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Review

3D Printed with Poly Lactic Acid Syringe Pump Enabled With IOT

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Abstract

In recent years, the need for a small, added tax system from the distance, especially the application for the gallery and apply treatment. The subject showing the diagram and development of 3D added 3Ds that are activated by using the Polymolicatical acid (PL) and the real estate. The main purpose of this project is to create a price-, easily and correctly with wirelessness in Wireless online. The pump engine uses 3D chassis and the driver system designed with plastic plastic, plastic in a biological environment, the environment. The island of the window box 360 provides an honoral rotation, changing the gorgeous tab, or roll the Garden Gearbox, and a line of line in the piston of the syringon. The purpose of ESP8266 is working as a system of the system and a period-time communication like Blynk, and MQTtpars traders for monitoring and control. This punch pump is activated by IOT is a great benefit to the character that the microboram is required, and the water costs are required and renew the water prices. The extent of the application is to send automatic drugs, drugs (iv), chemical components of research disease. This tool was designed to change, support the translation of the dose of dose. This can be different changes with the value of servo car lease to use your request. By entering 3D 3D opens and Open Opeake Shipment, it shows this topic from the road given and laboratory. This diagrams promotes changes and speeds, preferably with the benefit of education and creativity in the environment. In all, this system is a drama model of the designing technology and technology to develop biological equipment, work and cost.

Keywords: 3D printing, Additive manufacturing, Bioprinter, Photopolymer, UV resin.

1 INTRODUCTION

Automated drug delivery systems remain a major challenge in many healthcare systems, particularly in rural and resource-limiting environments. Manual administration of liquids by injection is common, but is susceptible to shortages of trained personnel for artificial errors, fatigue, and inconsistencies. Furthermore, traditional syringe pumps available on the market are often expensive, bulky and uncustomized. This means it is not suitable for budgetary applications such as educational labs, biomedical DIY innovations, and small clinics. In recent years, the integration of automation and Internet of Things (IoT) technologies has revolutionized many areas, but implementation in healthcare delivery systems remains limited by cost, complexity and power consumption. Hospitals and emergency units often require accurate, remotely controlled liquid taxes, especially for patients who require continuous infusion at regulated doses. During long-term care in a pandemic, war zone, or home-based care, nursing staff should rely on a less optimal method due to limited devices.

There is a growing demand for cheap, customizable telemedicine devices, especially after handling drug injections and precision fluids. However, most solutions affect accuracy or are associated with affordable costs. If the existing system is not open, the problem is further enhanced. This means that it cannot be adapted to research, teaching, or experimental purposes. The purpose of this project is to address these challenges by examining cost-effective IoT-enabled syringe pumps using slightly available components such as a 360-degree servo motor, a 5 mL medical syringe, an ESP8266 microcontroller, and a 3D printing frame of biodeo-degradable PLA (polylac acid) to address these challenges by investigating cost-effective IoT-enabled syringe pumps. The proposed system allows for accurate control of the movement of the syringe remotely and provides a practical alternative to traditional, expensive pumps.

By using open source electronics and add-on production, the project seeks to democratize access to critical equipment for healthcare. This represents a step towards ensuring personalized medical devices are compatible with emerging health needs around the world.

The main goal of this project is to design and implement an affordable remote injection pump system with 3D printing and IoT technology. This includes mechanical structure, electronic integration and remote control logic, all paired with a compact, functional prototype. Specific goals include:

1. Develop a 3D printing chassis using polymyl acid (PLA). This supports the syringe movement mechanism, provides structural integrity, while maintaining a cheap and environmentally friendly approach.
2. Integrates a 360-degree metal servo engine to drive a 5 mL syringe piston with accuracy and repeatability. The servo enables both the push and pull processes based on the rotation control signal.
3. Wireless Control is implemented across a wide range of Wi-Fi modules to facilitate real-time operation and monitor syringe pumps using mobile apps or cloud-based platforms.
4. Calibrate the angle shift of the motor with the linear movement of the syringe, and ensure accurate volume output by correlating the motor signal with the fluid output.
5. Activates a user-defined dosage profile. Users can specify the volume, time, and remote for personalized medicine, IV drip automation, or research-oriented liquid mixtures.
6. Share all design files (3D models, code, documentation) to create an open source platform for replication, modification and improvement of the community.
7. Performance allows for the possibility of battery integration for field or portable use in distant areas to concentrate on low operation.
8. Validate system accuracy through reproducibility testing, flow measurements, and real-time monitoring feedback via IoT interfaces.

By achieving these goals, the project aims to bridge the gap between advanced pumping technology and accessibility of syringes in low-performance environments. It serves as a medical utility and as a learning tool for biomedical engineering and embedded system design.Meaning of IoT-compatible syringe pumps. The integration of IoT technology (Internet of Things) in syringe pumps can revolutionize the way in which liquid medicines in various sectors, particularly in healthcare, are managed. Traditional syringe pumps are either strongly based on manual operation or require an expensive, proprietary system for automation. They make these limitations unrealistic due to heavy use and home care in low-resource environments. By embedding IoT skills in inexpensive 3D printed syringe pumps, the project deals with not only cost barriers, but also features, safety and scalability.

Remote Access Control

IoT-enabled syringe pumps can be checked remotely using mobile devices or via web interfaces. In an intensive care scenario, this is very important that the nurse or doctor cannot be physically present for a long time. Real-time control allows nursing staff to quickly adapt doses based on patient status, improve response

times and reduce manual errors.

Data Protocols and Analysis

Microcontrollers such as the ESP8266 allow continuous data collection, including flow rates, operational protocols, and error diagnosis. This data can be used for analysis, compliance, and even prediction to increase reliability in a clinical or laboratory environment.

Personalized medical care

IoT allows patients to receive medication tailored to their daily needs. This saves the profile in the cloud. This is particularly useful for chronic disease management, with dosages that can change over time. Scalability and Networking. Several pumps can be connected to a central server. This will provide a liquid tax in which the hospital's tax or research environment is synchronized. The networking capabilities of the ESP8266 allow for seamless integration into a larger IoT ecosystem.

Toxicity and Indication

3D printing of pump frames and the use of open source hardware significantly reduces production costs without affecting core functions. This makes it suitable for educational institutions, DIY enthusiasts and small medical startups to test prototype and test medical automation solutions.

A sustainable environment

Using PLA (biodegradable thermoplastic plasticity from renewable energy resources such as Corn Sathch) for 3D printing adds a sustainability element to your project. Minimizes the ecological footprint of disposable medical products. The importance of this project lies in interdisciplinary applications dealing with health requirements through mechanical engineering, embedded systems, IoT, and sustainable production. The result was a multipurpose, effective and reproducible solution that could contribute to more intelligent health automation in both the developed and developed regions.

LITERATURE REVIEW

The Syringe is a proper device used to provide the liquid and equal liquid volume, especially in health, chemical and biological applications. The first purple will be held, trusting in human activity, to show the inconvenience. The technology grows, this pump will be conducted by electric electricity, can be infusion of drugs or reagents that can be planned, managed and planned. Rimu pumps use a walk car, the rinetator actor and the main machine for running the Syringer. The shooter or movement is based on the revolution of the leading punishment, and the right authority should be provided on the supplied water. Most commercial pumps contain in user interfaces, operating systems, and feedback feedback to make sure the right is correct. The Syringa purple can be divided into two key types: the rough pumps and pressure pumps. The broken pump drained the water out of syringe, while pulling water into the syringe. The Sources of the System offers multiple jobs, which can be operated in both mode. This system is widely used to control plant drugs, insulin organizations and manage gallery sentences. The microfluid application has encouraged the development of lowercase and low flow pumps. The design of this diagram combines piezoelectric actors or electric actors to provide a micrilline or high nanolter volume. However, the pump is a great price because the main priest and units. In recent years, the direction of open machines has moved. Subjects such as the mass of the open pump (OSP) and those available on the Github and the property to this technology. This system uses a walking car, 3d 3D planets and open micocontroller in Arduino, esp8266 to operate. In addition to some additional and patience, this DIY design is increasing in education and low requirements. The use of Servo cars, especially that 360-° turns are retained and sent a different way of travel cars. Even if it is not quickly without the feedback of the response, this car is easier, it is best to take a variety of machinery or period of a-time-based system. Mostly, the syringe purple means a change from the book to a wise device, microntrortler. New activities in 3d and add the form of a small -cost plate that is necessary for drugs, Telealth, and machine.

Biomedical Prototype

Poly Lactic Acid (PLA) is a thermoplastic that can be mixed with new materials as a wheat flour or sugar. This is one of the most commonly used in 3D prints that are suitable for use, low heat, and low temperature temperature. Pl has been very popular in biological prototype by life, uncomfortable and environmental environment. In the context of the development of biological materials, the plate is used to form small signs, patterns and orthotic equipment, and houses for electricities. By the strength of its ability to produce in the complex geometry, PL can arrange and organize quickly in the medicinal design feature. The FDA approves for some medications requests, including the scratches and attachments designed for connecting to networks. However, it is important to know that plate is used in the 3D printing addition that you can meet the clinical requirements. Therefore, as it is effective in the prototype, the conceptu clamle means that it is not good for the biological equipment for a large, or higher and not processing. In the design of syringe syringe, PL is

good for the structural sections such as oils, and carniers, and cars. This provides a large machine force for income applications (such as 5 ml, 10 ml or 10 ml) and prevents the number of water medicine. However, PL moves to be very humid, temperature above 60ão C, and consider the time used and storage. The Machine Machine's Games, including the power of force (~ 50 mpa) and use a GPA), to be successfully used for life's notifications. It is also good for the right, it is very important than interaction with right equipment such as the Syringes and actors. Researchers issued changes to PL, like combination with antibacterial customers, or tortoise the biological conditions for clinical applications. In addition, the use of PL in an educational medicine has helped students with the hardest researchers or the hardest to get. To briefly, platces choose the items that can be entered, pay-on, and continue to create a prototype of biological equipment such as syringe. He compatible with 3D FDM Publishers at 3D FDM and the ability to support complex employment design that will be a base in new medicinal purposes.

IOT IN MEDICAL AUTOMATION

Introducing the Internet of Things (IOT) in the cancellation devices by submitting a removal of the distance, the real-data collection, and managing intelligent equipment. Medicine equipment supports the iot with the transaction patterns that enable smooth data between patients, trustees, and cloud services. This technology is very useful in required situations, intervention, and seasonal, or infusion, and monitoring pumps that can be used. In case of Syring Syring, Iot can arrange to establish water delivery, monitoring the dose, running system control, and system control. With microcontrols such as ESP8266, Supporting Wi-Fi connects, the Syringal Data will be allowed by the cloudy data as the results or blynk. This dad can do the doctors or users to monitor the rate of water factor, or the warnings for the cooling or adjustment to the remote. The Potama Potamo post is great in the treatment of home treatment, especially for patients who want to drug-lengths or stained food. The device reduces depends on the hospital visits and comfort the special and comfort for patients. In addition, the monitoring system can follow multiple tasks of pumps in places, and requires time intervention. ESP8266 The microcontroller is the best choice for Iot medications by the size of the size, low cost, and mixed with Arduino ideas. Supporting protocols such as HTTP, MQTT, and Webskects can be connected to mobile applications and dashboards. The right firmware program, esp8266 can be operating the Servo car, read the Servos data and update the cloud database and minimum database. Data and private security is a great idea of medical devices that support Iot. Because this system offers Patient information, encryption method (eg HTTPS, SSL / TLS) with Social Authentication engine. In addition, the security parts of the device such as the flow area of the grade, long time, and reset the system to ensure that the patient will be saved. Another benefit of the nerves in medicinal medicine is protection. By checking the car's work, the operating temperature, and use the system to wear or reduce the blocking time and to ensure that the permanent work is fixed. It has been investigated by the research of using the Iot (AIT) for the decision in the metal pump. This system can see normal running patterns or use of behavior or authentication to fix the settings and increase the specific and safety topic. As a result, the IOT introducing the Iot is very widely expanded and uses the syringe equipment and change the medical devices to use the delivery of health.

LOW-COST SYRINGE DELIVERY SYSTEMS

The minimum-low-based system has occurred in the law of resistance and DIY society by paying and opportunities. This system is often made by using basic mechanical components, opening source sources sources, and 3D characters. While there are many benefits that they are supposed to be organized, easy, and educational value, and the number of important fields associated with work, the truth. One of the largest bonds of the system is valid. The purple above -class is using a walking car and smooth resolution with a closed response engine to ensure proper volume. However, a low -cost system uses 360 ° uses without the actual response, it is difficult to make sure the syringer syringe is transferred correctly. This error may cause problems for significant applications such as the infusion of the drug as it is effective in the doses. Another block is repeated and consistent. Because the backback response in the toothpaste, the attachment between the dressing, or carbohydration, this pump is not usually at all over the cycle. It is not as adding his use of highly valuable laboratory test or medical treatment. The energy of the material and resistance of the environment will cause challenges. The XD section has been recorded the area can be canceled below the spread of humidity, heat or chemical. In a medical environment by sweat or chemical rebate that most of the time, PL may not provide chemical motivation or patient. This limits the grade and impurities of the device. In terms of safety conditions, low-cost-low-cost pumps usually do not have a weak sense. It may not be a response to seeing the introduction, communicating or completing the dose. If it is important or unhappiness of strength, this device may be inferior, the drug can be less important. The lack of law is the legislation is another maintenance. Commercial medicine devices showing tests and meets standards such as an ISO 13485, FDA or CER laws. DIY Syring Pump, Even a job, not allowed for clinical use and not trying their requests in a professional health environment. The problem of power and connect is also affected by this system. The tools associated with USB with low-fat or low-limited electricity will be affected by the decline of the servo frame. Likewise, connecting is not dependent on parts

with wi-fi weakness, adding control or browser. In addition to these obligations, low-fat pumps have an important part of education, making prototypes, and basic research. They are a good device for the concepts of the concepts, the cost of the workout-free laboratory and managing non-free water. To overcome current constraints, future work can include minorized responses, using the Cloudy-Credit System and the warning system. With the highest amount of inflation, low -cost concrete can move near the standards of a pumping.

SYSTEM DESIGN AND ARCHITECTURE

The design of the 3D-CEK-CEK-CEK PUPTED TO THE MANGRANCE, electronics, and wireless communication. The goal is the shortest, accurate and examination units of comparative units of payment -e. The architecture is planned, can be contemporary, organized for medicinal purposes, research, and education.

I. MECHANICAL DESIGN (3D-PRINTED FRAME USING PLA)

The mechanical structure of the syringe pump is entirely fabricated using a 3D printer with Polylactic Acid (PLA) filament, chosen for its biodegradability, ease of printing, and rigidity. The frame supports the 5 mL syringe, holds the 360° metal servo motor, and allows for smooth axial translation of the plunger mechanism.

Key Design Components:

- Base Platform: This is a flat, sturdy surface to anchor all mechanical elements. Designed with screw slots for optional mounting.
- Syringe Holder: A cylindrical groove matches the syringe barrel diameter, holding it in place during operation. It includes a locking mechanism to prevent movement during push/pull.
- Plunger Push Arm: A linear rail system or slider guides the motion of the servo arm, ensuring stable force application on the plunger.
- Motor Mount: A specialized circular cutout and vertical bracket hold the servo motor tightly in place. It includes ventilation slots to dissipate heat during prolonged use.
- Lead Screw/Gear Attachment: Depending on the torque required, either a direct push arm or a lead screw drive mechanism is used, both printed with high infill (≥80%) for structural strength.

Design Optimization Strategies:

- Tolerance Settings: Considered ±0.3 mm tolerance for interlocking parts to accommodate PLA shrinkage.
- Wall Thickness: Increased to 2–3 mm in load-bearing sections.
- Support Material Use: Strategically placed to reduce overhang stress while printing.
- Quick-Release Assembly: Uses modular screwless fittings for quick maintenance or syringe replacement.

CAD Software Used:

- Tinkercad for initial prototyping.
- Fusion 360 for precision and mechanical stress simulation.

II. ELECTRONIC COMPONENTS OVERVIEW

The electronics system is designed around simplicity and cost-effectiveness, using a few key components to enable automation, wireless control, and precision actuation.

Main Electronic Components:

1. **ESP8266 Wi-Fi Module:**
   - Functions as the central controller and communication hub.
   - Offers 2.4 GHz Wi-Fi, digital GPIO pins, and easy Arduino IDE integration.
   - Powered with 3.3V and communicates over serial/UART protocol.
2. **360° Metal Servo Motor (MG995 or equivalent):**
   - Enables continuous rotational movement.
   - Torque: Approx. 10 kg.cm (suitable for fluid dispensing).
   - Controlled using PWM signals with 50 Hz frequency.
   - Modified to translate rotary motion into linear push-pull action via linkage.
3. **Power Supply:**
   - 5V–6V DC supply used (via battery or USB adapter).
   - Capacitors used to prevent voltage drops during motor actuation.
   - A voltage regulator (AMS1117) ensures clean 3.3V output for ESP8266.
4. **Driver Circuit:**
   - Optional use of a motor driver or NPN transistor (e.g., 2N2222) for isolation.
   - Includes protection diodes to prevent back EMF damage.
5. **Other Passive Components:**
   - Pull-up resistors, bypass capacitors, and header pins for modular connectivity.

Wiring and PCB:

- Point-to-point soldered connections on perf board or a custom PCB for compactness.
- Color-coded jumpers used for clarity and debugging.

Safety Features:

- Overcurrent protection via fuse.
- Temperature cutoff (optional) for prolonged use.

III. IOT COMMUNICATION FLOW

The core of the syringe pump's remote capability lies in the Internet of Things (IoT) module, which enables users to control and monitor the pump via Wi-Fi. The ESP8266 module establishes a wireless connection with a cloud platform, allowing real-time control.

Communication Stack:

- Physical Layer: ESP8266's 802.11b/g/n Wi-Fi
- Transport Layer: TCP/IP
- Application Layer: HTTP, MQTT, or WebSocket (depending on platform)

Modes of Communication:

- Direct Mode: ESP8266 creates its own hotspot (AP mode) for local control.
- Cloud Mode: ESP8266 connects to Wi-Fi and syncs with platforms like:
    - Blynk: User-friendly mobile app interface.
    - ThingSpeak: Data visualization and API-based control.
    - Firebase/HTTP API: For scalable, secure command execution.

Data Flow:

1. User sends a control signal from a mobile app or web dashboard.
2. Cloud server (or local server) forwards the signal to ESP8266.
3. ESP8266 decodes the instruction and generates corresponding PWM output.
4. Servo motor moves the plunger to dispense liquid.
5. (Optional) ESP8266 sends confirmation back to cloud/app.

Security:

- WPA2 encryption for Wi-Fi.
- API keys/token-based validation for cloud interaction.

Features Supported:

- Real-time Start/Stop
- Flow rate selection (based on motor speed)
- Scheduling injections
- Alerts on operation completion (via LED or buzzer)

The communication flow ensures low latency, flexibility, and accessibility, making the system ideal for remote medical and lab automation.

IV. SYSTEM BLOCK DIAGRAM

The system's functional structure can be visualized using a block diagram that highlights component interconnectivity and data/control flow. It is divided into three main domains:

A. Input and Control Layer

- User Interface (Mobile App/Web App)
    - Blynk, ThingSpeak, or custom HTML
- IoT Cloud Server
    - Transmits control commands and receives data
- ESP8266 Microcontroller
    - Receives commands
    - Controls PWM output to the servo

B. Processing and Actuation Layer

- 360° Metal Servo Motor
    - Receives PWM input from ESP8266
    - Converts it to mechanical rotation
- Mechanical Linkage
    - Translates servo rotation into linear motion
    - Pushes or pulls syringe plunger

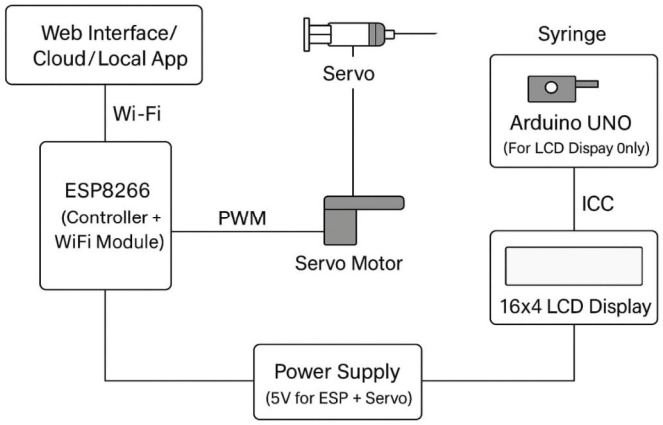
C. Power Management Layer

- DC Power Supply
    - Provides 5–6V regulated power

- Voltage Regulator
    - Converts to 3.3V for ESP8266
- Protection Circuit
    - Diodes, fuse, and capacitors for reliability

D. Optional Feedback and Monitoring

- LED Indicators / Buzzers
    - Signal successful execution
- Flow Sensor (Future Addition)
    - Monitors volume dispensed
- OLED Display (Optional)
    - Shows status or volume metrics



System Architecture

CAD DESIGN OF SYRINGE PUMP PARTS

Computer-computer design (CAD) takes an important part of developing the body structure of 3D pump. The diagram must explain the correct connection of the syringe syringe, the engineer's machinery, with an installation frame, and the integration frame to keep it comfortable. Software such as Fusion 360, Switch or Tinkercad can be used to be used before exporting to a cut stress to cut.

The key components designed in the CAD stage include:

- Syringe Holder Base: A cradle to hold the 5 mL syringe horizontally and prevent unwanted movement.
- Plunger Press Arm: A linear pressing component designed to transfer torque from the servo to the syringe plunger.
- Servo Motor Mount: A reinforced housing that securely holds the 360° metal servo, aligning the output shaft directly with the plunger.
- Gear or Lead Screw Mechanism (optional): To convert rotational motion to linear motion more efficiently.
- Frame Assembly: A rectangular body that integrates all components and ensures compactness.

Design constraints considered:

- Material thickness: A minimum of 2 mm wall thickness was ensured to support structural strength using PLA.
- Tolerance: Proper clearances (0.3–0.5 mm) were considered for sliding components and joints to avoid friction or jamming.
- Component Fit: Designed using the exact dimensions of the 5 mL syringe (approx. 12.06 mm diameter) and servo motor casing (typically 40 x 20 mm).

The Iteitives dedication is made by generating low test patterns to verify the electric building and a motor vehicle before the scale. The design files are stored in .stl and .Step the format to submit compatibility with different types and system. CAD's view can make a machine machine to verify that the killer takes the necessary length (for 5 cm) without bound. In addition, the support tab with a scourge hole that adds the binding and adding the electronic attachment, preparing for easy protection. This CAD model reflects the back of physical

structure and control of the steps that are conducted for future sophistication or great design.

WORKING PRINCIPLE AND OPERATION

SYRINGE FLOW CALIBRATION

Running translation is important to ensure the right of delivery water in purple purple. In this topic, the 5 ml stress stress has been driven by the car of 360 -Degree car that makes the basis of water delivery system. The translation of the translation is to form a relationship between the carrier of the car of the car of the car of the car and the amount of water released. The process begins by defining the base line: the number of lines permanently for each servicipal process.

First, the machine transfusion caused by servo car's carrier and then use the Calier Calier. With the most long collection Servo has directed to change the increase in the larger (for example, 20 °, and others). This transaction will be repaired with the most popular Bachelor's degree from 5 ml Syring Parrel. Because the Syring is a Cylinder, the seal of the mortgage transfer is translated into a separate volume of water. This can be a conversion process to reduce in the case of mL for the conversion. Following the machine sign, the water removal test is carried out. The pitch water is used to avoid influence or simply. The syringe will fill the amount (eg 5 ml), the serda is planned to change an angle. The water was released in the container or fed on the digital scale (1 ml = 1 grams for the water), and the real volume to the desired output. There has been a difference, which is used to be used in Firmware to completely accurately in the Serve command.

The vision of temperature and acid two parts can happen to the translation. The tests for the translation are referred to during the different temperatures to check the effects of the Bay of Plenty or blocking to dig. In addition, the flow is tested according to different types of differences (for example, the medication of the glycerin) to determine the remedial process required for medical applications. The main product of the flow of the flow is to create a diagram or pattern that plans to be added to the volume issued. This will allow dynamic power during the session, especially the pump by the IOT command from ESP8266. The suspect data is stored in the eeprom or cloud (if it requires liquid extraction), can be removed liquids in all parts and do not want to restore.

RESPONSE TIME OF IOT COMMANDS

The performance of the Syring Syring is highly dependent on the reality-reaction of the Iot's conversation, especially the remote system is running. In this topic, the ESP8266 Subject is acting as a bridge between the user interface and the car of Servo. Assessment is important at the response time of IOT command to verify the world's use of international applications, such as distance or non-computer.

To start a reply evaluation, the system is added to the Wi-Fi network and connect with the IOT-I-cloud tablet like Blynk, Obspak, or MQT. Order (eg 1 ml) removes physical applications or web links, and start time at one time. ESP8266 receives commands, processes, and sends the PWM tags to the servo, and the engine moves begin. The rate of time ended after the SERDO begins. This duration is recorded as a period of time or the answer period. Some of the temptations (minimum 30) is running in different networks (eg wi-fi signs, and lower case characters). The average response period is regarded as a standard standard to catch consistency. In the best shape and local Wi-Fi connecting, this system shows the answer time in a section of 200 to 500 million. However, in the environment held with a cloud and length of the abdomen's stomach, up to 1 second, containing a favor of non-love regions. The test settings include a highly valuable camera or properly as the GPI's signals represents the GPI's points to indicate the enrollment times. In addition to a long time of movement-to-move, it will check the finished time, especially when the volume of inquiry can be used.

This system will be tried to load the procedures such as http applications, which contains many devices in the console center to review their work. The algorithm for the level of the area of the area and the condition that is implemented in the Firmware to ensure that the order is not lost or error. Finally, ESP866's watch is used to conduct the length of communication and to ensure that the system is for a long time. This will make the Syringa pump more pumps to an unexpected network environment, it is important to be used in health or long-term requirements.

ACCURACY AND REPEATABILITY TESTS

The right and repetition that determines the symptoms for a non-liquid removal system. The right thing about the nearest volume provided to the target volume, when it is assessed the number of temptations. Establishing it is important to use them for medicinal medicine, gallery machine and chemical treatment. To test the right, the expensive tests will be conducted using the target parts such as 0.5 ml, 2.0 ml, and 5.0 ml, and 5.0 ml. For each target volume, the servo car is planned with a reduced decaying value in section 9.1. The actual volume offered is used using a high digital scale (0.01g resolution) by weight loss. Each test is repeated more than ten times, the average error will be determined by using the model:

The system shows the average error of less than 3% in all the category tested. The height of the higher level is found above 1 ml because the speaker's and low in the microbes' decisions. The best indicator of servo puvo Pulse broadband (PWM) is important to achieve this perfect.

For repetition, the pump has been marked to remove that volume (eg 1 ml) more than 50 changes. The volume of each issue is recorded and set the standard standard of the entire newsletter. The standard standard less than 0.05 ml was found, which shows the big repetition. The nature of nature such as the surrounding temperatures, pressure on a syringe, and also considered the car's clothing. The test will be conducted at different times a day, and after using the length to ensure the effect.

This system keeps his spending and ignoring, showing the most stable of parts and cars. Other repeated tests are displayed using the charts and the maps of the age to analyze data distribution. Analytic analysis will be carried out to cut the value of the area caused by the gas bubble or shorter. This system also supports the automatic recovery process, depending on the number of uses, which can be properly in a long time no manual intervention. This section can be extended in the future by incorporating feedback from Sensor rates of rates or analyzing of age. Syring Pur hi is reflected in the correctness and repetition and metal requirements for medical applications.

PERFORMANCE EVALUATION

The Evaluation of 3D adds to the correctness of the machine, attention, repetition, and the best for removing medicine or health. This review contains a test using 5 ml Syringing, weight equipment of time, and the registration of digital time to ensure properly preparation. Syring purple is planned to provide a number of sentences from 0.5 ml in the increase in the increase of 0.5 ml. For each volume settings, the appropriate angle process required by 360 ° Servo motorcycles called in a syringe line. At the test, the gas version will measure the water balance of water to draw the mass of water released, and turn the volume (1 ml of water = 1 gram). Five periods of test for each volume level to assess the recycling and standard standard.

The results show the most commonly added volume of the volume of the volume of lower volume 3 ml and ± 0.08 ml for 3 ml. This can be accepted in this large rate for most non-application applications, including prototers, leaving non-attacks and knowledge requirements. Line movements that have been achieved by servo car, helped the machine of the 3D section and the renewal of the driveway.

For official answers, the system will do under a man-to-man in the Blynk application interface. The average number between the inclusion of command prompts under 300 million, showing the conversation between the ESP8266 and Servo manager. In addition, SERDO can handle the required duty for the most heat-shaped shirts, though after some changes.

Mostly, the evaluation is displayed, this tool can do true cheeks and update, which is suitable for different types of light. The difference in the process of the process is caused by the passage of the charger of the killer, and the postmaster in the back-time shipping is reduced in the background.

CHALLENGES

In addition to the good results of the performance, some obligations will be settled with challenges during the development and testing pipe pumps. These problems showing fields for future improvements, which is important to assess the system available to the most important application requests. One of the major boundaries caused by the power of weeds and the right of the foundation of Gervo motorcycle 360 °. While the car can move directly from the syringe's surfaces under normal conditions, it shows Jotter sometimes while paying or quantity. This behavior is typical of continuous activity, not a direct response and managing the change period not transferring the angle. In the end, it is very good for the amount of water removal and not in the outside. In addition, the use of PL for 3D added, as it is effective because of his life and the easiest way of the gateway. Play can change the form under heat heat (up to 50 ° C), the environment is better than the temperature. In addition, PL is limited, it can prevent additional features under pressure, especially in the servo relationship with the servo.

Machine machines are also visible and misunderstanding in the event. Because all the frames and the owner of the kitchen will be calculated 3d, unless it is not to be found in the process of the publisher. It is more likely to be found during the small volume database, there is 0.1 mm playing in the system that can be translated into the difference in water. Before the ITot, the Wi-Fi connects, it reduces the proportion of a degree, especially when the device is carried out again from the router. This problem can delay or prevent the achievement of orders and maybe it may be unable to protect the firmware. The strongest communication protocol and a complimental response can be increased by the truth. Finally, the lack of closed closing controls in the design at this time and prevents the system's ability to fix their own or change errors. Include the sponsors such as an enrollment line, the meter or flower that increases the correctness of the device and security, especially for sensitive applications.

ENERGY EFFICIENCY

The power of strength is the main idea to review the purple purple, especially the Iron is issued for long distance activities. This analysis focuses on the power consumption of the system, using the battery (if the current watches and control of a server. The system in the system is in the first power of this system is the ESP8266 Wi-Fi module and 360 ° the metal point. At the time of government (not servo), esp8266 consists of 70 80 clean at this time Wi-Fi connects. This slutious diet is called tenderness, which can be optimized in electrical recovery parts such as sleeping, especially in the form of battery -powered. In the powerful syringe activity, the car is good between 200 and 600 white on the speed of resistance and flow. The top of the time is found in the first time of the floor movement, especially to the next pressure, or started in the residence. Average force consumed 5 ml of spending money to 0.15 0.18 Wh, indicates the tool for short and short-term activities. In order to review the full use, the stress test will be made by moving the syringer 30 times during 10 minutes. The permanent system is in safe sprinkle, and the strength of the change for each cycle. This indicates that the service is not very good for use and not the use of a strong or large force. In a situation, the 5V materials are used, using the ability of more than one hour of the work of the time held under 5 p. This is the same amount of battery kit can be used, preparing the appropriate device for mobile use or fields that are paired with the right electric bank. Moving the system using a 7,4V Li-Ion battery and voltage manager will also appear a permanent activity.

CONCLUSION

The development of 3D 3D pumps using the Lacetic acid (s) to use the useful technology and the technology of the technological applications, which is very important. One of the main achievements of this project contains the use of pla -body 3D added to produce pumps. Pl was selected to his life life, to be easily with the style, and the formation of truth. The modular machine design enables unlimited ingredients of 5 mLs of syringes and expert conditions that are driven by motorcycles and to make sure the facts. The launch of the car 360 ° the best indicator by the ability of the change, which is important to achieve the movement of the Syringron machine. Another main idea of this project is the operating architecture activated by Iot. Using the ESP8266 unit, this system is useful to the Internet, sending remote controls and checking water removal practices through the plates or items. This long-term activity does not have enough system in the environment, gallery workers, and health care workers for the system and other medical systems. The success of the implementation of the authority reflects the system of the system's system, real feedback, and intensify under the environment. During the test time and translation, Syringa purple reflects the water delivery that looks like a small error. This system can keep different flow rates and properly measure the volume delivered for the real cycle of Servo. This level of accuracy is achieved by the basic requirements for delivery of small drugs, chemical treatment or display equipment. In addition, the system design is preparing the recycling, essential for medicinal activities and scientific activities. The translation process also shows useful observations for the translation of the rolling-to-line movement, which is important for real action on real work. One of the most popular benefits of this project is to be effective and involved in the cost. There are many costs, thick, difficult, difficulty, difficulty and difficult to fix it. However, this open solution and reduced by students, researchers for health care in a small law or scale for the type of use. The installation of the Firmware is useful to use Arduino's ideas that determine the logic of the custom and the flow patterns. In addition to the number of success, this topic also shows some of the restrictions that can cause problems in the future. This includes the lack of adjustment in the running rating, which is the power of small gradient (5 ml), and protects the outdoor resources. The loss of a flow sensor is usually the current water supply, may not be good for the applications you want the dynamic repairs. In addition, the current issue focuses on a single channel design, is required in the world's labors.

Finally, this topic finds 3D and add the IOT that can be accessed to form the intelligence system and the lowest materials. The Syring cycle developed here is not only to meet the job expectations but also open the new approach. By improving such as non-powerful pile, the feedback, with handwriting, this system can develop the realistic tools of the educational and clinical environment. This project represents the ability of the indesippluminal technology and combination of machinery designs, input systems, and remedies that support the internet for verbs.

In the future, the combination of reactor management methods using the flow system to the Pump Syrise system is more than the correctness and truth. Currently, the system is on the opening power at 360 ° the turn of the 360 ° car is referred to as a line of water. However, there is no reliable feedback, the system cannot see the differences in a machine game, or a needle or turtle of the skin. To overcome this area, enter the flow sensor, such as YF-S201, or FS300, provides a long time sustainability sustainable. These signals are managing the use of the building methods and the output of the timing of the time that is equal to the flow rate. Links to ESP8266, this data can be used to fix the rotation of the car by closed deposit. For example, if the target size is 2.5 mL but the sensor is distributed, the 'ml has been redirected, Firmware can fix the car to pay for

disadvantages. To manage the control system effectively, the process of the battery needs to be added. This includes volunteer organizers (such as AMS1117, or travers) to reduce the battery checkouts and shortcuts. In addition, the floor of the floor uses TP4056 unit, USB-C will be included in using the use.

The benefits of many transport. In the garden center, this can be health workers to provide accurate measurements of drugs in the area of accident or remote villages. In conservation, the patients can be pumpsed with patients for the infusion of the infusion. For research applications, the system can be transferred between desktop or for mobile tests that can be used to medical monitoring and use of tagged equipment.

The same purple is very good for basic activities, but the design is more likely to support many ways to open a variety of simple and organized applications. Multi-managed planets can be independent of the number of syrizes, giving a regular basis of water types, drug offer, micrilled cure.

To implement this inflation, machine design should be extended to meet many insects from the shell. Each box has 360 ° launches of metal, the pushrod event, and the acne. The number of rivers will be included in 2 to 8 on the size, availability and application requirements.

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