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Design and Development of Saline Flow Rate Monitoring System Using Flow Sensor, Microcontroller and RF ZigBee Module

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Abstract— During last few decades, the population of the world has been increasing exponentially. This in turn increases the need for health care experts. But the ratio of number of health care experts to that of the number of people needing the expertise is unsatisfactory, especially in developing countries. This necessitates the use of remote health monitoring devices. This paper describes the development of saline flow rate monitor using flow rate sensor, microcontroller as coordinator and RF ZigBee module to transmit and receive the signal. Saline is often given to patients to rehydrate and fulfill the water and salt needs which depends on the patient. Hence it is necessary to keep the saline flow rate in check. The mentioned system enables the doctor or the nurse to monitor the flow rate of saline remotely.

Keywords— Biotelemetry, saline flow rate, flow sensor, microcontroller, RF ZigBee module, remote, monitor, health care.

INTRODUCTION

Saline is a term referring to sterile solution of sodium chloride (NaCl). In medicine, saline is often used for intravenous infusion in dehydration, hypovolemia or in nasal irrigation. The amount of saline needed depends on the condition of the patient. Thus it is important to measure the saline flow rate. This has been done manually by the nurses. The less than necessary number of nurses or doctors makes this task quite difficult to achieve. Thus it becomes necessary to develop remote health monitoring systems which will measure the required patient data accurately and transmit the same faithfully to a doctor or nurse as required. Many systems have been developed in last few years for measurement and transmission of parameters like blood pressure, glucose, pulse rate, temperature and so on. This has been possible because of advancement in the field of sensors, microcontrollers and telemetry.

SALINE FLOW MONITORING:

OVERVIEW:

A Hall Effect based flow sensor is attached at the neck of the saline bottle. The droplets pass through the sensor which are sensed by the pinwheel and the magnet inside the sensor. The output of sensor is in the form of voltage which is given to the microcontroller AT89S51 at one of its port. These voltage pulses from the sensor are counted by the microcontroller which are stored in its registers. They 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. So it becomes easier for them to monitor the flow at times whenever required.

BLOCK DIAGRAM OF SALINE FLOW RATE MONITORING SYSTEM:

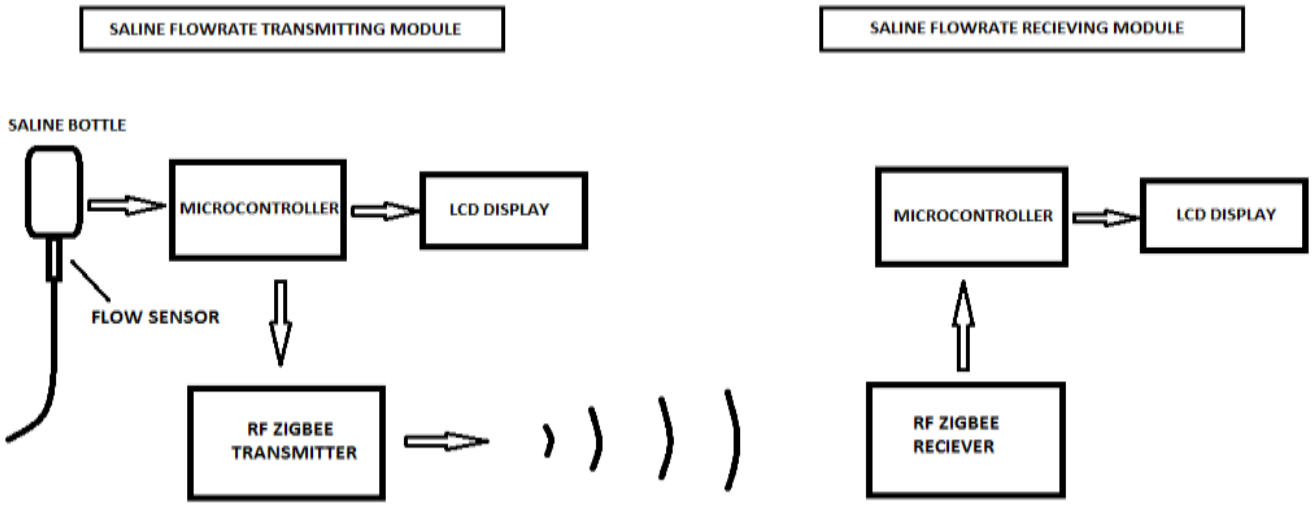


Fig 1: Block Diagram of saline flow rate monitoring system

SALINE FLOW RATE MONITORING SYSTEM DESCRIPTION

1. Flow rate Sensor:

The system uses a Hall Effect based flow rate sensor to measure the saline flow rate (Fig 2). The flow sensor consists of a plastic valve body, pinwheel rotor and a Hall Effect magnetic sensor. Tiny magnets are attached to each fin of the rotor. The sensor is inserted in the space made by cutting away a part of the saline flow tubing. Whenever the saline flows over the rotor, it makes revolutions and so do the magnets. These revolutions are counted by the magnetic sensor which in turn are proportional to the saline flow rate. The sensor has three wires: red (5-24V supply), black (ground) and yellow (Hall Effect pulse output).

Selection criteria of flow rate sensor:

- Should be able to measure flow rate of transparent fluid accurately
- Should be able to measure flow rate in the range of 0.05 mL/s to 0.5 mL/s
- Should have an output compatible with 8051 microcontroller

Specifications of flow rate sensor:

- Model- Sea YF –S201
- Sensor type-Hall effect
- Working voltage- 4.5 V to 18 V DC
- Maximum draw current – 15 mA at 5 V
- Output type- 5V TTL
- Working flow rate-1-30mL /min
- Working temperature range- -25 - +85 degree Celsius
- Accuracy- +-10%
- Maximum water pressure- 2M Pa
- Durability- Minimum 300,000 cycles
- Pulses per liter - 450

Fig 2: Flow rate meter

2. Saline flow rate transmitter module:

This module is installed near the saline bottle. The AT89S51 microcontroller counts the pulses obtained from the flow sensor. These pulses are compared with some predetermined values of flow rate ranges. After determining the flow rate range, the same is displayed on a LCD display on the module and transmitted through the RF ZigBee transmitter module.

This module works in half-duplex mode. Means it can either transmit or receive but not both at same time. After each transmission, module will be switched to receiver mode automatically. The LED for TX and RX indicates whether IC is currently receiving or transmitting data. If chip is transmitting and any data is input to transmit, it will be kept in buffer for next transmission cycle. It has internal 64 bytes of buffer for incoming data. When you power on the unit, the TX LED will briefly blink indicating that initialization is complete and it is ready to use. The RX LED is directly on TX OUT pin to indicate that actual data is received and it is sent to output pin.

Selection criteria of communication module:

- Transmission range – Up to 30 meters
- Safe to be used in hospitals
- Low power requirement

Specifications of RF ZigBee module:

- Model- Sunrom technologies No. 1124
- FSK technology ,half duplex mode
- Automatic switching between TX and RX
- 2.4 G Hz band , no need for frequency usage license
- Standard UART interface , TTL logic level
- Range- 30 meter

Microcontroller:

The microcontroller used here is AT89S51. The AT89S51 is a low-power, high-performance CMOS 8-bit microcontroller with 4K bytes of In-System Programmable Flash memory. The device is manufactured using Atmel's high-density non-volatile memory technology and is compatible with the industry-standard 80C51 instruction set and pin out.

Selection criteria of microcontroller:

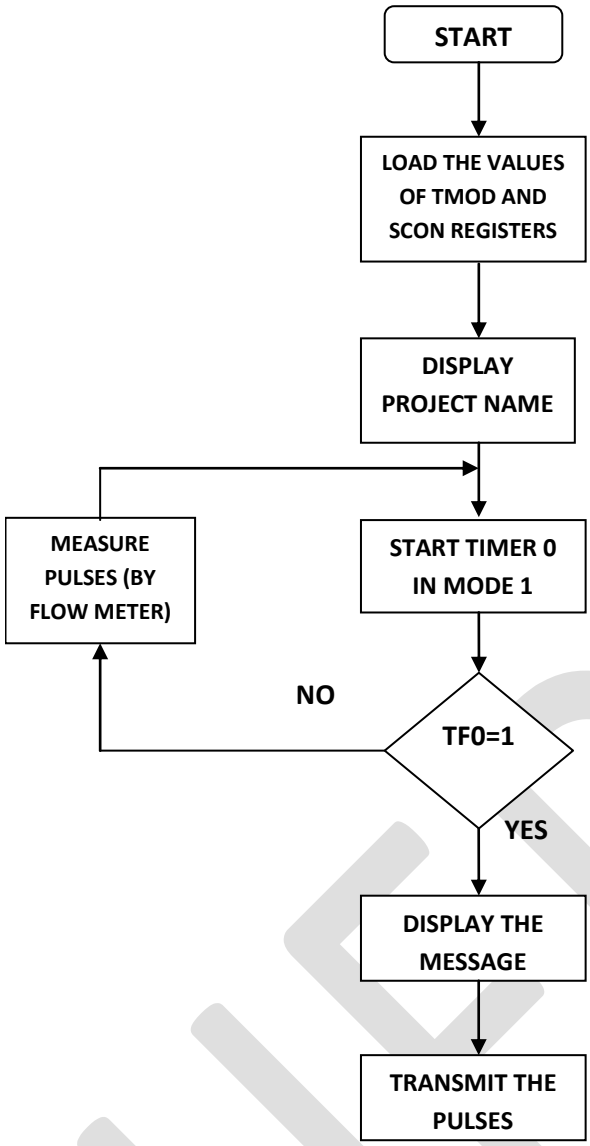
- Easy availability of microcontroller and assemblers, compilers, debuggers
- Compatible with flow rate sensor output (5 V TTL)
- Availability of interfacing with LCD display (16 by 2) and RF ZigBee module

Specifications of microcontroller:

- Model- ATMEL AT89S51
- Operating range- 4 to 5.5 V
- Memory – 1) 4K bytes of ISP flash memory 2)128 by 8 internal RAM
- 32 programmable input output lines
- 2 16bit timer/counter
- 6 interrupt sources
- Full duplex UART serial channel
- Watch dog timer

Given on the next page is the flowchart of the steps followed for counting the flow rate and displaying them through microcontroller for both the transmitter and receiver module.

TRANSMITTER MODULE



RECEIVER MODULE

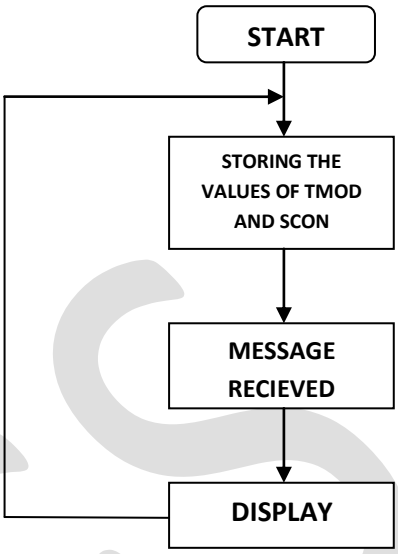


FIG. 3: FLOW CHART FOR PROGRAM

3.. SALINE FLOW RATE RECEIVER MODULE:

This module is placed where the doctor or nurse on duty can easily see it. The RF ZigBee receiver module receives the flow rate and same is sent to microcontroller for displaying on LCD. The selection criteria and specifications of the microcontroller and communication module are the same as in transmitter module.

EXPERIMENTAL RESULTS:

By implementing this system, we have measured the saline flow rate and transmitted the same to a remote location. The ranges chosen were: No flow, normal flow and maximum flow.

Serial No.	Flow rate range	Output pulses	Display
1	No flow	0	No flow
2	1-2 drops per second	4-8	Normal flow
3	Above 3-4 drops per second	Above 12	Maximum flow

Table 1: Table for output display and flow rate range.

The table shows the number of pulses counted by the microcontroller depending on the number of the saline flow drops and accordingly its display as shown in Fig 4.

Fig. 4: LCD Display showing observed flow rate

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CONCLUSION

Conventionally the doctor or the nurse manually measure the saline flow rate and then adjust it accordingly. It is practically very difficult for a nurse to be present at the patient's bedside all the time. This system will help nurses in remote monitoring of saline to large extent. The use of RF ZigBee module helps in reducing the power consumption and cutting down the cost of messages as is not the case of GSM module.

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