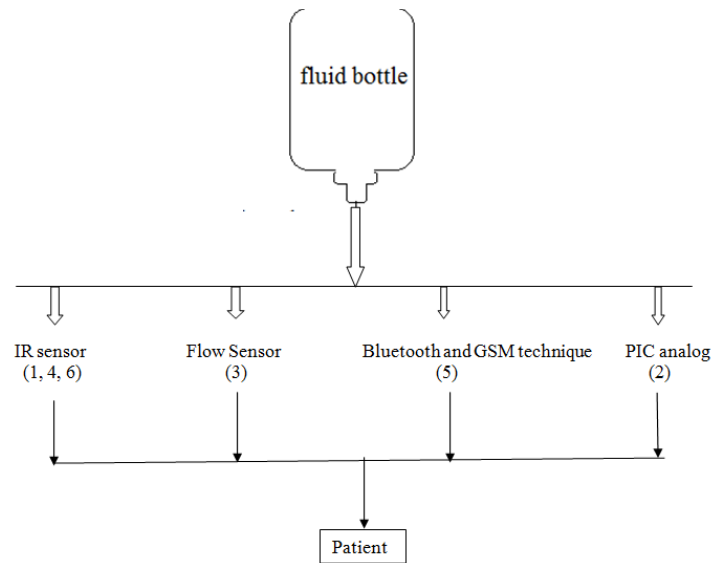


Figure 1. Types of IV fluid regulations

An infrared transmitter [1, 4, and 6] and an infrared detector are positioned on opposite sides of drip nozzle. Rate of dripping is being monitored while infra transmitter transmits the light energy. During the interruption of the light, the receiver shows the infusion fluid drops. The voltage generated will be send to the digital transmitter/counter and the person is alerted through either buzzer or wireless/Bluetooth monitoring.

Two metallic probes one grounded and other to 10K resistor, which one's other terminal connected to 5V. Amongst the probe and the resistor, a tapping is installed. The resistor transmits the 5V, when the saline fluid in the tube which results in low [0] voltage detection at the PIC [2]. However, when this is reversed, i.e. no fluid level, gives high [1] voltage detection at the PIC. '0' indicates the normal flow and '1' indicates the abnormality. Detection of '1' by PIC will raise the alarm by the connected LED. When it becomes normal, PIC will switch off the LED and alarm.

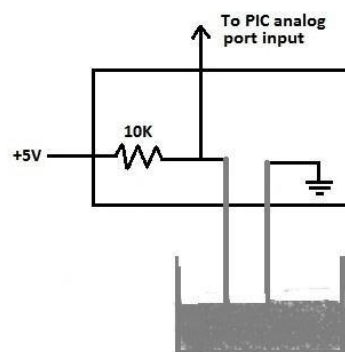


Figure 2. PIC analog system

Flow sensor [3] is fixed in the collar portion of the bottle. The sensory output will be as voltage, which is given to the microcontroller AT89S51 at one of its port. The outputs are then compared with the default values already defined and then further displayed at the LCD. This flow rate is then transmitted thought the RF ZigBee transmitter module to the receiver module via wireless transmission and displayed to a remote location where doctor or nurse is present.

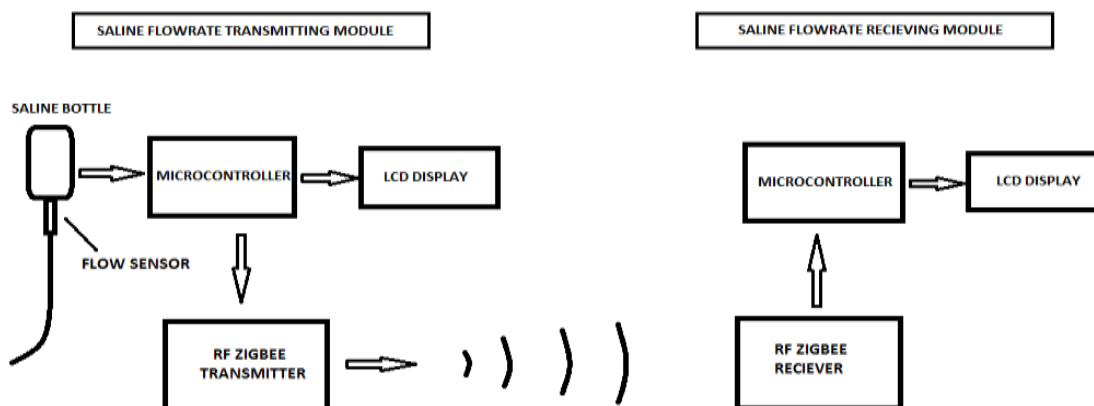


Figure 3. Flow sensor model

IR LED and phototransistor 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. The circuit, which conditions the signal, contains a multi-vibrator, a comparator attached 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) [5] modem for the corresponding flow rate. 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.

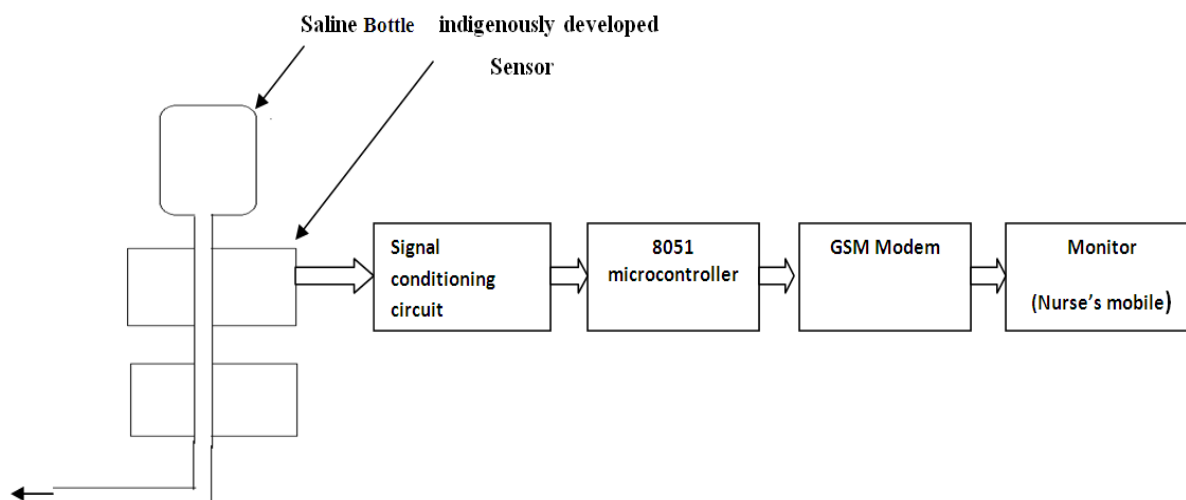


Figure 4. GSM Model

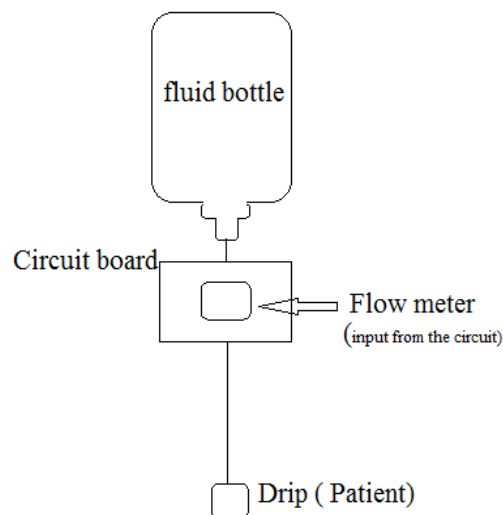
A double mode RFID label reception apparatus [7], which adequately changes radio wire mode as indicated by IV pack liquid levels. These two diverse utilize modes take into account application in stock administration and low liquid cautioning. In a healing facility setting, this framework gives a technique to overseeing IV utilize what's more, stock to lessen nurture workloads.

The development of science, innovation and drug, the universal connectedness and the acknowledgment of bioelectrical interfaces are empowering the outline of digital therapeutic frameworks to address [8] wellbeing administration in its different angles. This field is amazingly enunciated, as issues and arrangements are assorted. By the logical methodologies that encourage

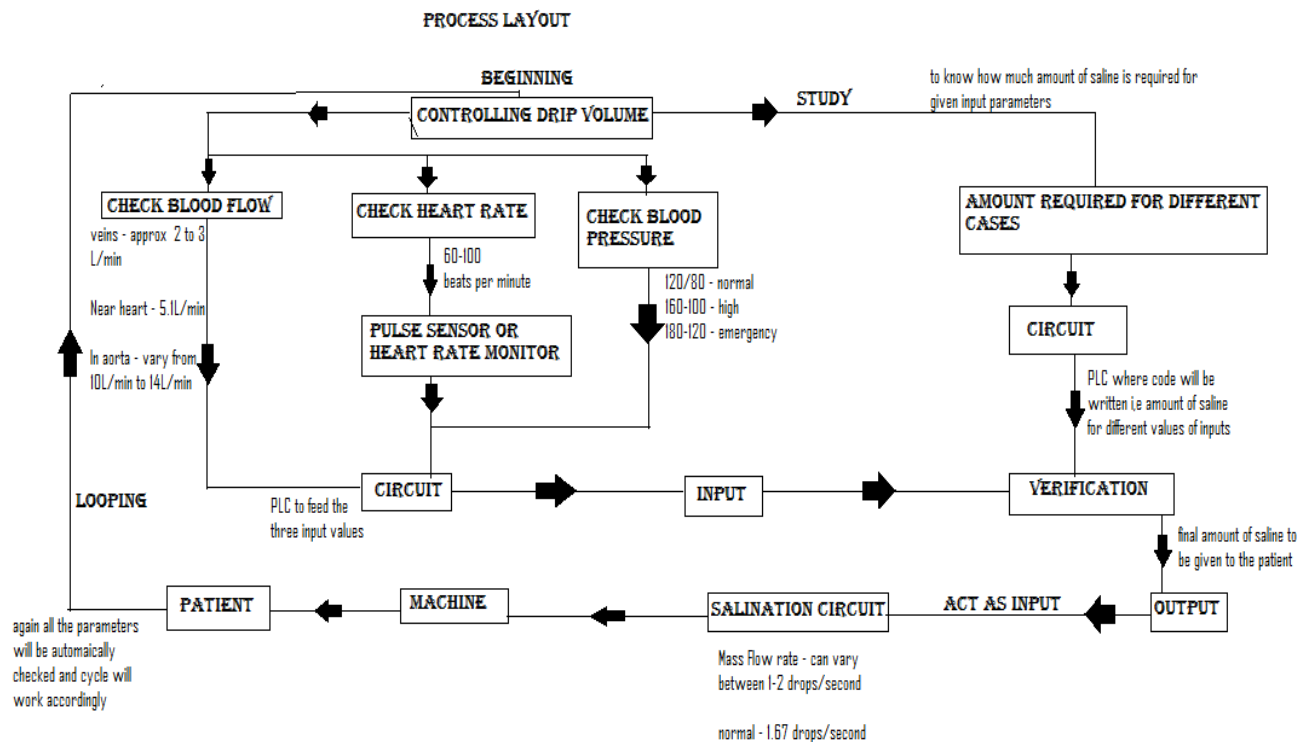
issue investigation, scientific classification and organized arrangements have the probability of accomplishing substantial and reasonable applications in front of conceivably expansive advancement costs.

3. Conceptual Design:

In all the cases reviewed, it is found that mass flow rate of the IV fluid is only monitored but it is based on the decision of the doctor or the nurse, at what flow, the fluid is to be injected. A system will be a closed system only when the decision, the monitoring: all the things are in a sequence. Hence, in this paper, a conceptual designed is being prepared and recommended to fill this literature gap.



Along with this, patients' Blood pressure and heart rate will be simultaneously monitored



In our model, we are focusing on both controlling the flow rate of saline or IV fluid as well as alerting the medical personnel to change the bottle. We are using flow meter for this purpose, which will be controlled by a circuit that circuit will tell the flow rate at which the saline is to be given and will directly give that value to the flow meter and thus the desired flow will be obtained. For example, if 500ml bottle is to be injected in say 100 minutes, flow rate will be 5 ml per minute and accordingly the flow meter will adjust the flow. By doing this, the advantage is that after 100 minutes, the flow meter will automatically close and thus no air or something will go inside. The next phase that comes is the constantly Monitoring the state of the individual. For this, we will be constantly Monitoring the heart rate and BP of the patient and while injecting, if sudden changes are coming, it will alert the medical personnel. For alerting, we can either go for buzzer technique with the use of transmitter or even GSM module technique i.e. alerting the personnel on phone itself (even Bluetooth technique can also be used).

A complete flow chart of our model has been given above. We can clearly see that for controlling the drip volume, we are using flow sensor and even monitoring the condition of patient, which include checking the blood flow, heart rate and blood pressure. In the PLC circuit as mentioned in the flow chart, these constraints act as the input, we are going to feed the normal value of these constraints, and any significant deviation from the normal values will ultimately alert the medical professional.

Secondly, the salination circuit near the flow meter controls the amount of IV fluid to be injected in the patient. That is a very basic circuit. The input being amount of saline to be injected along with the time in which the process is to be completed. This will ultimately give a value of flow rate, the same flow rate will go through the flow meter, and thus, process will continue.

After the bottle is finished, at one side, the flow meter turns off and on the other side; the medical personal is being alerted. This is what makes this study different from others. In this way, the whole system will get automated and thereby reducing manual work and this system can be feasibly used in practical times easily.

4. Conclusion

In this paper, a conceptual design based on the patient's complete detail has been presented. When these details are taken into account to a fuzzy model or PLC programming or MATLAB coding, the regulation will be done according to the patients live condition, which enables the speedy recovery especially in the emergency wards. This idea is having the highest amount of feasibility and act as a closed loop control system where the doctors or nurses monitoring level of contribution is comparatively reduced and of course indirectly the fatigue of the assistants are reduced very much. In addition, during the complete process, we can clearly see that at various levels, alerting system is present and thus, in any case of emergency, the medical personnel will be alerted so that there is no kind of compromise with the health of the individual. In future, considering the patients privacy, Big Data Analytics prove promising and can help to develop a systematic model for keeping patients information safe[9]. The model can be converted to monitor IV fluids along with enabling some security constraints that actually guarantees privacy and security of data.

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