Proceedings of the International Conference on Intelligent Computing and Control Systems (ICICCS 2020)
IEEE Xplore Part Number:CFP20K74-ART; ISBN: 978-1-7281-4876-2

Automatic sensing and switching the water pump: A new approach

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***Abstract*— In this paper, we introduce the design of an electronic system for automatic control of water pump motors that are used at homes to fill the overhead tanks with municipal water (piped water). The electric signals generated by the water flow sensor and water detector are feed to the microcontroller. Microcontroller process these detected signals to confirm whether water is present in the pipe and to calculate the water flow rate, to activate the relay that controls the switching of the water pump motor. The motor is switched ON if the water is detected in the pipe and its flow rate is greater than the critical flow rate if any one of the two conditions is not met then the motor is switched OFF. This work will be very helpful for people who rely on municipal water. As municipal water comes at random times in a day (in India), this work helps them to make their life easier.**

Keywords*— *water flow sensor, micro-controller, piped water, relay, water detector.

I. Introduction

As the population of India is growing rapidly, the demand for freshwater is also increasing. Even though India has 4.5% of the world's freshwater, we can't consider India as a water-rich country as it has a share of 17.74% in the world's population [8]. 70% of the earth is covered with water but only 2.5% of that is freshwater. Of the freshwater, 68.9% is in the form of snow and glaciers, 30.8% is groundwater and 0.3% is in lakes and rivers [6] which is the main source for piped water (municipal water or tap water). More than 80% of households of rural India are yet to get piped water supply, out of 17.87 crore rural households only 3.27 crore are currently getting water through piped connections. The government of India recently launched a new mission named "PIPED WATER FOR ALL BY 2024" (or) "JAL JEEVAN MISSON" to ensure water from the tap for each house in villages in the next five years [4]. At the same time, the state governments in India are also trying their level best to provide piped water supply to every house. Recently the government of Telangana launched mission Bhagiratha which aims to provide piped water to 2.32 crore people in 20 lakh households in urban and 60 lakhs in rural areas of Telangana by constructing pipeline network of 1.46 lakh kilometers [3].

Even though the government is doing its level best, it can't provide fresh water throughout the day due to the deficiency of water. In almost all parts of India, people are getting municipal water once in 2 to 3 days (especially in summers)[12], people are supposed to store the water for their future use. If the store that water in overhead tanks then they have to monitor continuously to start and stop the water pump motor as municipal authorities release water at random times in a day. The work investigated in [2], [9] helps to switch OFF and switch ON the water pump motors based on the water levels in the overhead tanks, but these works are useful only when one relies on underground water to fill their overhead tanks. But many people in India depend only on municipal water as their primary source of water, as underground water is not available everywhere, even though it is available, it is not suitable for drinking in many places. We worked on the limitations of the works proposed in [2], [9], and to introduce a design that is helpful for the people who rely on municipal water as their primary source of water. This work is useful to save the most valuable time of humans as the switching of water pumps happens automatically and they can utilize the time they spend on monitoring for municipal water effectively.

II. Literature Review

Anisha, Ankith R Menon, Archana Prabhakar [1] developed a smart system that consists of water flow meter and solenoid electro-valve and microcontroller which is connected to the live internet through internet which helps the user to make use of water in a modular way by intimating the user.

B. N. Getu and H. A. Attia.[2] designed a system that detects the water level and controls the water level in tanks with the main focus being on less power utilization by the system. They developed a digital system capable of detecting the water level in the tank and displaying using the 7 segment display and a control circuit which helps in maintaining the water level in tanks.

Priyen P. Shah [9] developed an application of monitoring the water level in tanks and controlling them using IoT. The project's main concern is to reduce the water wastage which generally occurs because of the lack of knowledge of whether the tanks are filled or not.

III. COMPONENTS USED

A. Water Flow Meter

The water flow meter is connected in series with water inlet to the house. It contains a rotor and a Hall Effect sensor in it. The rotor rotates with a speed proportional to the flow of water. The Hall Effect sensor gives PPM (Pulse Position Modulation) signal corresponding to the speed of the rotor as an output, by counting the number of pulses per second we can calculate the water flow rate. To read the pulse signals, we connect this sensor to the microcontroller. The drawback of this sensor is it cannot detect the presence of liquid, even if the rotor gets rotated due to airflow in the pipe it will send PPM signals to the microcontroller.

The sensor which we used in this paper sends 450 pulses per liter flow of water.

So, Liter/hour= (frequency of pulse signal*60*60/450). And these pulses will have an amplitude of +Vcc.

The working range of the sensor used in this work is 1-30L/min and its operating voltage is 5 to 18V DC.

Fig1: Water Flow Sensor.

B. Water Detectors

Pure water is a bad conductor of electricity, but the water which we use to drink will have few dissolved salts in it which makes the municipal water to conduct electricity. We designed Sensing electrodes with aluminum-coated single-stranded wires which are placed at the inlet of the water flow sensor. The output of these electrodes is taken as input to the microcontroller for the detection of the presence of water. To avoid floating analog values when the electrodes are not placed in a conducting medium a pull-down resistor is used. The pull-down resistor will avoid the floating values by bringing them to ground potential.

Fig2: Sensing Electrodes.s

C. Microcontroller

In this paper, we used Arduino Nano, which has AT mega 328p chip and it is a 30 pin microcontroller. From the chip name, we can say that it has 32kb flash ram and it is an 8-bit microcontroller. It has a clock speed of 16MHz, 16 Digital I/O pins (6 PWM pins), 8 Analog IN pins. We use a microcontroller to perform the following functions: -

- To receive the pulses generated from the water flow sensor and to calculate the water flow rate in liters/hour by counting the number of pulses received per second.
- To receive the output given by the water detector to confirm the presence of water in the pipe.
- To switch relay output which controls the switching of the water pump, when the flow rate is greater than 125 liters/hour and water is being detected by the water detector.

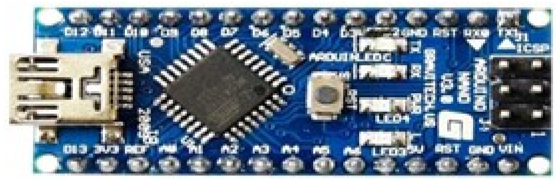

Fig3: Arduino Nano microcontroller

D. Relay

Relays are used to control the switching of high power circuits using low power signals. They are used to open or close the contacts (basically it is an electrically operated switch). It can be controlled with low voltages (5V) which can be provided by an Arduino. The high voltage side of the relay has 3 terminals mentioned below:-

- COM (common).
- NC (normally closed):-If we need the circuit to be closed by default, we use this configuration. (In this case when Arduino sends 5V output to relay, then high power circuit will open.)
- NO (normally open):- If we need the high power circuit to be open by default (and the high power circuit will get closed only when microcontroller sends 5V signal to relay), then we use this configuration.

Fig 4: Relay

IV. CONSTRUCTION AND METHODOLOGY

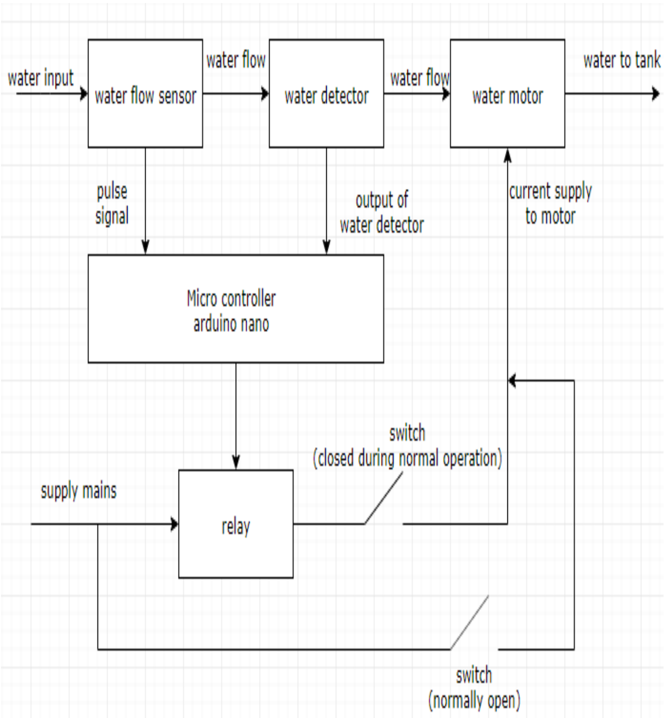

Fig5: Construction Block Diagram of the System

The water flow sensor is kept in series with water inlet into the house, 2 electrodes of water detector are inserted in the pipe vertically opposite to each other. Both the water flow sensor and water detector are connected to Arduino Nano. Arduino Nano controls the relay, which controls the water motor. One manual switch is connected in series to relay and one more manual switch is connected in parallel to relay. Whenever there is the flow of water in the pipe, water flow sensor sends PPM signals as input to the Arduino and the code is written in the Arduino IDE and then it is uploaded to the Arduino Nano to calculate the flow of water in liters/hour by counting the number of pulses. But there is a drawback in this sensor, the rotor of this sensor rotates even there is the flow of air, and hall effect sensor will give out PPM signals as output only based on the speed of the rotor. So to differentiate the flow of air and the flow of water we use a water detector in the pipe to detect the presence of water. Here the logic we used to detect the presence of water is water which has dissolved salts in it will conduct electricity. The salts present in municipal water are enough to conduct electricity. Here we place two electrodes in the pipe, one of the electrodes is connected to 5v supply and the other is connected to the analog input pin of Arduino. When water is present in the pipe it acts as a conductor and the electrode which is connected to the analog input pin of Arduino will give some voltage greater than 0V and less than 5V as an output, the analog voltage is then mapped into integer value in between 0 and 1023 by the inbuilt analog to digital converter of Arduino. The two copper conductors of the water detector are placed vertically opposite to each other in the pipe so only when the pipe is filled with water Arduino will get input from the water detector. And the code is written in such a way that when the input from the water detector is greater than particular voltage and the water flow sensor reads the flow rate >125 liters per hour(here we considered 125 liters/hour as critical flow rate) the Arduino will send 5v as an input to the relay. Here we use a relay in a normally open configuration which means when relay gets 5v input it closes the circuit and the motor starts drawing current from the mains and it pumps the motor into the tank. We have also added 2 switches, one in series with relay and other in parallel with the relay and normal operation series switch has to be closed and parallel switch should be in the open state, but if there is any fault in the device the series is switch is opened so that operation of relay does not affect switching on the motor. And the motor can be switched on using parallel switch manually whenever required.

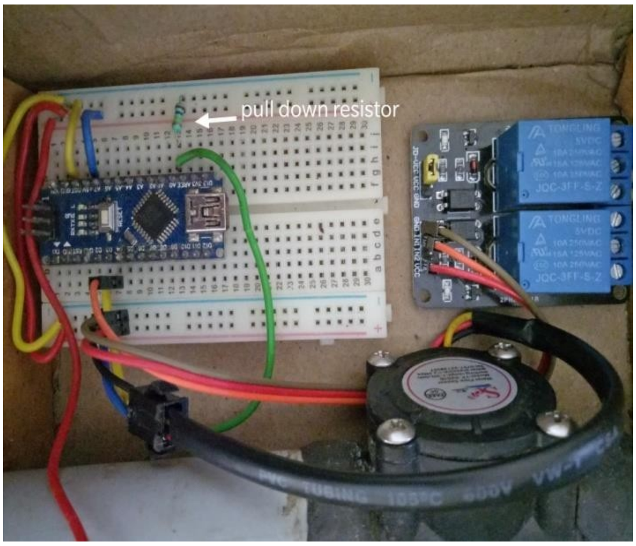

Fig 6: Snapshot of the project

V. RESULTS

The graphs below show the output of the water flow sensor, water detector, and relay respectively, and all the three graphs are plotted at the same time. The graph of the water flow sensor is plotted between water flow rate (liter/hour) Vs time, the graph of water detector is plotted between the digital equivalent of analog output voltage (water detector gives analog voltage to Arduino as an input, Arduino has an inbuilt analog to digital converter, it maps the analog voltage between 0-5V to integer values between 0-1023) given by water detector Vs time, the graph of the relay is plotted between the status of the relay (0-OFF, 1-ON) Vs time. From the graphs, we can observe that the relay is getting turned on only when the output of the water flow sensor gives more than 125 liters per hour (critical flow rate) and the output of the water detector is greater than 3.9V (the digital equivalent of 3.9V is 800).

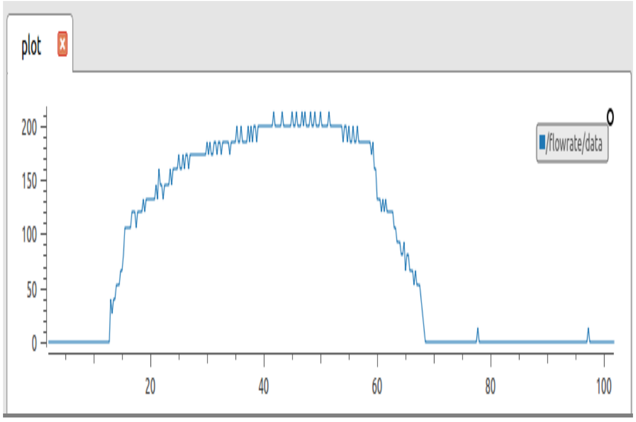

Fig7: Screenshot of the output given by the water flow sensor.

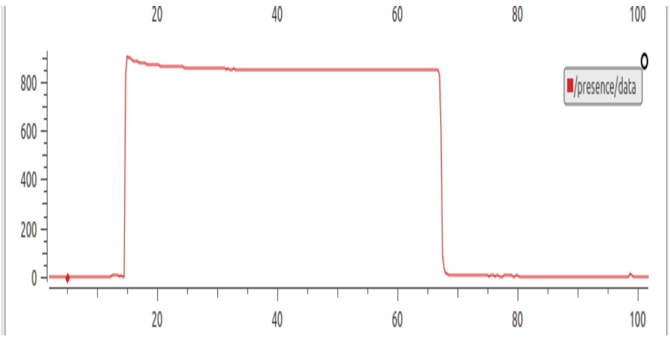

Fig8: Screenshot of the output given by the water detector.

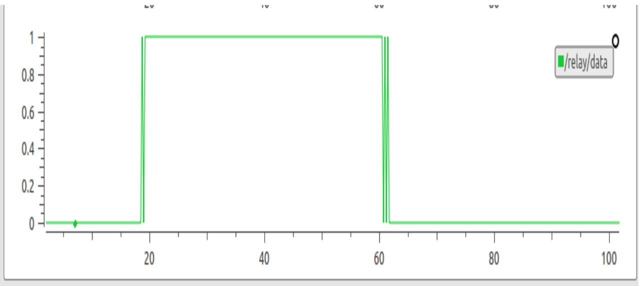

Fig9: Screenshot of the output given by relay.

TABLE I. SENSOR OUTPUTS AND CONDITION OF MOTOR CORRESPONDING TO THOSE OUTPUTS.

S.No	Output of Water Flow Sensor	Output of Water Detector	Motor Condition
1	<125 liters per hour	1(water detected)	TURNED OFF
2	>125 liters per hour	0(water not detected)	TURNED OFF
3	<125 liters per hour	0(water not detected)	TURNED OFF
4	>125 liters per hour	1(water detected)	TURNED ON

VI. CONCLUSION

Installing this system at home makes life easy. One need not wait for municipal water to get released by municipal authorities. Municipal water will automatically go into the overhead tanks as automatic switching of the water pump motor will take place. This saves time as well as energy which we spend in monitoring the motor to switch it ON and OFF. The user can also put a water detector at the top of the tanks so that the motor will automatically get switch off whenever the tank is filled with water (we have not included it in our project).

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