

Design and Fabrication of Automatic IV Fluid Feed System

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Abstract— Technological advancements are happening in the hospitals. Normally, doctor and nurses monitor IV fluid feed of a patient. They may forget or can't monitor it properly which may lead to severe problems for patient. Design and fabrication of automatic IV fluid feed system will be helpful in this regard. The main Objective of this project is to develop an automatic fluid feed system which can be used in hospitals, clinics etc. replacing manual feeding automatically. Multiple IV fluid can be feed to the body through one system and one line. Here, one can easily set the time of feeding saline or injection automatically by the system. The need of extra nurse and care can be minimized by using the system. This system will be controlled by Arduino Mega 2560 which is a micro-controller board. Two servo motors, solenoid valve, Bluetooth module, RTC etc. are used this system.

Index Terms— Intravenous, automatic system, Bluetooth module.

1 INTRODUCTION

TECHNOLOGIES are changing day by day. In order to cope with it, technologies in medical field are also changing and evolving. Advancements in medical technology have allowed physicians to better diagnose and treat their patients since the beginning of the professional practice of medicine. In today's world, technology plays an important role in every industry as well as in our personal lives. Out of all of the industries that technology plays a crucial role in, healthcare is definitely one of the most important. This merger is responsible for improving and saving countless lives all around the world. In past few years there has been great effort expended by researchers in a medical field for developing an intravenous feeding pump adapted to accurately measure and positively pump solutions from saline bag into the veins of a patient without depending on gravity force. Doctors often desire to introduce drugs into the blood stream of a patient, and whenever the patient is being fed intravenously, it is usually desirable to introduce the drug through the intravenous feeding system, as by injecting into the delivery tube to the patient. Now, this new Infusion System frees the healthcare worker to attend to more critical care areas. The present intravenous feeding system consists of a saline bag containing the solution, an administration set which usually comprises a drop chamber and a valve for flow control and a needle which is inserted into the patient. Some problems will arise in traditional system. Always presence and monitoring of nurse is also needed. The automatic IV fluid feed system is a simple and inexpensive solution to regular monitoring and injecting IV fluid like injection fluid, saline etc in vein. For assuring the safety of the patient during IV period, there is a need to develop an efficient health monitoring system. This invention will be helpful in this regard. A close control of solution feeding rate can be thereby achieved. This idea of automatic IV fluid feed system can be done where servo motor, arduino, dc power supply, RTC, buzzer, water flow valve etc are used to provide control and injecting IV fluid in time which is set by the doctor or nurse. This will reduces the stress in continual monitoring and all time presence by the doctor or nurse at an affordable cost.

2 PROBLEM DEFINITION

The infusion pumps commercially available are not entirely automated. They cannot be controlled precisely. They are equipped to give required amount doses at a particular time but they have to be manually set. Hence development and fabrication of an automatic IV fluid feed system that can be monitored from a distance and the infusion rate is very necessary. The benefit of such a system is that it would enable the physician to monitor and control the IV fluid feed system at the comfort of his/her office and there is no need of continuous presence of him.

3 LITERATURE REVIEW

The first recorded attempt at intravenous medicine dates to 1492, this branch of medical science gained real momentum in the 17th century. The first working IV infusion device was invented by the famous English architect Christopher Wren in 1658[1]. Intravenous technology stems from studies on cholera treatment in 1831 by Dr Thomas Latta of Leith.[2] Intravenous therapy was further developed in the 1930s by Hirschfeld, Hyman and Wanger[3][4] but was not widely available until the 1950s.[5]

Dalton L. Truluck Attorney, Agent, or Firm-Cameron, Kerkam, Sutton, Stowell & Stowell [6] proposes closed intravenous infusion system comprises a completely filled, collapsible bottle of accordion type construction, motor driven means so as to provide a desired feeding rate and to stop the feed when the bottle has been emptied to the desired degree, or in the event of a fluid blockage or other malfunction of the system.

R.Vasuki proposes that a portable monitoring device of measuring drips rate by using an intravenous (IV) set. In this method the IV set is attached to the drips chamber. The flow sensor is used to detect each drops of IV set. For each drop, the beam of light is broken at each time and that is transmitted and received by IR sensor. This provides a change in sensor output and comparator gives a pulse output for

each drop. The drip rate is indicated using the LCD with which the observer can identify the volume of fluid in IV set. If the device is not sensed for 45 seconds it will give an alarm.[7]

C.C.Gavimath proposes an method of Design and development of versatile saline flow rate measuring system and GSM based remote monitoring device. In this device an indigenously developed sensor is attached to the neck of the drips bottle. For every drop of the saline, the signal conducting circuit produces one pulse.[8]

A new Wireless Sensor for Intravenous Dripping Detection is proposed by Paul Bustamante, Gonzalo Solas. Karol Grandez.[9]

All of these proposed system is only applicable for saline feed. There is no combined system for both saline and injection feed. And these can't be controlled remotely. This is why, design and fabrication of automatic IV fluid feed system will be helpful in this regard.

4 MATERIAL AND METHOD

For the development of the project automatic IV fluid feed system, the following components are required.

- 1) Arduino Mega 2560
- 2) Real time clock
- 3) DC power supply
- 4) Saline bag
- 5) Water flow valve
- 6) Injection syringe
- 7) Servo motor
- 8) Bluetooth module
- 9) IV Stand

Resistor, Transistor, IV Chord, Connecting wire are also used in this system. A brief description of the required components is given below-

4.1 Arduino Mega 2560

Arduino MEGA 2560 is designed for more complex projects. It is the recommended board for 3D printers and robotics projects. It has 54 digital input/output pins, 16 analog inputs, 4 UARTs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power. In this project, Arduino is the heart of everything. It is the main command center. In this project, Arduino is connected to DC power supply, Bluetooth module, Real time clock, servo motors and water flow valve.

4.2 Real Time Clock

A real-time clock (RTC) is a computer clock that keeps track of the current time. Although the term often refers to the devices in personal computers, servers and embedded systems, RTCs are present in almost any electronic device which needs to keep accurate time. Real time clock is used in this project to keep the right track of time.

4.3 DC Power Supply

DC Power Supplies are commonly used in DC-DC converter, PV inverter, telecom, battery chargers, automotive, burn-in, and plating/electrolysis testing applications. Programmable DC Supplies range from 600W to 15kW up to 150kW with constant power operating envelope, current range up to 160A. In this project, transformer in put is 220V-2.5 A and output is 12V-2.5 A. IC 7806 is also used in this system to get required output current and voltage. Transformer is connected with power and bridge rectifier. There, 3 IC 7806 is used. Here, DC power supply connected with the arduino mega 2560. It converts AC current into DC current. Finally, the DC output is 6V-2.5A.

4.4 Saline Bag

In medicine, saline (also saline solution) is a solution of sodium chloride (NaCl, table salt) in water. It is used to flush wounds and skin abrasions, as eye drops, for intravenous infusion, rinsing contact lenses, nasal irrigation, and a variety of other purposes. The Saline Bag is a common medical item that can be found in medical centers. In order to use a Saline Bag, it must be combined with an IV Start kit, forming a Saline Bag IV. Here, saline bag is used for keeping necessary fluid.

4.5 Water Flow valve

A water valve is an electromechanically operated valve. The valve is controlled by an electric current. It is connected to the arduino. It is a two-port valve, the flow is switched on or off. Fluid flows through inlet and outlet valve. In this project it is used to control flow of IV fluid. It is connected with the arduino. It has two port; which are incoming and outgoing. Incoming port is connected with the IV saline feed and outgoing port is connected to the patient's body.

When signal comes from arduino valve opens and fluid flows through it.

4.6 Injection syringe

A syringe is a simple pump consisting of a plunger that fits tightly in a tube. The plunger can be pulled and pushed along inside a cylindrical tube (called a barrel), allowing the syringe to take in and expel a liquid or gas through an orifice at the open end of the tube. The open end of the syringe may be fitted with a hypodermic needle, a nozzle, or tubing to help direct the flow into and out of the barrel. Syringes are often used to administer injections, insert intravenous drugs into the bloodstream, and apply compounds such as glue or lubricant,

and measure liquids.

4.7 SERVO MOTOR

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing. In this project, servo motor is used to push the injection syringe. When servo motor gets signal, it's spindle rotates and it pushes the injection syringe and fluid goes to the fluid line.

4.8 Bluetooth module

It is a powerful, small device and very easy to use. This Bluetooth module is designed to replace serial cables. The Bluetooth stack is completely encapsulated. In this system Bluetooth module is used to give the required data input. It receives data from mobile app via Bluetooth and transmits it to the Arduino.

4.9 IV Stand

IV stand or IV pole is generally used in the hospitals. IV pole is a steel pole provides strength and durability. It is kept beside the patient's bed and is used to hang the IV saline bag. In this project, a IV stand is used to hang the saline bottle.

5 WORKING PRINCIPLE

Intravenous therapy is a medical process where infusion of liquid solution directly into a vein is occurred through an IV tube and needle is inserted into the patients' vein. To regulate the IV fluid to be delivered by an IV pump, the tubing should be threaded into the machine correctly. Nurses should dial in the hourly IV rate (cc to be delivered over an hour) and start the pump following the manufacturers guidelines. In this system, one can set the time of saline flow and time of injection feed, and it will be done automatically. In this system, Arduino microcontroller is used. A saline bag with water flow valve is attached with the arduino. Servo motors are used to push the injection syringe. Solenoid valve opens in pre-set time and allow IV fluid flow. A real clock timer is also used in this system. By using it, one can set the exact time of saline flow and exact time of injecting IV fluid. DC power supply is also used in this system. For designing the process, at first pushing of injection syringe and flow control of saline line should be given top priority. This project of automatic IV fluid feed system relates to the automatically controlled administration of intravenous fluids and or drugs to patients, thereby eliminating the need for continuous supervision and the monitoring of those patients while they are receiving their I.V. therapy. It is a control system that functions utilizing a servo system to mechani-

cally control injection fluid or drug flow, thereby controlling the rate of flow through that IV tubing to the patient by using water flow valve. Bluetooth system is also used here for setting the proper time by the doctors or nurses. It is a common practice in treating patients, particularly patients who must be cared for under emergency conditions, to administer medications into the patient intravenously. An intravenous solution, commonly referred to as parenteral fluid, is fed from a container, bottle or I.V. bag, through a tubing and a catheter which has been inserted into the patient's vein. The catheter is secured to the patient by a strip of adhesive tape. Saline flow is gravity fed. Now, two injection syringe is used to show the system. A saline bag is also used. In, hospitals, there is a iron stand or bar is attached to the patient's bed or kept individually. It is used for hanging the saline bag or IV bag. It is called IV pole. For this project, a IV stand is also used. A saline bag is hung using IV stand. A base is used for keeping the servo motors, injection syringe, and water flow valve. The figure of this system is shown in fig .1, IV chord is connected to the saline bag, This IV chord is connected to one open port of water flow valve. The other open port is connected to the drip chamber by using other IV chord. From drip chamber, fluid goes to the patient's vein. Water flow valve is also connected to the arduino .It is done for controlling the flow of fluid and when signal is sent from arduino to the water flow valve, it's port opens and fluid flows through it. Servo motors which are kept on the base also connected to the arduino. Two injection syringe are kept in front of the servo motor. Necessary fluid or drugs are filled in it. When signal is sent from arduino, servo motor starts working and its spindle starts to rotate. By their rotation, they push the syringe of the injection and because of their applied force, fluid flows through the needle. By this, rotary motion of spindle is converted into linear motion of injection syringe.



Fig. 1. Automatic IV fluid feed system

IV chord is connected to the needle and other part of the chord is connected the main line. By flowing through the line, pa-

tient is fed necessary injection fluid or drugs. A real time clock module is used in this system. Real time clock module helps to keep right track of time. A DC power supply is also used in this system. The outline of this system is shown in fig. 2.

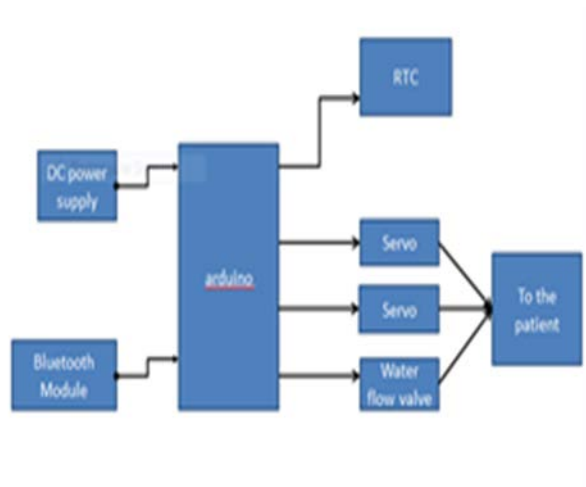


Fig. 2. Layout of the system

Arduino is connected with power supply. It is also connected with Bluetooth module, servo motors, Real time clock and a resistor. Resistor is connected with a transistor, one part of it goes to ground and another part is connected with water flow valve. Required input is given by mobile via Bluetooth module using Android Bluetooth app. RTC that is used in the system keeps right track of time. After setting time, in pre-set time, Arduino sends signal and servo motor pushes injection syringe and when signal goes to water flow valve, it opens and saline fluid flows right through it.

6 RESULT

The automatic IV fluid feed 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 desired quantity of fluid and drugs is sent to patient's body individually from saline bag and injection syringe. The desired time is set and input is given by mobile Bluetooth. The automatic IV fluid feed system is performed without any flaw.

CONCLUSION

A wide variety of digital innovations are revolutionizing healthcare and technology in medical field is here to stay. The main purpose of all of this innovation is the gathering of information, leading to more specific, personalized cheaper, faster, more efficient patient care. This idea of design and fabrication of IV fluid feed system will be helpful in this regard. This arduino based project will assist doctors and nurses in patient monitoring. This arduino based project will play a significant role in medical field if it is implemented. The work of automatic IV fluid feed system is a little redundant. But it provides a great scope for further works. This system can be implemented in other projects and systems. In this system a sa-

line bag and two injection syringe are used but the number of injection syringe and saline bag can be increased as per requirements. In this system, data input is given by mobile Bluetooth. The wireless technology can be implemented in this system.

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