# Real Time Monitoring of Syringe Pump Using Internet Of Things

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*Abstract*- **A syringe driver or syringe pump is a small infusion pump (some include infuse and withdraw capability), used to gradually administer small amounts of fluid (with or without medication) to a patient or for use in chemical and biomedical research. Though this system has a pre- built alarm systems, it still needs someone to get watched continuously. Thus to avoid this controversy among the Nurse or caretakers, we are developing a IOT based alert system, which do alert on all Inbuilt Alarm set to the Nursing centers periodically and helps us to monitor the pump status in real time.**

Keywords— syringe pump; fluid drive; real time monitoring; alarm system; Nursing centre;

## I. INTRODUCTION

and their application in various fields, such as medicine. Enhancing accuracy, increasing speed of operation and reducing costs are the primary performance objectives in the improvements to design and manufacture of devices or robots. One of the best ways to achieve these aims is using devices or robots instead of human resources. The injection pump we designed and manufactured in this work is a type of robot that has applications in medicine and health centres. This device is used for patients who are unable to receive foods and drugs orally. By examining similar foreign devices, studying their advantages and disadvantages, and researching health centre requirements for these devices, we designed and constructed such a device for the first time in this country. The most important items achieved in these investigations include time, accuracy, speed of drug injection, wireless real time monitoring and cost reduction. A syringe pump is a small infusion pump (some include infuse and withdraw capability), used to gradually administer small amounts of fluid (with or without medication) to a patient or for use in chemical and biomedical research. Though this system has a pre- built alarm systems, it still needs someone to get watched continuously. Thus to avoid this controversy among the Nurse or caretakers, we are developing a IOT based alert system, which do alert on all Inbuilt Alarm set to the Nursing centres periodically.

## SYSTEM DESCRIPTION

The system has two parts namely, hardware and software. The hardware architecture consists of an embedded system that is based on Arduino Uno board, a GSM Module, Motor Driver and an Android based smart phone. The GSM Module provides the communication media between the nursing station and the ICU. The pump has been designed for achieving desired flow rate of drugs into the patients. The pump activity has been set to monitor and control from the nursing station for periodical monitoring and alerts. The Pump has been connected to the Nursing station using the IOT connectivity with pump. The malfunctions and the errors are monitored using the several sensors such as U-slot Speed sensor. The alert is given in an android based application.

**Arduino Uno**

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, 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 it with a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

**Internet of things(IOT)**

The **Internet of things** (**IoT**) is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators, and connectivity which enable these objects to connect and exchange data. Each thing is uniquely identifiable through its embedded computing system but is able to inter-operate within the existing Internet infrastructure. The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities."Things," in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, cameras streaming live feeds of wild animals in coastal waters, automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring or field operation devices that assist firefighters in search and rescue operations. Legal scholars suggest regarding "things" as an "inextricable mixture of hardware, software, data and service". These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices. The term "the Internet of things" was coined by Kevin Ashton of Procter & Gamble, later MIT's Auto-ID Center, in 1999.

## MATERIALS AND METHODS

The low-cost open-source families of syringe pumps are completely customizable allowing both the volume and the motor to scale for specific applications. The bills of materials for the three variations of the syringe pump are shown in. The user/designer must first determine the size of motor to enable that application. The appropriate motor size can be selected once the required torque is known following. A bigger motor provides more torque, but necessitates larger printed components. A bigger syringe allows more fluid to be pushed out, both per second and in total, but decreases the precision of the device. A simple change to the OpenSCAD script specifying the motor selection defines the dimensions for the printed parts.

## OPEN SCAD AND 3-D PRINTING

Open Source and freely available open SCAD is script-based, parametric cad software possessing powerful 3-d modeling capabilities. it is not graphical; models are created by adding and subtracting primitives to produce the desired shape. it supports creation and extrusion of polygons and poly lines, so can be used to create very complex shapes. the script language is based upon c++ and only a few methods are required to produce very complex designs, so the learning curve is short, albeit steep for those not possessing programming experience. the scripts are written such that designs are parametric – the design can easily be altered by changing key dimensions. for instance, the syringe pump script can be altered to produce parts fitting different motors simply by specifying which motor to design for. the script written for the syringe pump is available online. models rendered in openscad are typically exported as stereolithography (stl) files for the first step in producing a 3-d print using any of the reprap 3-d printers currently available. images of syringe pump parts rendered by openscad and photographs of the printed parts are shown in figures s1–s10.

Reprap printers almost universally require g-code, a human-readable file format specifying the path the print head must follow to produce a physical object from a software model. G-code is produced by software referred to as a "slicer", which, as the name implies, slices an stl model into layers each having the same thickness in the z-direction. Cura was used to slice the syringe pump stl models. Cura is also open-source and freely available.

The parts were printed with reprap3-D printers. Two different printer designs, a Cartesian and a delta printer, were used to produce the parts out of 1.75 mm polylactic acid (PLA) filament. The printer design employed is ultimately irrelevant as both produce shapes using exactly the same method and materials and are different only in the way the print head is moved. Both printers were equipped with hot ends having 0.5 mm nozzles and prints were sliced at a layer height of 0.25 mm and a print speed of 60 mm/s. Parts were printed in plates, that is all of the printed parts needed to assemble a syringe pump were printed in one printer cycle.

## V. SYRINGE PUMP CONTROL AND INTERFACE

The syringe pump is controlled by an open-source Python program developed here running on a Raspberry Pi, which is an ARM based computer running GNU/Linux. The Raspberry Pi is an inexpensive, credit card-sized computer having integrated networking, sound, video, USB host and most importantly, exposed and readily accessible I/O lines. The wiring diagram for the syringe pump controller utilizes a single Pololu A4988 stepper controller, which controls the stepper motor that drives the syringe pump. The Raspberry Pi is installed with the standard Raspbian operating system. A custom web server is run, which serves a web page via either wired network or wirelessly via a wireless USB adapter attached to the Raspberry Pi's USB port. Any computer on the network can then control the pump through this web page.

## VI. CALIBRATION AND PERFORMANCE ASSESSMENT

The pump is calibrated by setting it up with an initial calibration value set to 1 mL/mm. A small arbitrary volume appropriate for the size of syringe used is pushed twice from the syringe and the actual value of the second push is measured. This is done to partially account for drops staying on the end of the syringe. This number is divided by the amount the syringe was told to push out, the resulting number goes into the calibration window. The sequence is repeated three times to ensure correct calibration.

The force produced by the lead-screw actuated design was measured by placing the assembled syringe pump with a steel rod in place of the syringe in a frame along with with a 30 kg-capacity scale. The pump was oriented such that the motor end sat upon the scale and the steel plunger faced upward, pressing against a fixed platform. The pump motor was advanced until it stalled or a component failed and the maximum force produced was read off the scale display.

The pumps' maximum delivery rate is a function of the speed at which the motor stalls. Stall speed was determined by increasing pulse rate to the motor until it stalled and then decreasing to the point where it ran again, establishing the maximum speed and therefore maximum delivery rate.

Precision was tested by repeated delivery of a preset volume (fixed by setting the total number of motor steps) of distilled water onto a Mettler AE100 scale having a readability of 0.1 mg. The relative humidity within the weighing chamber was maintained in a saturated state by placing containers of distilled water in it, permitting it to equilibrate and then ensuring that it was kept well sealed for the duration of the assessment. Performance of both the NEMA11 and NEMA17 pumps was assessed at different micro stepping settings.

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