**SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING**

**(Affiliated by VTU)**



**Department of Electronics and Communication**

Project synopsis on:

**Digitalization of Peristaltic Pump**

|  |  |
| --- | --- |
| Anirudh G | 4JC12EC018 |
| Darshan A | 4JC12EC037 |
| M N Sunaada Hebbar | 4JC12EC058 |
| Mrithyunjaya | 4JC12EC064 |

Submitted By:

Submitted To:

**Dr. N M Renukappa**

Professor & Research Scientist

SJCE, Mysuru

1. **Introduction**

A lot of equipment around us uses the mechanisms of pump, from the smallest Pump used in the house to the biggest scales and specification pump used in industries. A peristaltic pump is a type of positive displacement pump used for pumping a variety of fluids. Peristaltic pumps are typically used to pump clean or sterile fluids. Because the pump cannot contaminate the fluid, or to pump aggressive fluids because the Fluid cannot contaminate the pump. Some common applications include pumping Aggressive chemicals, high solids slurries and other materials where isolation of the Product from the environment, and the environment from the product, are critical. Viktor Shkolnikova, John Ramunash, Junan G. Santigoa, [1] makes a miniature peristaltic pump which uses a single reciprocatory actuator motion to produce pumping. Pumping is achieved the upstream valve and then compresses the section of the tube. In this the delivery of pump is not continues i.e. only in compression stroke delivery of pump happened. Marion H. Bobo, Michael M Brown [2] addresses housing is adopted to receive a flexible tube. The housing has curved wall & clamp. The roller assembly includes at least to a compression roller assembly includes at least one guide roller. The guide rollers are peripherally spaced between compression rollers whose race of them comes into contact with the flexible tube during rotation of the roller assembly. They use the gear system for rotating the roller from the above we can understand the operation of roller and tube. Theirs Scope to redefine the number or roller etc. Robert B. Clay and William A. Dorering [3] design the pump by squeezing the roller pressing and elastic tube supported by side a semi cylindrical chamber. The collapsed tube responded by travelling side roller which press the tube transversely. This expedites refilling and increases the pump capacity. A surge chamber consisting of an elastic hollow cylinder housed inside chamber housing provided with inwardly projecting annular ribs smoothen out both minor and major surges inflow of the viscous material. Corey Koch, Vicent Remcho, James Ingle [4] presents the design and characterization of novel PDMS (Polydimethylsiloxane) and tubing-based micro pumps based on direct actuation. A simple PDMS microchip consisting of a micro channel formed around a circular hole in the center of the microchip was pumped peristatically. The center hole housed a miniaturemotor driven, roller type actuator, analogous to that used in bench-top peristaltic pumps. The roller type actuator compressed the channel walls together as it rotated, thereby invoking peristalsis. A miniaturized tube based micro pump was designed to utilize the same actuator by employing a polycarbonate housing fabricated to hold commercial peristaltic pump tubing.

A Peristaltic Pump is a type of a Positive Displacement Pump. It is often used to pump different types of fluids. The principle of positive displacement uses a mechanism to repeatedly expand a cavity so as to allow fluids to flow into the cavity, and then seal that cavity. The fluid then moves forward. The only pumping element of peristaltic pump is flexible tube. The pump works by squeezing the tube with rollers or shoes. This means that pump can run dry, self prime and handle viscous or abrasive liquids, plus, as the tube is one complete unit, there are no seals. This makes the pump leak free and hygienic.

Peristaltic pump has many domestic usages such as in medical sector and handling of critical fluid. Thus, a study is needed to systematically be conducted in order design and analyzed the principle operation of such device. This paper focuses on the basic principle of peristaltic pump and its function which is helpful to develop new peristaltic pump.

User interface of existing Peristaltic pumps is complicated and requires in depth knowledge about the system to operate it, this project aims to implement simple user interface using Graphic LCD and matrix keypad. Several modes of operation will be implemented which makes the pump suitable for versatile applications. Further, the Micro Stepping technique will be used to drive the stepper motor for smoother rotation and to reduce stepper noise. Advanced feature like Calibration, Volume based mode, Time based mode, Repetitive & Discrete Dispensing mode and RS485 serial communication with external devices will be implemented.

1. **Block Diagram and Description:**

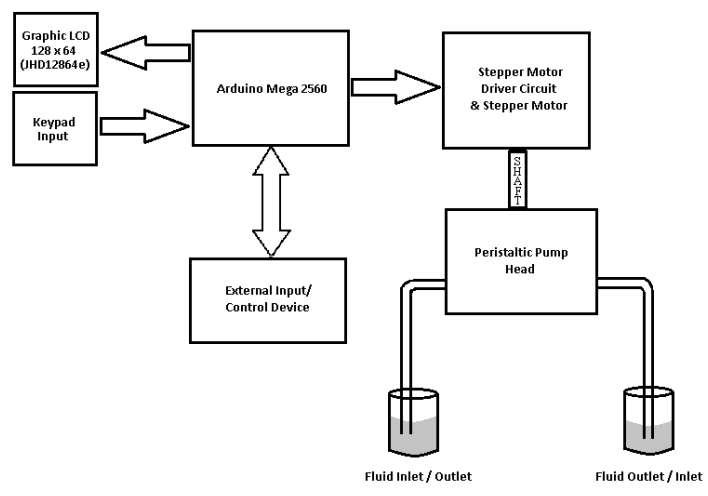


Figure 1: Block diagram of the Digital Peristaltic Pump System

**2.1 I/O Block:** It has a 4x4 matrix keypad, which is used to take inputs from the user. It has 128x64 Graphic LCD display used to provide visual output and much customizable user interface.

**2.2 System Controller:** This block is central processing and control block of the entire system. Microcontroller used is Arduino Mega 2560. It provides the interface between input block and the Stepper Motor Block. It takes input from user and controls the functioning of stepper motor by generating appropriate signals. It also provides serial communication interface to connect other devices to the system.

**2.3 External Input/Control Devices:** Devices like a weighing balance can be connected to system in order to provide additional features like weight based dosing control for the pump. External foot pedal switch can also be used to control the pump.

**2.4 Stepper Motor Block:** Stepper motor is used to provide peristaltic pumping mechanism with desired precision. A driver a circuit is used to amplify the current signals generated by the microcontroller to drive the motor in the desired mode. Micro Stepping mechanism is used in order to provide smooth and precise control of stepper motor.

**2.5 Pump Head:** Pump head is connected to the shaft of the stepper motor. Based on the requirement pump head can be replaced with its available variants. It contains a number of rollers which enable the movement of the fluid inside the flexible tube by the process of [peristalsis](https://en.wikipedia.org/wiki/Peristalsis). Pump head with more number of rollers can be used to provide higher precision and smoother pumping of liquid.

**3. Advantages:**

1. **Seal-less design:** The main feature of the peristaltic pump is the tube/hose: because this is the only part of the pump to come in contact with the product it means the pump avoids corrosion and is leak-free.
2. **Dry running:** Many pump users face difficulties when the pump runs dry, peristaltic pumps are able to do this without any lubrication from outside.
3. **Self priming:** The pumps are capable of self-priming and can handle products that are likely to contain “air” or “gas”.
4. **Gentle pumping action:** In addition, because of the tube/hose and the pumps’ gentle action, the product being pumped is not damaged in the process thus making peristaltic pumps ideal for shear sensitive products.
5. **High suction lift:** The pumps also have high suction capabilities and can provide high discharge pressures meaning they are suitable for use where the product being pumped needs to be moved away from the area of the pump.
6. **Reversible:** Due to the action of the pump it can be used to empty lines or clear blockages by reversible rotation.
7. **Accurate dosing:** The pumps are accurate in dosing, with repeatability and metering capabilities.
8. **Enhanced Hose Life - Abrasion resistant:** Tube/Hose life is not related to a product’s abrasive qualities. The tube/hose only fails due to fatigue or chemical action.
9. **Low Life Cycle Costs:** When the tube/hose does need replacing the cost is minimal compared to other pumps’ maintenance costs, in addition the time needed to replace the tube/hose is much less then that needed to repair other pump types.

**4. Applications:**

|  |  |  |
| --- | --- | --- |
| Industrial | Medical | Research |
| * Waste water processing * Chemical Processing * Ceramics * Paint & Coating * Dairy Processing * Cosmetics * Beverage Industry | * Pharmaceutical * Medical Infusion Pumps * Dialysis Machine | * Auto Analyzers * Analytical Chemistry Experiments |

**5. Literature Survey:**

DeBakeyinvented the roller pump in heart-lung machine during his student years in 1932. This device, which rhythmically propels fluid through a flexible tube, would later become a crucial part of the heart-lung machine used during open heart surgery. Its ability to replicate the rhythmic pulsing of the human heart earned it the name “peristaltic pump.”[3]

Chris Garneau, Kevin McNamara, Jae Chungin May 2006, in their “Final Report Team D Peristaltic Pump ME 340.4” work have designed and developed a rotary peristaltic pump for contamination free drinking water supply. The challenge for this project was to design and manufacture a subscale pump prototype to be used in a water filtration system. The system must pump a minimum of one gallon of water per minute, and it must provide sufficient delivery pressure to push the water through the system. The system must be manufactured at minimal cost, and so the prototype made with specified, limited resources. They used batteries charged by a solar cell system. After external search, the team chose to pursue a positive displacement type pump. Foremost among the advantages of this type of pump is significantly easier design, resulting in a (theoretically) better approximation of final performance. Positive displacement pumps are also self priming (able to draw in water without external intervention), whereas dynamic pumps are not. They considered three types of positive displacement pumps as linear piston design, peristaltic design and centrifugal pump. The team considered the positive and negative aspects of each pump and selected peristaltic pump as it is self sealing and requires no valves to operate. Team carried out the comparison of analytical and experimental results.

Major problems faced in existing design by this team are as follows:

1. Friction: Most of the discrepancy between theoretical and predicted performance lies in the huge amount of friction in the worm gear mesh, which was grossly underestimated at the start. Excessive friction in the gears had a couple consequences. The first was that it made the pump a lot slower. The pump was not getting close to a competitive flow rate with the high friction in the gears. The improvement that made the most sense was to apply some form of lubricant to the gears to reduce the amount of friction.

2. Tube shifting problem: Unsteadiness, of the tube running through the peristaltic pump also proved to be a problem. The rotating arm in the peristaltic pump caused the tube to move and shift, and there was also nothing supporting the tube at the top of the pump when the arm was not at the peak point of its rotation. They provided wood support to solve this issue. [2]

Mohd Firdaus Bin Mansor**,** in November 2008, in his “Design and prototyping a peristaltic pump” work designed and developed a rotary peristaltic pump. The scope of his research was to design the pump for fabrication and determining the component that will be applied on the pump. Then engineering analysis and testing was done on the prototype to test its functionality. He used mild steel angle bar and aluminium and powered by an electric motor. Further improvement to the part of the pump like housing and motor are recommended for further stage of the study.

According to Mohd Firdaus pump designed should have one or more of following advantages:

1. There should be very accurate positioning of the occlusion bed with respect to the rotor assembly to properly occlude the tubing.

2. It should retain automatically a wide range of tubing.

3. It should be simple to operate.

4. It should provide consistent tube tensioning independent of the type of tube used and

5. It should be installed from a single side or single end of the pump. [1]

**4. Objective:**

To design and implement programmable peristaltic pump and enhance user interface for versatile applications

* Design and development of software in embedded C programming language in order to facilitate different modes of operation such as calibration, volume based, time based, repetitive dispensing, discrete dispensing and serial communication modes using Arduino IDE software tool. The developed software will be running on Arduino MEGA 2560 microcontroller. In addition the software also provides user interface through GLCD display and Keypad.
* Design and development of Micro-step Driver circuit to drive the stepper motor and provide smoother rotation and precise control. In addition to that interface between Arduino MEGA microcontroller and input/output devices like Graphic LCD and Keypad is designed. Further, RS485 serial communication port is designed to support interface between the system and external control devices.

**7. Outcome:**

This project aims at providing user friendly interface through Graphic LCD display and matrix keypad to the peristaltic pumps. The system provides multiple programmable modes of operation of peristaltic pump which makes it suitable for versatile applications. The system is also designed to support interfaces to external devices.

**8. References:**

[1] Mohd Firdaus Bin Mansor, “Design and prototyping a peristaltic pump,” 14 November, 2008, submitted to University of Malaysia.

[2] Chris Garneau, Kevin McNamara, Jae Chung, “Final Report Team D Peristaltic Pump ME 340.4”, 3 May, 2006.

[3] Methodist DeBakey Heart & Vascular Center - Dr. Michael E. DeBakey, accessed on 27 June, 2010. [4] Michael smith engineers ltd, “How a Peristaltic Pump works” .