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Intelligent Drug Dosage Decesion & Administartion Using R-Pi SBC An Intravenous Pre-Operative Insulin Administration Scenario

An Subcutaneous Pre-Operative Insulin Administration Scenario

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***Abstract*:** *After the advent of automated drug dispensing systems in late 80's, these systems have became indispensible in health care. But after drastic improvements in IT systems, these systems remain on the same concept of programmed drug or dosage injection. These systems lack the ability to automatically adjust the drug type or dosage.*

We propose a Intelligent Drug/Dosage Decision and Administration system which can not only administer drugs on a preprogrammed basis, but can change drug type or dosage as per patient requirement after sensing the stats to be controlled using sensor suite

Keywords: *Automatic Drug Administration, Intelligent Dosage Modulation, Raspberry Pi, Intravenous Drug Infusion, Single Board Computers, Biomedical Instrumentation*

1. Introduction

As abstracted after multifocal development in IT systems, Drug Delivery & Infusion System remain on the same concept of programmed drug or dosage injection. These systems lack the ability to automatically modulate the dosage or modify the drug type according to patient condition.

We propose a Intelligent Drug/Dosage Decision and Administration system which can not only administer drugs on a preprogrammed basis, but can change drug type or dosage as per patient requirement after sensing the stats to be controlled using sensor suite. The intelligence of the system is imparted by using Raspberry - Pi, Credit Card Sized Single board Computer. The second generation raspberry pi, packs a decent power by using 900MHz quad-core ARM Cortex-A7 CPU & 1 GB RAM. PIC microcontroller from Microchip is our selected choice for Sensor Suite Implementation. Selected software platform for SBC is Raspian OS which is an R-Pi optimised version of Debian Linux, & Mikro 'C' for PIC Microcontroller Implementing Sensor Suite.

We propose an Pre-Operative Blood Sugar control regime, to be handled by this device, by periodically sensing the Blood Sugar levels in patients blood stream, and decide/alter Insulin dosage or type combination according to blood sugar levels & other stats. Then decided dosage is infused in patients blood stream intravenously.

As the entire device is managed by SBC, real time reporting of drug rates to concerned Doctors & Paramedics, Display Primary and Auxillary, WiFi Connectivity & Emergency Notification & Alarms are invariably available.

2. Methodology

2.1. Automated Drug Delivery & Infusion Systems

In late 80's, automated Drug dispensing devices were introduced, three decades after the advent of unit-dose dispensing. The introduction and Acceptance of these devices brought hopes of reduced rates of medication errors, increased efficiency for pharmacy and nursing staff, ready availability of medications where they are most often used (nursing station, patient bed side or inpatient ward), and improved pharmacy inventory and billing functions.

An infusion pump infuses fluids, drugs, medications or nutrients into a patient's blood stream. It is mostly used intravenously, but subcutaneous, arterial and epidural infusions are occasionally used.

Fig. 1: A Commercially Available Infusion Pump

Infusion pumps can administer fluids much more reliable & inexpensively as compared to manual administration. manual administration of small dosages or multiple time per day dosages are to unreliable to be done by nursing staff, whereas , infusion Pumps can administer as little as 0.1 mL per hour injections (rate too low for a drip), injections every minute, or fluids with varying volumes according to time of day.

2.2. Raspberry PI SBC

A **single-board computer** (**SBC**) is a complete computer fabricated on a single PCB (Printed Circuit Board) , with microprocessor(s), RAM/FLASH ROM, Input/Output (I/O) and other accessories such as UART Etc. Single-board computers now a day(s) employ SOC (System on Chip) architectures to pack more processing power, increase reliability & reduce costs.

The original Raspberry Pi was based on Broadcom BCM2835 SoC (System on Chip), which packs an ARM11 700 MHz processor, VideoCore IV GPU, and originally had 256 MB RAM, later upgraded (models B and B+) to 512 MB. The system had Secure Digital (SD) (models A and B), but was upgraded to MicroSD from models B+, sockets for boot media and non volatile storage.

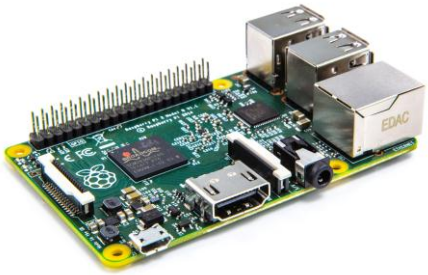

Fig. 2 Raspberry Pi – Single Board Computer

The latest version of Raspberry Pi, Raspberry Pi 2 (Model B) features a Broadcom BCM2836 SoC, a quad-core ARM Cortex-A7 CPU and a VideoCore IV dual-core GPU, 1 GB RAM, 4 USB 'A' Slots, & an Ethernet Port.

2.3. PIC Microcontroller Based Biomedical Sensor Suite

The PIC Microcontroller based sensor suite allows Raspberry Pi to acquire biometric and medical monitoring by using different sensors: pulse, oxygen in blood (SPO2), airflow (breathing), body temperature, electrocardiogram (ECG), glucometer – Blood Sugar, galvanic skin response (GSR - sweating), blood pressure (sphygmomanometer), patient position (accelerometer) and muscle/eletromyography sensor (EMG).

Fig. 3 Typical Biomedical Sensor Suite

The PIC MCU collects biomedical data from various sensors using analogue & digital ports, compiles the data in our required protocol, & sends the data on RS232 Bus. We have powered the PIC microcontroller based patient stats acquisition system using a 5V DC-DC converter with 1KV Rms Isolation for patient safety.

Also data from the PIC microcontroller based stats acquisition system is fed to Raspberry Pi by Using RS232-USB converter using FTDI's USB RS232 converter IC. Also the RS232 Interface to the converter is electrically isolated by using optocouplers for patient safety.

2.4. PIC Microcontroller Based Infusion Pump Controller

Again the versatile PIC microcontroller from microchip, is used as an infusion pump controller. The infusion pump controller is also interface to Raspberry Pi via USB Bus, which is converted to RS232 by FTDI's USB Serial Converter & then the recognized serial command is executed by PIC microcontroller.

The infusuion pump is a dual piston pump controlled by PIC microcontroller. The syringe piston is driven by ball screw arrangement, controlled by 1.8 Degree NEMA23 stepper motor. Toshiba TB6560AHQ stepper motor driver IC is Used as a stepper motor driver, optical encoders are used to track the piston position.

2.5. Application Note: Automatic Insulin Administration

The author proposes an application note of the above mentioned technology. The scenario is that a pre operative patient's blood sugar is to be controlled by insulin administration. The author's prototype device is capable of monitoring blood sugar levels non-invasively by optical method & by periodic sampling of patient blood in glucometer (Invasively). The author(s) device automatically takes the blood sugar reading, non-invasively, calibrates the non-invasive readings periodically with invasive glucometer readings and then decide(s) the combination & dosage of insulin, and administers the required dosage subcutaneously.

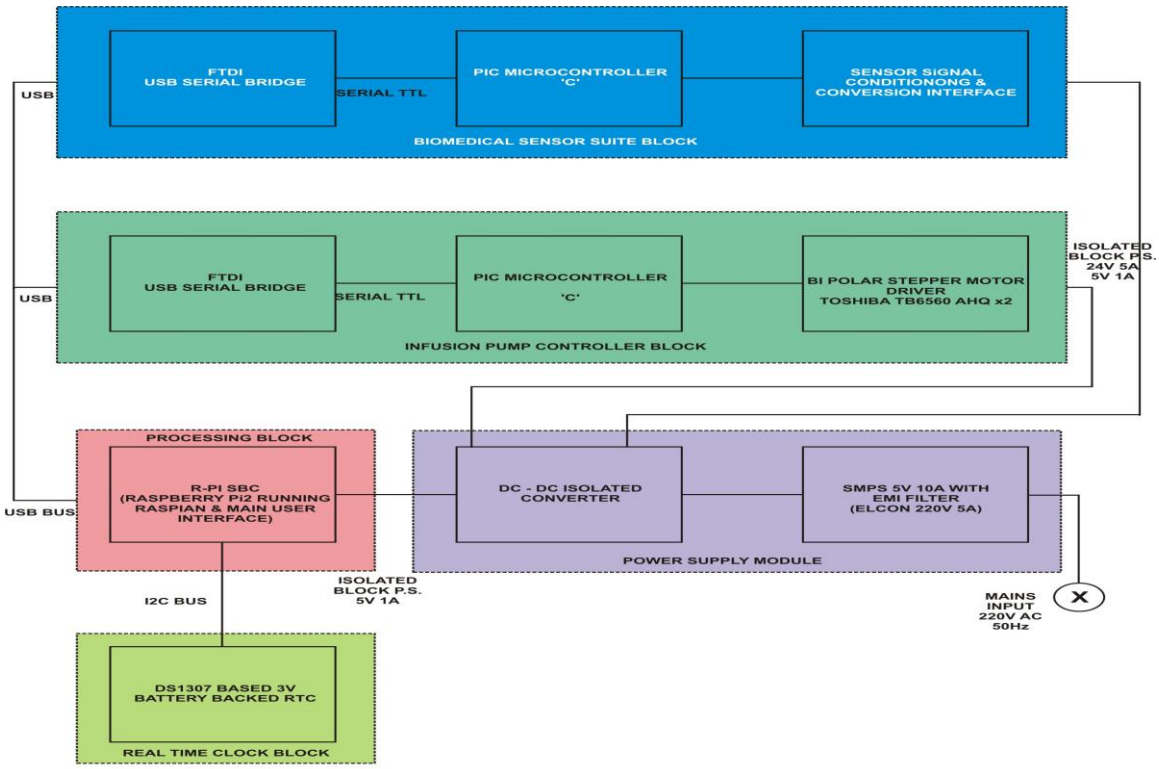

Fig. 4 Functional Diagram of System Operation

3. Conclusion

The proposed prototype has been designed by the author(s). After non – production test run non – clinically, the technology promises a vast outcome & drastic improvements in medical care & medical systems. After promising results from non-clinical trials of non – medical standard prototype (hardware functionality only), the authors are waiting for management approval for manufacturing of the system with medical grade components & equipment, so that permission for clinical trial can be obtained & trails can be commenced. Apart from providing hassle free medication for patients, it also provides for storage of patient data, such as patient's biomedical parameters, drug type & dosage in a database which might be reviewed by consultant doctor any time. Also use of SBC with WiFi availability allows to seamlessly interconnect various systems to the central hospital server wirelessly.

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