Design and Development of Wireless Intravenous Multidrug Delivery System

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***Abstract*—Continuous monitoring is an indispensable factor in competent patient care. But the available human resource is scarce leading to inadequacy in monitoring. Efficient monitoring can be made possible by using wireless control for medical devices. This paper illustrates hardware and software aspects of such structure and then presents their implementation in a real system. An infusion pump device is upgraded with remote access capabilities using communication software and an electronic module based on modern system-on-chip microcontroller.**

Keywords - Multi-drug infusion system, intravenous, mobile phone, control system, SMS (short messaging service).

I. INTRODUCTION

In today's world conserving time and resource is a major issue. Humankind has been able to automate many of our daily necessities. The multi-drug infusion system should not be an exception. It should be modernised such that it does not need a close watch as it is done presently. Infusion pump (drip-feeding pump) doses fluids or medication into a patient's circulatory system. The commercially available infusion pump is shown in fig 2 below. The need for controlled perfusion (in time and in liquid temperature) is very important in treatment of diseases.

The present devices perform the task in manual way that is expensive and not entirely reliable. The present systems administer minute quantities as per requirement on timely basis.

Thus, these systems require high-performance electronics for a precise control. By using electronics we can achieve control over the system which will enhance the consistency and reduce the risks. Monitoring techniques can be applicable not only to infusion pumps but also to other medical devices, if they share same hardware interfaces and communication protocol [1].The future of the world lies in telemedicine[4] with the likes of wireless ECG(electrocardiogram) and DaVinci that will make treatment of patients just a click away. The wireless multi-drug infusion system technology will add another feather in the cap of telemedicine. The block diagram of the proposed system is shown in fig 1.

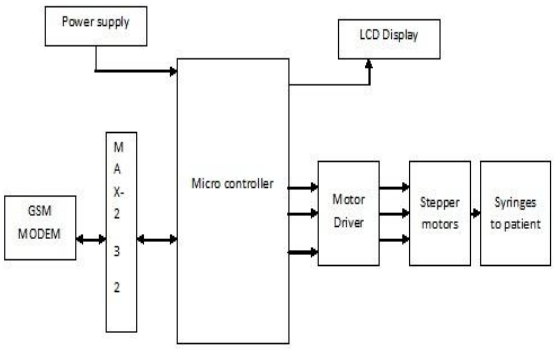

Fig 1: The block diagram of the wireless infusion pump

II. PROBLEM DEFINITION

The infusion pumps commercially available are not entirely automated. They are equipped to give certain doses at a particular time but they have to be manually set i.e. they cannot be controlled wirelessly. Hence there is a need to develop an infusion pump that can wirelessly monitor the infusion rate and alert the doctor for deviation from the normal.

The benefit of such a system is that it would enable the physician to monitor the dosage rate and control the multi-drug infusion system at the comfort of his/her office.

Fig 2: Commercially available infusion system

III. HARDWARE

The design of a wireless infusion system is based on microcontroller and GSM(Global System for Mobile Communications) technology. Microcontroller is the core of the system that would control the rate of infusion and the precise timing depending upon the inputs given by the user from the mobile. The microcontroller AT89S51 [2] is a low-power, high-performance CMOS 8-bit microcontroller with 4K bytes of in-system programmable Flash memory. The on-chip Flash allows the program memory to be reprogrammed. It has 32 programmable I/O lines and 4 I/O ports of 8 lines each. It has two, 16-bit timer/counter. It has a full duplex UART serial channel which is useful in interfacing with the GSM modem.

Analogic's GSM Smart Modem [3] is a multi-functional, ready to use, rugged and versatile modem that can be embedded or plugged into any application. It is interfaced with the microcontroller. It transmits and receives the commands from the user that can in turn, is conveyed to the microcontroller which controls the flow rate of multi-drug infusion system. The GSM modem provides a secure network with no data loss.

The system uses stepper motors that are used to push the plunger of the syringes and are useful for selecting the syringes in case for multi-drug infusion system. We are primarily interested in open loop models which have a rotation angle in range of 90^{o} to as small as 0.72^{o} per step. These motors are driven by the ULN 2003. They are interfaced to the microcontroller that controls and coordinates the speed and rotation of the stepper motor to control the infusion rate and time.

IV. WORKING

The multi-drug infusion system that was built is a completely automatic system. The user sends an SMS to the system which is received by the GSM modem. It deciphers the SMS and orders the microcontroller to actuate the motors. The modem then deletes the received message so that the memory space in not unnecessarily withheld. The actuated motors perform the task, that is, the correct syringe is selected and the fluid is infused. The GSM modem sends a confirming SMS to the user that, the required task has been successfully accomplished.

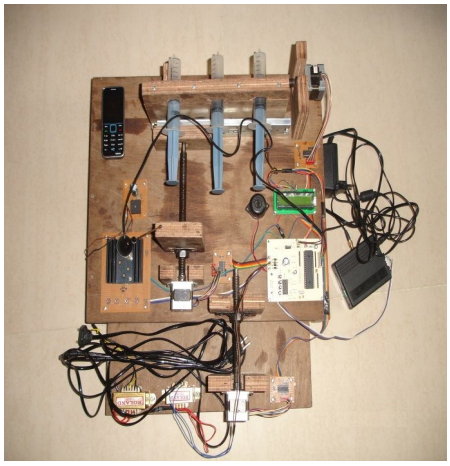

Fig 3: The hardware implementation of wireless multidrug infusion system.

V. RESULTS

The multi-drug infusion system was designed and the working was verified. It worked efficiently and the results were precise as per the standard values that were set. The quantity desired along with the syringe to be selected for infusion was sent as an SMS to the system. After performing the task the system was able to send a confirming SMS to the user. We infused 20 ml of fluid through the second syringe and the task was performed without any flaw.

VI. CONCLUSION

Infusion pumps improve medical activity in a hospital. Modern electronics and mechatronics bring together features like, precise infusion of very small quantities. Advanced system-on-chip microcontrollers offer simple solutions for control of infusion pumps with enough processing and memory reserves for further improvements.

Adding wireless capabilities to an existing medical device with console can be performed with moderate effort and with effective costs. The time and effort of the working personnel will be trimmed down and the efficiency of the system will be increased manifolds.

VII. FUTURE WORK

The multi-drug infusion system in our research work is a little redundant. But it provides a great scope in miniaturization. This system can be implemented at MEMS (MicroElectroMechanical systems) level. System with micro needles can be used and a wearable wrist or arm size device could be designed.

Our system is a 3-channel device but the number of channels can be increased to 8 or 12 channels as per requirements. The wireless technology can be implemented for other hospital devices with the similar hardware.

REFERENCES

[1] Drumea, Al. Vasile, 'Infusion pump medical system controlled with modem system on chip devices', 29th International Spring Seminar on Electronics Technology-ISSE2006, May 2004, St. Marienthal, Germany.

[2] Janice Gillespi Mazidi, Muhammad Ali Mazidi 'The 8051 Micro controller and Embedded Systems'.

[3] Theodore S. Rappaport 'Wireless Communications'.

[4] K Shimizu, 'Telemedicine by mobile communication', IEEE Engineering in medicine, Biology magazine. Vol. 18(4), 1999, 32-44.