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AUTOMATED FLUID CONTROL DEVICE USING SMART PHONES AND ARDUINO

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Abstract:-

The design and implementation of an automated liquid observation was analyzed in this paper. The PIC Micro controller platform has been used as controlling unit for providing necessary control along with a 3×4 matrix keypad. Bluetooth module is used to control the drop per minute manually and by using an android phone. The designed flow sensor will be hooked up to the drip chamber of the saline container to determine the saline flow rate as well as an accurate number of a drop of the saline. The obtained outputs from the sensor are continuously checked with the given command and if any mismatch is found.The micro controller moves the motor control to modify the circulation rate to balance with assigned command. This setup allows healthcare providers to remotely monitor and control the saline flow rate, ensuring accurate and consistent delivery of fluids to patients

Key Words:- FLOW SENSOR,REMOTE MONITORING,PIC MICRO CONTROLLER,SALINE CONTROL ,DRIP RATE CONTROL

1. INTRODUCTION:-

1.1. Objective:-

An automated affordable price saline tracking and control method is important to control the saline flow rate for different patients. The circulation flow rate depending on the physical condition of the patient such as heart rate as well as the pulse rate, body mass, blood pressure, heart range of the patient's body. The technologies are transforming further than one's visualization. It exactly gives the information about the rate flow and how many drops required per minute. This reduces the constant tracking of the physician. Regular saline is usually called as a sterile solution of sodium chloride (NaCl) in standard water. The sodium chloride sterile solution is utilized to get nasal irritability, rinsing out contact lenses, into the vein infusion and to cleanse a fresh piercing. Regular Saline is frequently used in intravenous drips or the patients who are not able to have liquids by mouth as well as tend to be in threat of leading to dehydration or hypovolemia. Regular saline consists of 9 grams of NaCl, and the osmotic agent of NaCl is usually 0.93. The quantity of Regular Saline consumption by the patient completely relies upon the physical state of the patient but usually, it is among 1.5 to 3 liters per day for a mature person1.

2. Description:-

Automated fluid control systems have gained significant attention in various fields, including industrial automation, medical applications, agriculture, and domestic usage. These systems are designed to regulate fluid flow efficiently, ensuring optimal operation without the need for continuous human supervision. With advancements in microcontrollers, sensors, and actuators, automated fluid control has become more precise, reliable, and cost-effective. This literature survey explores existing research, technologies, and methodologies used in automated fluid control systems.

1.3. Focus Of The Project:-

The focus of this project is to develop the efficiency of automated fluid control in medical applications. It develops the efficiency in the medical field and helps the medical administration to develop the modified features.

2. COMPONENTS:-

2.1. SERVO MOTOR:-

A servo motor is a rotary or linear actuator that precisely controls angular or linear position, velocity, and acceleration. It consists of a motor coupled with a sensor for position feedback and a control circuit to drive the motor. The servo receives a control signal, which determines its position. It compares this signal with its internal reference and adjusts accordingly using a closed-loop control system. Used in robotics, automation, and fluid control systems to precisely adjust valve positions. High precision, reliable operation, and low power consumption.

2.2. VALVE :-

A valve is a mechanical device used to regulate, direct, or control the flow of fluids—such as liquids, gases, vapors, or slurries—by opening, closing, or partially obstructing passageways within a system. Valves are essential components in pipelines and fluid systems across various industries, including oil and gas, water treatment, chemical processing, power generation, and manufacturing.

They serve crucial functions such as isolating equipment, controlling process variables, preventing backflow, and ensuring safety by releasing excess pressure. Depending on the application, valves can be manually operated or automated using electric, pneumatic, or hydraulic actuators. There are several types of valves— such as gate, globe, ball, butterfly, and check valves—each designed with specific flow control characteristics.

The selection of valve type, material, and actuation method depends on factors like fluid properties, pressure, temperature, and the desired level of control. Valves are integral to maintaining efficient, safe, and reliable operation in both simple and complex fluid systems.

2.3. FLOW SENSOR :-

A flow sensor is a vital instrument used to detect, monitor, and measure the flow rate or quantity of a fluid either liquid or gas moving through a system. It serves as a critical component in numerous industrial, commercial, and domestic applications, ensuring that processes operate efficiently, safely, and accurately. Flow sensors are integral to systems such as water distribution, chemical processing, HVAC (heating, ventilation, and air conditioning), oil and gas pipelines, medical equipment, food and beverage manufacturing, and automotive engines. These sensors function by detecting changes in flow characteristics and converting the data into electrical signals that can be processed by controllers or displayed for human interpretation. The measurement provided by a flow sensor can be expressed in terms of volume (liters per minute, cubic meters per hour, etc.) or mass (kilograms per hour, pounds per minute), depending on the sensor type and application. There are various types of flow sensors, each based on different operating principles to suit specific requirements. Common types include differential pressure flow sensors, turbine flow sensors, electromagnetic flow sensors, ultrasonic flow sensors, thermal mass flow sensors, and vortex flow sensors. Differential pressure flow sensors, one of the oldest types, calculate flow by measuring the pressure drop across a restriction in the flow path. Turbine sensors use a spinning rotor; the rotational speed correlates with the flow rate. Electromagnetic flow sensors, suitable for conductive liquids, measure flow based on Faraday's Law of electromagnetic induction. Ultrasonic flow sensors use the transit-time or Doppler effect to measure the velocity of a fluid using sound waves, making them ideal for clean or dirty liquids. Thermal mass flow sensors measure the heat loss from a heated element in the fluid stream and are particularly useful for gas flow measurement. Vortex flow sensors detect vortices created by an obstruction placed in the flow stream, with the frequency of vortices being proportional to the flow rate. Each type of sensor has advantages and limitations based on factors such as fluid viscosity, pressure, temperature, and required measurement precision. Flow sensors are available in a range of materials like stainless steel, plastic, or brass to withstand corrosive fluids and harsh environments. Many modern flow sensors are equipped with digital interfaces and advanced features like data logging, self-diagnostics, remote monitoring, and communication protocols such as Mod bus, HART, or wireless connectivity for integration into smart control systems and Industrial Internet of Things (IIoT) platforms. In addition to measuring flow, some sensors also provide information on temperature and pressure, offering multifunctional monitoring capabilities. The selection of a flow sensor must consider key parameters such as flow range, accuracy, repeat ability, fluid compatibility, and installation conditions. Proper sensor placement and maintenance are crucial to achieving reliable performance and long-term durability. As industries continue to move toward automation and precision control, flow sensors play an increasingly important role in enhancing process efficiency, reducing energy consumption, and ensuring product quality and operational safety. Their importance in modern systems cannot be overstated, as they are fundamental to achieving accurate flow measurement and control across a wide spectrum of applications.

2.4. MICROCONTROLLER:-

A micro controller is a compact integrated circuit designed to perform specific tasks within an embedded system, combining a processor, memory, and input/output (I/O) peripherals on a single chip. It serves as the brain of many electronic devices, enabling them to process inputs, make decisions, and control outputs based on programmed instructions.

Micro controllers are widely used in consumer electronics, automotive systems, industrial automation, medical devices, home appliances, robotics, and Internet of Things (IoT) applications. They typically consist of a central processing unit (CPU), flash memory for storing programs, RAM for temporary data storage, and various I/O ports for interfacing with sensors, actuators, and other hardware.

Depending on the application, a micro controller may also include timers, analog-to-digital converters (ADCs), digital-to-analog converters (DACs), pulse- width modulation (PWM) outputs, communication interfaces like UART, SPI, or I2C, and power management features. Micro controllers are designed to be energy-efficient and cost-effective, making them ideal for embedded control systems. Popular families include the PIC series by Microchip, AVR by Atmel (now part of Microchip), and ARM Cortex- M series used by many manufacturers. Programmable using languages like C or assembly, micro controllers allow precise control of devices and are essential for developing smart, automated, and responsive electronic systems.

2.5. KEYPAD:-

A keypad is an input device consisting of a set of buttons or keys arranged in a grid pattern, typically used to enter data or commands into an electronic system. Keypads are commonly found in a variety of applications such as calculators, telephones, security systems, ATM's, and micro controller-based projects. They are designed to be simple and user-friendly, allowing users to input numeric, alphabetic, or functional data depending on the application.

Keypads come in various configurations, the most common being the 4x3 and 4x4 matrix layouts, which contain 12 and 16 keys respectively. Each key is connected through a matrix of rows and columns, and when a key is pressed, it completes a circuit between a specific row and column. This interaction is then detected and interpreted by a micro controller or processor to identify which key was pressed. Keypads can be made from different materials such as plastic, rubber, or membrane layers and may be either mechanical or capacitive. .

In embedded systems, keypads are often interfaced using digital input pins and scanned using software algorithms to detect key presses accurately. Durable, low-cost, and easy to implement, keypads are essential components in systems requiring manual data entry or control functionality.

2.6. BLUETOOTH MODULE:-

A Bluetooth module is a compact wireless communication device that enables electronic systems to exchange data over short distances using Bluetooth technology. It is commonly used in embedded systems, microcontroller projects, smartphones, computers, and a wide range of consumer electronics to provide wireless connectivity without the need for physical cables. Bluetooth modules operate within the 2.4 GHz ISM band and follow the Bluetooth communication protocol, allowing seamless pairing and data exchange between compatible devices.

One of the most widely used modules in electronics projects is the HC-05, which supports both master and slave modes, making it versatile for many applications. These modules typically communicate with microcontrollers via serial communication protocols such as UART (Universal Asynchronous Receiver Transmitter), enabling easy integration with devices like Arduino, Raspberry Pi, or other development boards.

Bluetooth modules are ideal for creating wireless connections in applications such as wireless data logging, remote control, home automation, wearable devices, and health monitoring systems. They support features like automatic pairing, secure communication, and low power consumption, making them efficient for battery-operated systems. Modern Bluetooth modules may support Bluetooth Low Energy (BLE) for reduced energy usage and enhanced functionality in IoT devices. Overall, Bluetooth modules are essential for enabling flexible, wireless communication in modern electronics.

2.7. AURDINO:-

Arduino is an open-source electronics platform that consists of both hardware and software components, enabling users to create interactive projects and embedded systems. At its core, Arduino is a micro controller-based development board that can read inputs from various sensors or devices (like temperature sensors, switches, or light sensors) and control outputs such as LED's, motors, or displays. The platform is highly popular among hobbyists, engineers, and educators due to its simplicity, accessibility, and flexibility.

Arduino boards, like the Arduino Uno, come with an ATmega328 micro controller that processes data and controls I/O (input/output) pins. The boards can communicate with other devices via various communication protocols such as Serial (UART), I2C, or SPI. One of the main features of Arduino is its ability to be programmed using the Arduino ID

(Integrated Development Environment), where users write code in a language similar to C++.

The platform supports a wide variety of sensors, actuators, and communication modules, making it suitable for applications like robotics, home automation, IoT (Internet of Things), and more. Arduino simplifies the development of prototypes and embedded systems by providing a user-friendly interface, extensive community support, and vast libraries of pre-written code to interface with various components.Due to its open-source nature, Arduino is highly customizable and can be adapted to a broad range of projects, making it one of the most widely used platforms in DIY electronics and education.

2.8. NOISE REMOVING CIRCUIT:-

Noise in electronics refers to any unwanted electrical signals or disturbances that can interfere with the intended operation of a system. Noise can originate from various sources such as power supply fluctuations, electromagnetic interference (EMI) from nearby electronic devices, or even thermal noise generated by resistors and other components. Noise can manifest as random fluctuations or spikes in voltage and can corrupt signals, especially in analog circuits or digital communication, leading to inaccurate data or erratic behavior in systems. For example, noise in a sensor reading may result in erroneous measurements or false triggers in a control system. Managing and eliminating noise is a critical aspect of ensuring the reliability and performance of electronic circuits.

Noise Removal Techniques are employed to reduce or eliminate unwanted noise from a signal, improving system performance and accuracy. One of the most common approaches to noise removal is the use of filters. Filters, such as low-pass, high-pass, or band- pass filters, use passive components like resistors, capacitors, and inductors to block or pass specific frequencies, effectively eliminating unwanted high- frequency noise. Another popular method is using Ferrite beads or inductive coils, which suppress high- frequency EMI in power lines or signal lines. Capacitors can also be placed across power inputs to smooth voltage fluctuations. In digital systems, software filtering methods, such as signal averaging or digital smoothing algorithms, can be implemented to remove noise from sensor data. Combining these hardware and software techniques ensures that the system's performance remains stable, accurate, and reliable despite external disturbances or interference.

3. METHODOLOGY:-

The automated fluid control system using smart phones integrates modern technology to provide an efficient, real-time monitoring and control solution for fluid management. The methodology involves the use of sensors, micro-controllers, actuators, wireless communication modules, cloud storage, and smart phone applications to automate the process of fluid regulation. This system enhances precision, reduces human intervention, and ensures optimal fluid utilization in various applications such as home water management, industrial fluid control, and agricultural irrigation.

The first step in implementing the automated fluid control system is to design the system architecture and select appropriate hardware and software components. The system consists of fluid level, flow rate, and pressure sensors that monitor fluid characteristics and send real-time data to a micro controller such as an ESP8266, Arduino, or Raspberry Pi. The micro controller processes the data and sends control signals to actuators like solenoid valves and pumps, which regulate fluid flow. To enable remote communication, a wireless communication module such as Wi-Fi, GSM, Bluetooth, or LoRa is integrated into the system. The smart phone application, which acts as the user interface,
allows users to monitor fluid levels, receive alerts, and manually control fluid flow. Additionally, an IoT cloud platform (such as Firebase, Blynk, or MQTT) is used for data storage, analysis, and remote accessibility. Sensor Data Acquisition
and Processing The sensors installed in the fluid system continuously measure critical parameters

such as fluid level, flow rate, and pressure. These sensors send the collected data to the micro controller for real-time processing.
Calibration of the sensors is performed to ensure accurate and reliable measurements. The micro controller processes this data using predefined control logic to automate fluid regulation. For instance, if the fluid level falls below the threshold, the micro controller automatically sends a signal to the pump to start operation, ensuring a continuous fluid supply.
Conversely, if the level exceeds the predefined limit, the micro controller shuts off the pump to prevent overflow. In case of unexpected fluctuations in flow rate or pressure, the system triggers an alert notification to the user

4.WORKING PROCESS:-

4.1 Sensors for Fluid Monitoring

The system uses various sensors to monitor fluid conditions in real-time and send data to the micro controller: Ultrasonic/Float Level Sensor: Measures the fluid level in a tank and detects high or low levels to prevent overflow or dry conditions. Flow Sensor: Monitors the rate of fluid flow through the pipes, ensuring correct distribution. Pressure Sensor: Measures fluid pressure in pipelines to prevent leakages or pipe bursts. Temperature Sensor Used in specialized applications like chemical industries to maintain optimal fluid temperature. These sensors continuously transmit data to the micro controller for processing and decision-making. 4.2 Microcontroller (Control Unit)

The micro controller unit (MCU) acts as the brain of the system, receiving sensor data, processing it, and triggering appropriate actions. Popular micro controllers include: ESP8266 / ESP32 (Wi-Fi enabled for IoT-based communication) Arduino Uno / Mega (suitable for simple automation tasks) Raspberry Pi (used for advanced real-time processing) The micro controller executes a predefined algorithm that analyzes sensor data and activates actuators like pumps and valves based on real-time conditions.

4.3 Actuators for Fluid Control

Actuators are responsible for controlling fluid movement based on micro controller commands. The most commonly used actuators are: Solenoid Valves: These electronically controlled valves open or close to regulate fluid flow. Motorized Valves: These provide more precise control over fluid regulation, useful in industrial applications. Water Pump / Motor: Turns ON or OFF to fill or drain fluid when necessary. The microcontroller sends a signal to these actuators when certain threshold values (e.g., low water level) are reached, allowing automatic operation.

4.4 Wireless Communication Modules

The system integrates wireless communication to enable remote control via a smart phone. The following modules facilitate connectivity: Wi-Fi Module (ESP8266/ESP32): Allows internet- based control and cloud connectivity.
GSM/GPRS Module (SIM800L/SIM900A):
Enables communication via SMS or mobile networks, ideal for remote locations. Bluetooth Module (HC-05/HC-06): Used for short-range communication with smart phones. LoRa Module: Provides long-range wireless communication in industrial and agricultural applications. The communication module transmits sensor data to the cloud and receives commands from the smart phone app for manual or automated fluid control. 1.5 Power Supply Unit The hardware components require a reliable power source for uninterrupted operation. The power system consists of: AC-DC Adapter (12V/5V) for micro controller and sensors Battery Backup
(12V or Li-ion) for uninterrupted operation Solar Panel (optional) for remote applications with no power supply The power supply ensures the system functions efficiently even in case of power failures.

4)A WORKFLOW:-

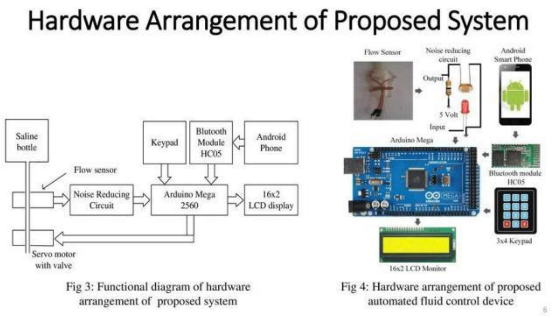

Figure-1

5) CONNECTIONS:-

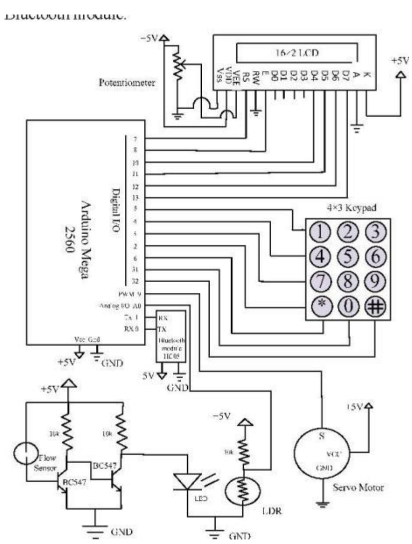

Figure-2

6) FUTURE SCOPE:-

The future scope of automated fluid control is vast and promising, driven by advancements in technology and the increasing demand for efficiency, precision, and sustainability in various industries. As industries move toward more sophisticated automation, fluid control systems are expected to become increasingly integrated with digital technologies, such as the Internet of Things (IoT), artificial intelligence (AI), and machine learning. This integration will enable real-time monitoring, predictive maintenance, and adaptive control, improving system reliability and reducing operational costs.

In the industrial sector, automated fluid control systems are anticipated to play a key role in process optimization, especially in chemical manufacturing, water treatment, oil and gas, and pharmaceutical industries. Smart sensors and IoT-enabled devices will provide continuous data on flow rates, pressure, temperature, and fluid quality, allowing for dynamic adjustments to the system based on real-time conditions. AI-driven algorithms could optimize fluid flow for maximum efficiency, reduce energy consumption, and minimize waste, while also enabling early detection of anomalies or potential failures.

In home automation and smart cities, the demand for automated fluid control systems will continue to grow, particularly for smart water management. Automated systems will regulate the distribution of water, manage waste treatment processes, and monitor usage to reduce waste and improve sustainability. In HVAC systems, automated fluid control will enhance temperature regulation and energy efficiency in buildings.

The future of automated fluid control will also be shaped by advancements in robotics and remote operation capabilities. For example, fluid control systems may be used in autonomous vehicles or drones for applications such as fuel management, cooling systems, and liquid handling in harsh or remote environments. Furthermore, as industries increasingly focus on sustainability and reducing their carbon footprints, automated fluid control systems will contribute to energy efficiency, resource conservation, and environmental protection.

Overall, the future of automated fluid control systems lies in their ability to provide real-time intelligence, adaptive responses, and greater integration into complex systems, improving both operational performance and sustainability across a wide range of sectors.

7. CONCLUSION:-

Due to a combination of the two important disciplines of medicine and engineering, the medical facility and treatment have achieved a rapid advancement and development. The progress in medical care has been rapid In order to design a fluid control device, the main difficult was to design a device which responses correctly as well as rapidly and design of sensor to detect the fluid drop. However in this project flow sensor which consists of two metal wires were placed much closer to each other. This sensor was very sensitive and was able to detect any types of fluid with different colors and responded very quickly as compared to the sensor available in the market. The device can be used in the medical application as well as in chemical lab where the very accurate flow of fluid is required. The device is reliable and therefore, can be used effectively. Once the command is given to the device it keeps the flow rate constant regardless of the level of water from the patient. This low- cost medical device may have potential use for patient health care, especially in developing countries like Bangladesh. The automated fluid control system using smart phones represents a significant advancement in fluid management across various sectors, including hospitals, agriculture, industries, and smart homes. By integrating micro controllers (such as Arduino), flow sensors, servo motors, and wireless communication modules (Bluetooth/Wi-Fi), users can remotely monitor and regulate fluid flow with precision.

TABLE II. COMMANDED FLOW RATE (DROP/MIN) AND SETTLING TIME(S)

No.	Commanded flow rate (drop/min) and Settling time(s)	
	Command in Drop/Minute	Settling time in Second (T_s)
01.	0	0
02.	120	0.5
03.	180	1
04.	220	1.3
05.	280	1.6
06.	330	1.8
07.	390	2
08.	450	2.3
09.	600	2.5
10.	720	2.7

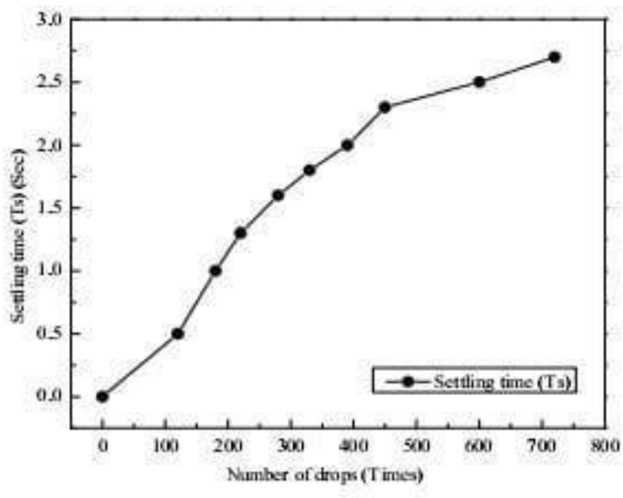

Fig. 12. Relation between commanded flow rate and Settling time

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