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IoT Based Automated Water Distribution System with Water Theft Control and Water Purchasing System

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Abstract: ***The expanded living spaces in provincial and urban territory require great quality water dissemination administration framework. In this way, there is a basic prerequisite to outline a programmed water supply framework to accomplish rise to measure of water conveyance to every one of the natural surroundings. Internet of things, another idea is employed as a part of the planned framework for programmed water circulation and fault identification. The key idea of this paper is to plan a cost proficient framework to accomplish better water supply by regular supervising and furthermore controlling it from a central server to eliminate problems in the supply of water to the habitats. The proposed design utilizes an Arduino as minicomputer, water flow sensor, and solenoid valves. Arduino is utilized to control the valve and flow meter. The purchase of water should be possible by utilizing cayenne application in which the requisite of water for any of the habitats can be fixed. To associate the Arduino board with the internet the Arduino Ethernet Shield V1 is utilized. It depends on the Wiz net W5100 Ethernet chip (datasheet). The Wiz net W5100 gives a system (IP) stack fit for dealing with both TCP and UDP packets. The proposed design takes care of the issue of overflow, over utilization, acquiring of water and makes an appropriate distribution.***

Keywords: Arduino, Distribution, Monitoring, Purchasing of Water, Solenoid Valves, Water Flow Sensor, Water Supply.

I. INTRODUCTION

In urban territories with the enormous monetary development, the water request of individuals is additionally expanding. Water is critical asset for every one of the livings in the earth. In that a few people are not getting the adequate measure of water in view of unequal distribution of water. The water wastage is because of numerous reasons, for example, we are utilizing drinking water for planting and water leakages are not checked accurately. There is an additional issue of inconsistency of water supply. So as to actualize the proposed water supply framework the Arduino controller is associated with the flow meter and solenoid valve, and afterward to the relay circuit.

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At whatever point the water flow surpasses the relay circuit will be shut and the supply to the valve will be cut-off. At that point we can likewise set the measure of water to be bought to the specific habitat and it is additionally given an electrically worked solenoid valve to supply water to the purchasers. The valve turns on/off to stop the water supply at whatever point the flow rate surpasses a predefined restrain. The solenoid valves are likewise controlled by relay circuit to control flow of water as needs be for a settled span of time.

This framework is proposed to utilize an Ethernet for wireless correspondence with the goal that the data can be exchanged to the individual who is checking the framework. In past technique, individual who is keeping up will touch base to the place and check the association. Once the time over again the in control individual will go to a similar place and close the valve. It is wastage of time. The proposed automated framework is completely programmed thus human work and time is diminished. The water leakages and identifying the leakages and operating error can be avoided.

To solve these problems the proposed work plans and builds up a low cost model for continuous checking of water circulation in Internet of things platform. IOT is a scenario which can be used to detect billions of objects, impart and share data; all are organized in a manner over Internet Protocol (IP) systems. These will aggregate the information constantly and afterward exchange the information to the cloud.

The remaining part of the manuscript is structured as follows: Section 2 describes the related work. The methods and overview of devices are discussed in Section 3.Section 4 represents the results & discussion and conclusion & future work are presented in final section.

II. RELATED WORK

A. Microcontroller Based Automatic Water Level Control System

Ejiofor Virginia Ebere (2013) has proposed a firmware based water controlling framework which will control the water flow [1]. The proposed work utilized microcontroller to automate the procedure of water drawing in an over-head tank stockpiling framework and can analyze the quantity of water and it will educate the client through LCD shows. This examination gave great outcomes by utilizing implanted framework and utilization of DC rather than AC to stop electric shock.

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B. Water Anti-Theft and quality monitoring system by using PLC and SCADA

Gaikwad Sonali Ashok (2013) has planned this strategy as a model for water circulation framework involving a control framework, communication means, funneling, actuators, sensors and valves [2]. This framework uses a communication bus for controlling and checking water flow through the channeling by means of control of the actuator and valves. Control framework is additionally coupled to Supervisory Control and Data Acquisition (SCADA) unit. This paper concentrates especially to a control framework for controlling and checking segments inside a water dispersion framework. To transmit or receive the control and status information man machine and electrical interfaces are incorporated to PLC (Programmable Logic Controller).

C. Design of a PI controller for a computerized building water distribution system with PLC system

Hassaan Th. H. Thabet (2011) has considered and built up the framework for water supply framework's energy conservation guideline of a pump with flow control as indicated by unsettling influences [3]. The framework can distribute the water with steady weight and spare energy effectiveness. The framework was tried for every whole day for 21 days with limit of (20 - 120) liter/minute of water, and around ten meters building elevation. The weight of the supply system is around 1.2 Bar. The test results of the simulated and actualized framework demonstrate enhanced proficiency and expanded precision in the variable heaps of the water devoured in a multi-story working with a constant pressure controlled operation. The PLC connects and controls the operational parameters to the speed asked for by the framework and screen the framework amid typical and anomalous conditions (over-loading and dry running).

D. PLC based automatic corporation water distribution system using solar energy

P. Mukesh Aravind (2013) has implemented the strategy to depict about the PLC based programmed enterprise water circulation framework, which encourages to disseminate the water naturally as per the requirement of the particular region [4]. In conventional framework there is no legitimate strategy took after for the dissemination of water. To defeat the trouble in the regular framework, the PLC based automated framework utilizing embedded controller is used for disseminating the water to the general population similarly as indicated by their usage. The embedded controller is as of now pre-modified to do the tasks and results are appeared in ladder diagram utilizing Pico software. So as to make the framework more effective and contamination free, solar based energy is utilized as an elective hotspot for control supply activity of the PLC unit.

E. Wireless Sensor Networks for monitoring and controlling of water distribution systems

A. J. Whittle (2013) has built up the technique for in-situ, on-line checking of water dissemination frameworks with a precise target to support effective administration and task [5]. Specifically, it is critical to recognize and restrict pipe failures not long after they happen, and pre-emotively, distinguish 'hotspots', or zones of the circulation arrange that will probably be helpless to basic failures. These capacities are indispensable for diminishing the time taken to recognize and repair failures and thus, alleviating impacts on water supply. Water Wise is a tool that oversees and examinations information from a system of wireless sensor nodes, constantly observing pressure driven, acoustic and water quality parameters. Water Wise helps numerous applications including dynamic forecast of water request and pressure driven state, online recognition of occasions, for example, pipe blasts, and information digging for ID of longer-term patterns. This paper depicts the WaterWiSe@SG venture in Singapore, concentrating on the utilization of Water Wise as a tool for observing, recognizing and foreseeing unusual occasions that might be demonstrative of auxiliary pipe failures, for example, blasts or breaks.

F. Automated drinking water system and theft detection using embedded technology

Sagar Khole (2015) has exhibited the technique to implement the proposed water supply framework, every purchaser ought to be furnished with an embedded based water flow observing framework comprising of a microcontroller to record the flow rate utilizing a flow sensor and to transmit the same to a remote checking station utilizing wireless transmitter and it is likewise furnished with an electrically worked solenoid valve to supply water to the buyers [6]. The valve turns on/off to stop the water supply at whatever point the flow rate surpasses a predefined restrict. The solenoid valves are likewise controlled utilizing continuous clock to control flow of water appropriately for a settled span of time. It is proposed to utilize a GSM modem for wireless communication so the data can be passed to specific capable officer's PDA for quick activity.

G. Controlling and Monitoring of Automation of Water Supply scheme based on IOT with theft detection

Ahmad T. Jaiad (2017) has proposed the strategy to concentrate on persistent and constant supervision of water supply in IOT scheme [7]. Water distribution with constant supervising formulates a legitimate dispersion so quantity of water in tanks, flow rate, variation from the norm in supply line can be made. Internet of things is only the method of substantial items embedded with electronics, sensors, programming, and system network. Monitoring should be possible from any place as central server. Utilizing Ada natural product as free disjoin information constantly pushed on cloud so information can be seen continuously. Utilizing typical sensors with controller and raspberry pi as Minicomputer can supervise information and moreover control task from cloud with skilled customer server communication. This framework is centered on, Internet of things which is new state of affairs to make city as a smart city with various applications. Principle target to implement this scheme is to sketch out and make up a negligible effort

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dependable and productive system to make appropriate water conveyance by consistent checking and furthermore controlling it from a central server with the goal that water related problems will be taken care. Arduino collects the data from sensors and forward it raspberry pi. The important issues of water distribution process which includes overflow, over utilization and water quality are solved.

III. METHODS AND OVERVIEW OF DEVICES

A. Existing System

The water wastage is because of numerous reasons, for example, inappropriate utilization of tank and pipes, leakages in tanks, administrator mistake and so forth. There is likewise issue of inconsistency of water supply i.e. the calendar of water supply isn't settled. In this day and age, water stockpiling and appropriation, water obtaining, water administration are in inclining. It is hard to recognize the theft in urban drinking water supply. Water flow control is unimaginable. The water supply scheme is a piece of the urban foundation which must guarantee the proper water distribution, water quality control and examination. In existing framework as appeared in figure 1, urban water is provided to the habitats with the assistance of labor. The individual in control will go to the place and afterward open the valve to that specific territory. Once the time is over the individual will go again to that place and close the valve. This sort of activity needs labor. This is exercise in futility to go to that place and rebound frequently. Likewise the general population may take overabundance water for their own utilization with the assistance of engine or some other hardware. Because of this numerous individuals won't get adequate water for their utilization. Water is the fundamental needs of the people. The theft can be counteracted just when any public educate the authorities about the theft. So, the chances of public educating to higher officers are rare.

Figure 1.Manual Controlling of Valve

B. Proposed Method

The elementary design of this manuscript is to build a scheme for legitimate water appropriation framework, which can distribute water to the habitats. For such kind of water dispersion, it is important to have an appropriate dissemination design with the end goal that it can do the trick the essential necessities of the habitats. As the fundamental goal of our task is to have a framework which can achieve the habitats their essential need of water, with legitimate amount, time and to buy the water at required quantity by utilizing an android application.

C. Methodology

To switch ON/OFF the solenoid valve the relay circuit is used. The relay circuit is triggered by the Arduino. If the switch is turned on in the Blynk application the solenoid valve is opened and water is supplied to the habitat tank for a fixed duration and after that water supply is automatically stopped as shown in figure 2.The habitats of rural/urban area can get the additional amount of water rather than actual interval allotted to the entire area, can be delivered using the selector switch which is fixed for that particular habitat.

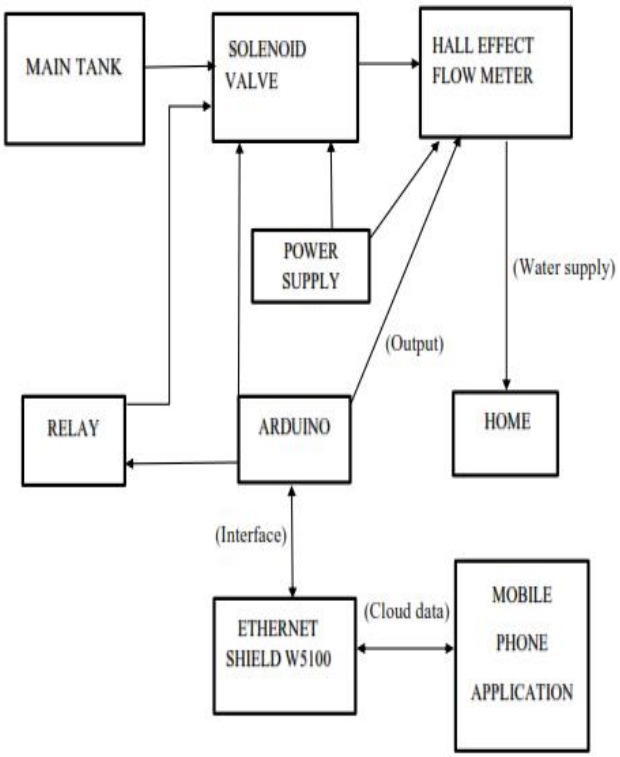

Figure .2 Block Diagram of the Process Flow

D. Process Involved

To control the water level measurement, the process uses flow meter to calculate the quantity of water flowing through pipelines. The flow of water is calculated with flow sensor consists of hall effect sensor, it makes the turbine wheel to rotate and hence the magnet flux obstruct the hall sensor, the rate of obstruction depends on the velocity of water flow, so the hall effect sensor generate pulse signal output, the pulses generated will be taken in to account for the calculation of amount of water flow. The YS-S20 flow sensor has three wired systems and it can be used to connect any microcontroller and Arduino board as shown in figure 3. It requires only +5V Vcc and gives pulse output, the sensor needs to be tightly fitted in the water pipeline.

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Figure.3 Flow Meter Internal Structure

The flow meter and Arduino interface is shown in figure 4.In this interface the +5V wire is connected to Arduino power pin 5V, ground pin connected to ground and the signal pin is connected to Digital pin D2.

Figure.4 Flow Meter and Arduino Interface

In the first step of code for water flow sensor, the variables are initialized and the two methods, void setup() and void loop() are implemented. The setup() function is called when the program starts working and to initialize variables, pin modes, start using libraries, etc. The setup() function will run once, after each power up or reset of the Arduino board. Void loop function that is required by all Arduino sketches. In other case, the loop function is the main function which will run throughout the program.

A display and load resistor connected between the pin 13 and ground in the Arduino board is a convenient feature for testing purpose. The earlier code would not be seen by a standard C++ compiler as a valid program, so when the user clicks the "Upload to I/O board" button, a copy of the code is written to a temporary file with a header function that is included additionally. In this all the output data are printed and the count values are also incremented in this loop. Upload the flow meter code to the Arduino. The code will use an external interrupt on the Arduino's digital pin 2 for this purpose. This is used to read the pulses coming from the flow meter. When the Arduino detects the pulse, it immediately triggers the pulse Counter () function to count the number of pulses. In this Arduino flow rate sensor, for every litre of liquid passing through it per minute, it outputs about 4.5 pulses. Dividing the total pulse count by 4.5 will give you the total amount of liquid passing through it in litres per minute. Dividing it by 60 will give the flow rate for litres per minute, which gives the total amount or quantity of water/liquid that has passed through it. The accuracy of the sensor is maintained as 3%.

In this the flow limit and the stop function is done through the Arduino software, that is the flow is continuous through the flow meter whenever the value for the flow is fixed then the Arduino will start to monitor the flow continuously. In this program the flow is fixed to 17 Litres per minute whereas capacity of the flow meter YF-S201 is 30 Litres per minute. When the flow is going to exceed 17 litres/minute then relay is turned on and the water supply is cut off to the particular valve. If anyone tries to use pumps or motors the relay will shut the valve and the water supply to the home stops.

The volatile integer “count” is used to store the number when the second test function is called. It will be incremented every time when there is count in pulses and it will call the function again and again. Here flow rate is determined by change in velocity of water. Velocity depends on the pressure that forces the flow through pipelines. The cross sectional area of the pipeline remains always constant and the average velocity is an indication of the flow rate. The basis relationship for determining the liquid’s flow rate in such cases is

Q=VxA, where Q is flow rate/total flow of water through the pipe, V is average velocity of the flow and A is the cross-sectional area of the pipe

Calibration Factor = The hall-effect flow sensor outputs pulses per second per litre/minute of flow.

Flow Rate(litres/minute) = ((1000.0 / Total time) x Pulse Count) / calibration Factor

Flow Rate(Millilitres/Second) = (Flow Rate / 60) x 1000

There is a need to calculate the total water flow in a given time by adding flow rate for each second. Thereafter check the set point value (400ml). If condition satisfied, turn off the Solenoid valve.

E. Flow chart for the proposed system

The flow chart for the proposed system is shown in figure 4. Water flow is individual homes will be monitored and reported in the serial monitor that how many liters of water is going out . On estimating these measured values, the habitats which over consumes water can be easily identified and alert is produced. All the planned modules can be realized by using Embedded C. The water supply can be well executed by including all the details such as time and quantity to the microcontroller. Arduino family microcontroller is used in the proposed system. Flow measurement on each channel can be easily measured by employing flow sensors.

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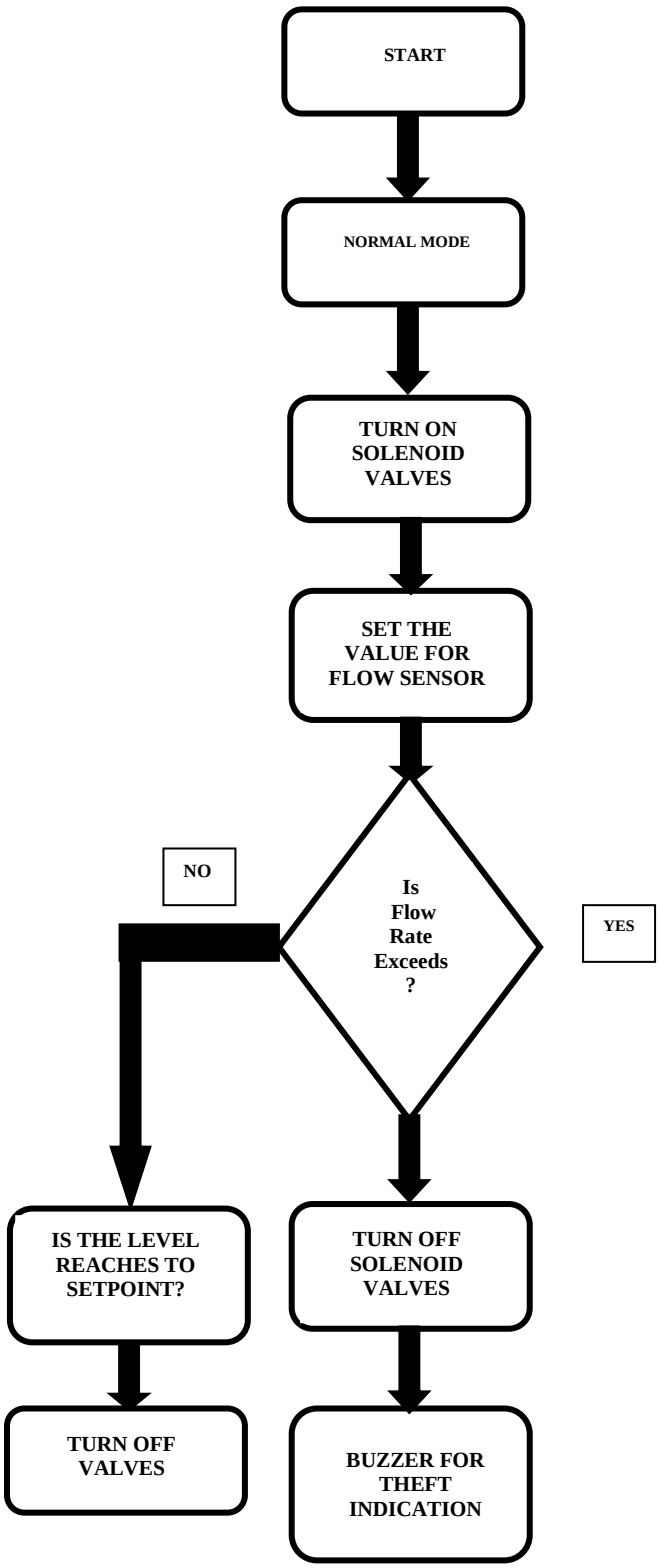

Figure.4 Flow Chart for the Proposed System

Voltage is produced when water flow through the sensor and by modulating the calculated value, flow can be easily found which is shown in figure 4. The consumption of water will not be uniform for all the habitats. The scarcity may be realized when some of the habitats consuming excess water. By measuring flow in all habitats, the one with high water consumption of any habitat is calculated by employing flow meter at each of the habitats. Hydrogen ions plays important role in checking. The circuit diagram for Ethernet control and flow control is shown in figure 5 and 6 respectively.

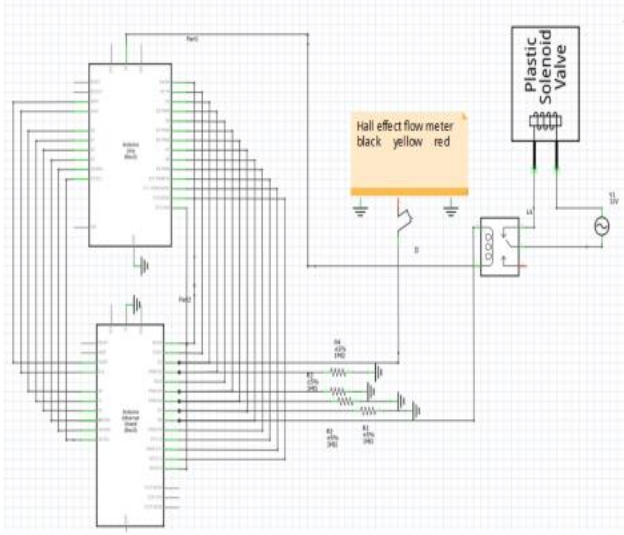

Figure.5 Circuit Diagram for Ethernet Control

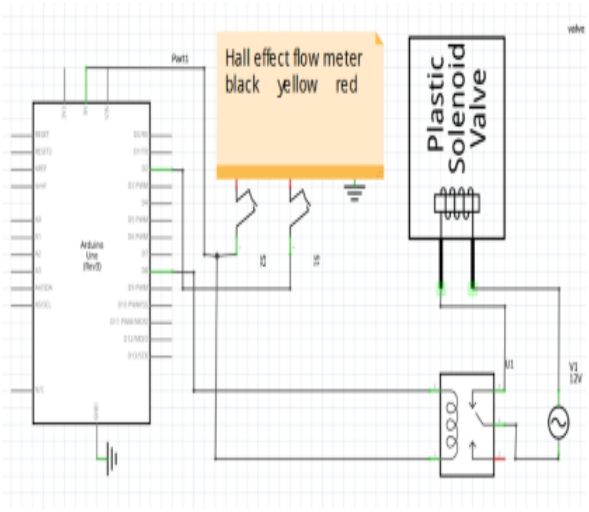

Figure.6 Circuit Connection for Flow Control

IV. RESULTS AND DISCUSSION

A feed for each parameter is designed on Blynk cloud application. As the system gets started the overhead tank is filled according to its level of water. The water is supplied by this valves which operate automatically based on the flow rate given by flow sensors in ml/sec. The figure 7 shows the Blynk Application Switch for Purchasing Flow.

If the water supply of any line needs to be stopped, it can be controlled from Blynk cloud application through mobile by making relay ON/OFF shown in figure 8. So, controlling of the solenoid valve is possible.

For empty pipeline at any situation, the solenoid valve will be always closed. So there will be no stagnation of water or leakage through pipes. The water distribution is achieved by proper scheduling by maintaining time period at Blynk. On Blynk server the previous records can be observed and the data is continuously pushed on cloud for real-time monitoring and controlling. The 16×2 LCD is used to visualize the data which is connected to Ethernet Shield via Arduino.

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Figure 7. Blynk Application Switch for Purchasing Flow

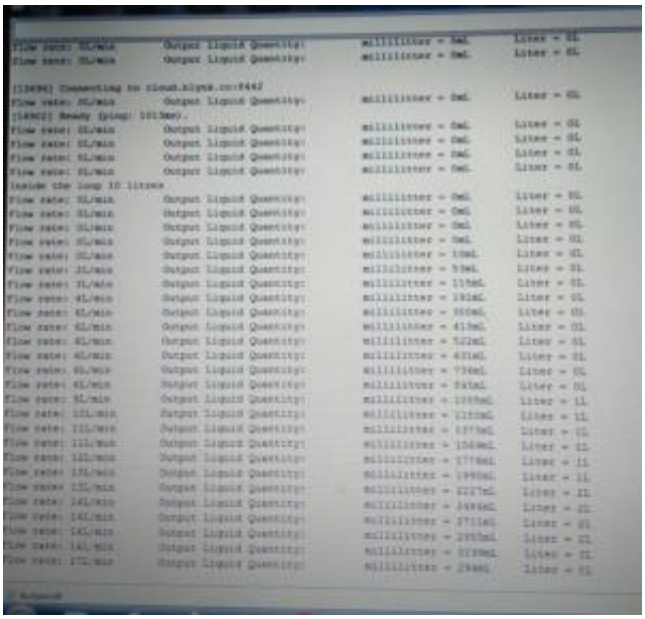

Figure 8. Solenoid Valve Stops the Flow after Reaching 3 Litres

V. CONCLUSION

In this paper an automated system for water supply, purchase of water and water theft control is designed. This proposed work is an essential requirement for the modern world people to solve the water related issues. Reliable data monitoring from the central server helps the habitats in getting adequate water by incorporating automatic theft control. By implementing this proposed research work the water theft in the government pipelines can be absolutely avoided and also the habitats can achieve the additional water requirement by making purchase. So that getting water for needy purpose will not be a cumbersome process. This proposed work not only suitable for water supply, but in future our government can supply liquid petroleum gas and other fuels through pipelines using this proposed work.

Further this proposed work can be implemented by using SCADA along with PLC in future to monitor and control the entire system from main control units. The unskilled operators can also understand the SCADA graphical interface and storing data for future use. The future work can focus the identification of water tanks with less quantity of water by incorporating GSM modules in the system. The system can also be extended to detect the accurate location of pressure drop in the water distribution system.

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