Water Wastage Control & Monitoring System for Railway Coaches using IoT

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ABSTRACT

The project aims to provide the ubiquitous surveillance system for water wastage control management and monitoring system for Indian Railways. This system provides real-time updates on the output display in every 2 seconds with the help of the Internet of Things (IoT) platform. The agile project management is the plan for specially for premium section trains later will be introduced in all the trains. This will thus help us prevent unnecessarily filling of water, to avoid time delay and give a smooth and comforting experience to all the passengers in their journey.

KEY WORDS: AGILE, INTERNET OF THINGS(IOT), RAILWAY, SURVEILLANCE, UBIQUITOUS.

INTRODUCTION

The railways are the biggest lifeline, important & affordable means of transport in India. Indian Railways is considered amongst the 'Largest railway Networks in the World' as it is ranked at no.4 & it's operating route length is at 68,525km. As it is the backbone of the means of transportation in India & lakhs of people travel every day. So as a result, lot of water is required for the passengers in the running trains but unfortunately in this process tons of water is also wasted at the railway stations in the refilling process of the watertanks.

The core motivation for the design & implementation of this project is that since we are experiencing an acute shortage of water in around 50% of the cities & villages of India & in the coming years this problem is going to spread like an epidemic. The project desired to build a solution to this problem, with the help of IoT technology. Detecting

the threshold levels of the tank using the ultrasonic HCSR04 sensor, the tank has been divided into 3 levels of low, medium & high respectively. Alternatively this data of the water level status in the tank will be available in real-time monitoring status & control via an online IoT platform. With the help of this system, we will be able to analyze how much water is needed and consumed by passengers in railway coaches each day, this statistical analysis will help us for proper water management. As the system will be continuously monitoring the trains, the trains detected with the lowest water threshold will be given the first priority to fill up the water.

It can possible that the other train coaches have full or sufficient water levels and thus these trains can be eliminated from filling up. By doing this overflowing of this train coaches can be avoided and wastage of water can be controlled. As this is a real-time situation various problems can be controlled by this system such as, if the train is running out of the water then prior information will be given to the upcoming station of how much water is required and to which coaches have the lowest threshold of water. This will help to manage up the situation smartly and quickly as the platform authorities will be ready with the required amount of water respectively. If due to some unfavorable circumstances if they are unable to meet up water requirements then this information will

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be pass to the nearest station. The paper is organized as follows section 'A' has flowchart, 'B' section has an Experimental setup, 'C' has a Block diagram, 'D' has Result, and Proposedwork.

METHODOLOGY

The Block Diagram is shown in figure 1, it consists of the Cloud Server which is Things speak. Through cloud server two microcontrollers are connected which is NODE-MCU. The 1 st NODE- MCU is for train tank and 2nd NODE-MCU is for the Platform. Both are sending the information to the cloud server of things speak. The RGB LEDs which are red, green, blue LEDs are connected to show the status of water levels. Here the sensor used to turn ON and OFF the solenoid is an ultrasonic sensor. The 2nd NODE MCU has the control of the relay and solenoid valve.

a. Experimental Setup & Results

a. One 5 Litre water jar(as a dummy similar resemblance to the coach water tank, jar's height vertically in a horizontal rested position is equal to '22cm'.)

- b. 2 ESP8266 Nodemcus(with built inWifi).
- c. One 2-way Solenoidvalve
- d. Plasto PVC pipeconnector
- e. One 2-RelayModule(JQC-3FF-S-Z)
- f. PushButton
- g. One UltrasonicSensor(HCSR0-4)
- h. RGBLED
- i. 12V Adapter & jumper, connector, crocodile wires & pins etc.

Figure 1: Systemlow

b. Software Used

1. Arduino 1.8.12version
2. Online IOT Platforms:-ThingsSpeak, Adafruit IO, etc.(for online monitoring & continuous real- time transfer of data to the specified user & the display of it via Gauge, Graphs,etc.)
3. The jar has been divided into three levels of water level detection i.e Low, Medium & High & the equivalent values will be covered further.
4. The working execution is divided into two parts that 1 Nodemcu is connected on the jar alongside the RGB LED & the ultrasonic sensor for continuous updating of the water level online via IoT platform & also it can be viewed & tracked manually & live by the staff inside the coach compartment via the

RGB LED indicator (3dot digitalswitch).

5. The other Nodemcu has been connected with the solenoid valve, Relay module, Pushbutton & to the pipe available at the platform. This connection will ensure the 'Automatic Turn-Off ' mechanism of the solenoid valve in coordination with the Push button & the Relay module.
6. After the correct connection setup is done, we'll a red light on the RGB LED initially seen since as mentioned above in point 2), we have divided the jar into 3 levels:- From the point, 1a) If the Monitor displays value ' 22cm' it means the jar is empty & it will gradually decrease with the increase in the water level from the pipe inlet. i) Low- For water level range from 17-22 cm.ii) Medium- for water level range from 16-9 cm & High- for water level range between 9-0 cm.
7. Now to turn ON the solenoid valve for the filling process, we press the Pushbutton & the Relay state initially being = 0, now after pushing the button & turning the valve ON the Relay State displays = 1 on the Monitor screen to convey that the waterinlethas been allowed inside the jar via the pipe from the valve.
8. As gradually the water keeps filling inside the jar the equivalent color indications will be shown on the RGB LED as from point5)above.
9. The project provides the 'Real-Time Monitoring' of the water level & Relay switch state online via the IoT platform. The 'Field Chart' will display the real-time & the equivalent levels in a continuous graph form. The analog needle type 'Gauge display' has also been provided on the screen initially from the server-side to clearly view the same & it would start from the '22cm-i.e empty' reading to the '0 cm full brim' position beingdisplayed.
10. Finally when the water level approaches towards the 0 cm value, the green light indication is already there at the RGB side from 9 cm onwards & also a message will be initiated online. Just after 1cm reading, the Relay module will automatically disconnect the solenoid valve by giving a 'click sound' indication on the Push button as well & thus the " unnecessary further filling & the water wastage will be monitored & controlled".

c. Block Diagram for Experimental Setup

Figure 2: Flowchart of Water level indicator connected to cloud server.

The block diagrammatic representation shows the complete set of sequences occurring from the trains' couches water tank side setup from where the water level of the tank is being monitored by the Ultrasonic sensor which is further being shown by the indication on the manual indicator (RGB) and these values being detected by the installed microcontroller (here NODE MCU) are being transferred in real-time via online cloudServer.

Figure 3: Flowchart of Sequences of water pipe controlled, data detection , updating to cloud server

The block diagrammatic representation shows the sequences from the station's platform's pipe filling side where the "Relay-Solenoid valve and switch (Push Button) mechanism" senses the amount of water required to be filled in the tank and it switch mechanism and here also the data is detected and controlled by the microcontroller (NODE MCU) is beingupdated.

RESULTS

a. Figure 4 in the image works in accordance & in contemporary to the point no. (6) mentioned in the Experimental Setup. Since after the push button is triggered & the valve is ON, the equivalent Relay State displays the 'Relay State' value = 1 on one of the window boxes of the Serial Monitor. Similarly, in accordance with this process continuing as mentioned in point no. (5), the tank initially being empty i. Distance value = 22cm. As gradually this is being filled up with water the value is constantly decreasing from 22cm & this continuous updating is being shown on the 'Distance' heading & after each update the 'Channel update successful' message shows.

b. The figure 5 (a) and (b) shows the image which follows the point no.8) of Experimental Setup, where IoT is deployed on an online monitoring platform on the 'ThingsSpeak Server' & all those processes occurring in the setup & as mentioned above in the first image are being displayed here in 'Real Time' continuous update in the Field Chart & the equivalent level on a more

Figure 4: Serial Monitor's with Relay State & Channel update the successfulvalue.

Figure 5 (a) and (b): Online monitoring platform on the 'ThingsSpeak Server'

stringently provided 'Field gauge' analog needle meter type display.

4. Proposed Work: Planning to reduce the dependency of the deployed Solenoid valve towards the online Wifi enabled 'Nodemcu-relay' mechanism & trying to convert it to an 'Automatic Off Pressure mechanism', Back mechanism type. These types of valves are also known as 'Automatic Control Valves'. The hydraulic actuators will respond to changes in pressure or flow and will open/close the valve. Automatic Control Valves do not require an external power source, meaning that the fluid pressure is enough for opening and closing the valve. For the transmission & communication purposes for multiple tanks & to avoid ambiguity & reduce the costs we are planning to execute this work process via a minimum of a single control NODEMCU SOC & using the multiplexing concept to good effect with the 'SPI communication protocol'. SPI Interface uses four wires for communication. Hence it is also known as four-wire serial communication protocols. SPI is a full-duplex master-slave communication protocol. This means that

only a single master and a single slave can communicate on the interface bus at the same time. SPI enabled devices to work in two basic modes of SPI operation i.e. SPI Master Mode and SPI Slave Mode.

Master Device is responsible for initiation of communication. Master Device generates Serial Clock for synchronous data transfer. Master Device can handle multiple slave devices on the bus by selecting them one by one. Nodemcu based ESP8266 has Hardware SPI with four pins available for SPI communication. With this SPI interface, we can connect any SPI enabled device with NODEMCU and make communication possible with it. ESP8266 has SPI pins (SD1, CMD, SD0, CLK) which are exclusively used for Quad-SPI communication with flash memory on ESP-12E, hence, they can't be used for SPI applications. We can use the Hardware SPI interface for user-end applications. The below figure shows Quad SPI interface pins that are internally used for flash. It consists of quad i/o (4-bit data bus) i.e. four (SDIO_DATA0 – SDIO_DATA3) bidirectional (i/p and o/p) data signals with synchronizing clock (SDIO_CLK) and chip select pin (SDIO_CMD). It is mostly used to get more bandwidth/throughput than dual i/o (2-bit data bus) interface.

Figure 6: Nodemcu SPI Pins

MISO (Master In Slave Out): Master receives data and slave transmits data through this pin.

MOSI (Master Out Slave In): Master transmits data and slaves receive data through this pin.

SCLK (Serial Clock): Master generates this clock for the communication, which is used by the slave. The only master can initiate a serial clock.

CS (Chip Select): Master can select a slave device through this pin to start communication with it.

CONCLUSION

Water is a non-renewable important natural resource, and one of the most basic elements of needs for all living organisms. But many times this valuable resource is wasted due to unavoidable situations. By designing this project, the main goal of water wastage control and monitoring for Railway coaches using IoT is achieved. The design system will help to provide continuous water distribution in Railway coaches, thus monitoring the levels of water in each coach and also preventing the overflow of water as well as a shortage of water. This will help to avoid unreasonable time delay while filling water in the railway coaches.

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