

Survey on IoT Based Water Monitoring and Controlling System

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ABSTRACT: The Internet of Things (IoT) constitutes a network of devices connected to the internet. Nowadays Internet of Things (IoT) and Remote Sensing (RS) techniques are used in different areas of research for monitoring, collecting and analysis of data from remote locations. Water management is one of the widely used application which uses IoT to manage and monitor the water efficiently. .Water management involves water monitoring and controlling system for conservation. This paper focuses on various models for continuous and real time water monitoring system in IoT platform

KEYWORDS: IoT, Sensors, Raspberry, Arduino

I. INTRODUCTION

Internet of things is the emerging technology in today's world. IoT is a world where billions of objects can sense, communicate and share information; all interconnected over public or private Internet Protocol (IP)[6]. These interconnected objects have data regularly collected, analysed and used to initiate action for planning, management and decision making depending on the requirements[6]. Thus IoT is a network technology that monitor the status of physical objects, capture meaningful data, and communicate that data over a wireless network to a computer in the cloud for software to analyze in real time and help determine action steps. This technology uses microprocessor, sensors etc... The sensors senses the data and then the sensed data is processed by the microprocessor. The processed data gets uploaded in the cloud for the users to view in mobile phones/web sites.

One of the rapid influences of the IoT is in the field of water monitoring and controlling system. It is because, in the present era, water is considered as the most significant and scarce resource. The society faces numerous challenges in managing and conserving the water. Hence there is a need to preserve the water for the future by monitoring the water, so that the water resource can be used carefully. Thus the main objective of this paper is to describe the various means through which IoT enabled water monitoring and controlling system is achieved. .

The paper is organized in three sections and the first section gives the overall view of IoT which includes history of IoT, architecture of IoT and working of IoT. The next section explains the overview of the existing water monitoring and controlling system followed by conclusion.

II. INTERNET OF THINGS

The actual idea of connected devices had been around longer, at least since the 70s. Back then, the idea was often called "embedded internet" or "pervasive computing [14]. Since Internet was the hottest trend in 1990's, new technology RFID (Radio Frequency Identification) added to it, it is referred as 'Internet of things'. But it was not popular for 10 years. It gained its popularity in 2010 and thus now it has become the most popular topic in the IT technology.

The IoT consists of three layers, including the perception layer, the network layer, and the application layer as shown in Figure-1. The perception layer includes a group of Internet-enabled devices that are able to perceive, detect objects, gathers information, exchange information with other device through internet communication networks[13]. Examples will be sensors, RFID etc.. The role of the network layer is to forward data from the perception layer to the application layer under the constraints of devices' capabilities, network limitation and the applications[15]. IoT

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Vol. 6, Special Issue 11, September 2017

technologies such as zigBee , Bluetooth, Wi-Fi, 2G, 3G are used for this purpose. And the last layer is the application layer where the information is received and processed [15].

Perception Layer Wireless sensors-RFID-Cameras
Network Layer Gateways, ZigBee, Bluetooth, WiFi, 2G, 3G, 4G
Application Layer Smart homes, demand response, fault detection, smart cities

Figure- 1: IoT Layers

The 'Internet of Things' basically works as M2M (Machine to Machine) communication, in which physical objects or 'Things' function by interacting with each other. The user can assess, analyse and control the functioning of 'Things[16]'. They use built-in hardware and software to send and receive data via various communication protocols. It uses smartphones act as their gateway to connect to the Internet. They also often send data to cloud-computing servers where it's then analyzed.[16]

III. RELATED WORK

In 'Smart E-Agriculture using Internet of Things'[7], the water level sensor with Arduino is used to measure the water level of sand as shown in Figure 2 .Thus the water level is monitored and gets stored in Arduino microcontroller. So if there is any lack of water level in the soil, the microcontroller pump the water to the desired level using motor. The desired level is measured using sensors and the information about the state of the soil is send to the database thereby providing automatic motor detection. An alert message is also sent as a sms to the concerned authority by Global System for Mobile Communications (GSM) The results are viewed through Light Dependent Resistor(LDR).

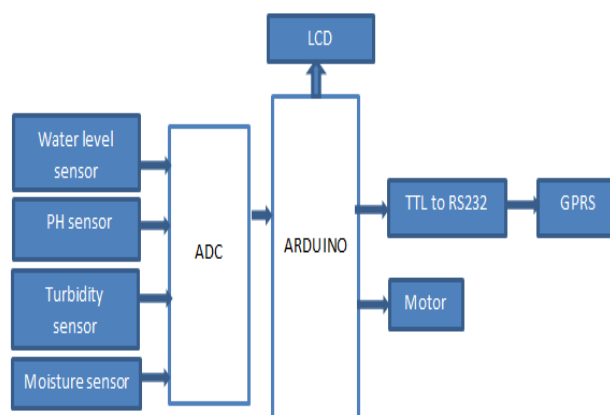


Figure- 2: Smart E-Agriculture using IoT

In 'IoT based Water Supply Monitoring and Controlling System with Theft Identification '[6], Raspberry pi, Arduino, level sensor, flow sensor, turbidity sensor, GSM module are used as shown in Figure 3. In this system, data is collected using several sensors in the Arduino. The water flow sensor with a plastic valve body and water rotor is used to monitor the water . A pinwheel sensor to measure how much liquid has moved through is also used. The turbidity sensor is used to measure the quality of water. Level sensors are used to get the information in 4 levels and define the level of water present in the overhead tank or sump. The Arduino is connected to raspberry to processes the data and push the data to cloud. GSM(Global System for Mobile Communications) is used to prompt a message in the

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absence of water or if there is abnormality or theft occurred in water supply line. Relays with solenoid valves in pipeline is used to provide automatic ON off control. 16*2 LCD is connected with a Raspberry pi which shows all the parameters readings. The logic is written using python programming. ADAFRUIT which is a free server for viewing data on to cloud is used so that even valves can also be controlled through it.

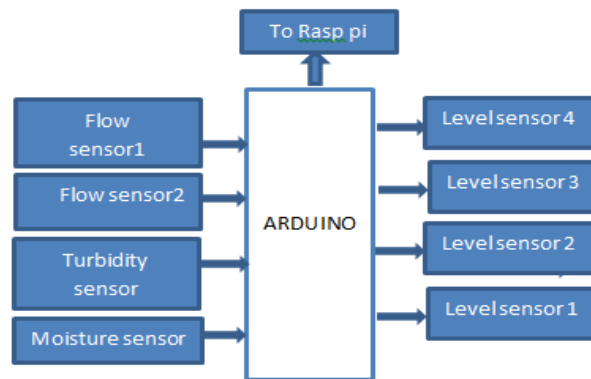


Figure- 3: IoT based water supply monitoring and controlling system

In Aquarius"- Smart IoT Technology for Water Level Monitoring System'[9], Ultrasonic sensors are used to find the level of the water in the tank in cm as shown in Figure 4. Raspberry pi will fetch sensor output from controller using its GPIO pins. It is then transformed into percentage and gets stored on a cloud using MQTT(Message Queue Telemetry Transport) technology. Then the web server by using HTML and XML in Android will formulate and represent the data in graphical format. The data is retrieved from cloud and displayed on LCD screen using smart phones (android applications)and websites.

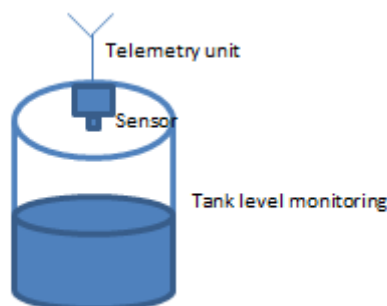


Figure- 4: Protoype of smart IoT technology for water monitoring system

Node.js server is used for web-hosting . The Node.js server constantly demands the Raspberry Pi to send the level, and on receiving the level-data it is mapped to the web user interface. Thus when website and/or Android app requests the Raspberry Pi to send the water-level , broker receives the request and forwards to Raspberry Pi. Then Raspberry Pi calculates the level and publishes the level data which is received by the broker first and then finally by website/android

In 'Internet of Things (IoT) Enabled Water Monitoring System'[3], a controller board based on the ATmega328P was deployed for the prototype design. Ultrasonic sensors are configured to determine the distance between the sensors and the water level in a tank. The sensor sends out the wave and reflected and transmits the data into LCD, display the distance in cm. A bespoke cloud server is deployed to host the water data analytics schema that manages the entire water monitoring system. The server collects the water monitoring data forwarded by the gateway and store in a database for analytics as well as displaying them in web-based dashboard. It is done based on 3 types

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indicators. It is in safe level if the distance measured is greater than 45.0cm. It is not in safe level between 35-45cm. And it is in danger level if less than 35cm..Both the danger and not safety will trigger the led and the buzzer alarm to indicate high water level. A Twitter handle is also incorporated as part of the alert system as shown in Figure 5.

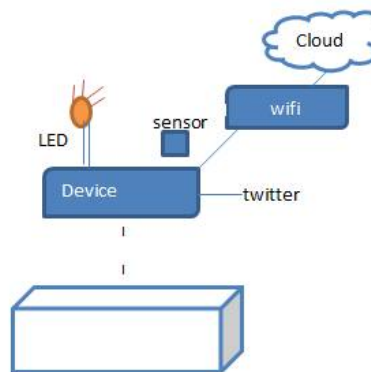


Figure- 5: IoT enabled water monitoring system

In 'IoT based Smart Irrigation and Tank Monitoring System'[10], water level is continuously monitored through mobile application with automatic off in water supply. And the water content of the soil is also measured thereby turning on the sprinklers automatically. It is all done using the Arduino board, sensors with Wi-Fi module ESP8266 connected to it as shown in Figure 6. Thus Arduino reads from the sensor and transmits the readings to the mobile application over the Internet.. The HC-SR04 ultrasonic sensor is used to measure the water level inside the tank. It is planted on top of the water tank. A floating pad is placed inside the tank which indicates the water level. LEDs glow till water level is below threshold value. LCD is used to display the water level. In case, if tank is full, the system is notified by the sensor thereby shutting down the supply of water automatically. And the data read by the sensors also get uploaded into the Blynk server which helps to view the data in Android device through the application. A warning notification is sent to the user and the LED glows when the difference between the height of the tank and the current water level is less than 10% of the total height of the tank.

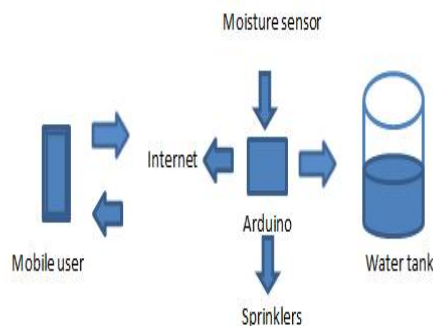


Figure- 6: IoT based smart irrigation and Tank monitoring system

In 'Agriculture Field Monitoring using Wireless Sensor Networks to improving Crop Production'[12], the greenhouse parameters like temperature, water level and humidity are monitored from the agriculture land and uploaded to server. The sensors are interfaced with the ARM7 Processors. The sensor values are continuously uploaded to the system using IoT gateway. The level indicator is used to measure the water level in irrigation land. In the water level sensor, value is measured by using scale level and it's represent in cm. If the water level reaches the bottom of the

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metal rod it indicates abnormal condition and the control will automatically turn ON, the motor. If the water reaches the certain level the motor can be turn OFF automatically. These statuses can be continuously updated to the system

In ‘Microcontroller Based Automated Water Level Sensing and Controlling:’[1], An 8 bit microcontroller, an inverter, a reserve tank , water tank and water pump are used. Water level sensor is used to control the water pump. Four water level sensors are used to measure the water level. Microcontroller takes the input of the inverted sensor data. MPLAB programming software is used . The display LED starts to become OFF one by one from the top to bottom with decrease in water level. Once when all the LEDs are OFF, it indicates that the tank becomes empty and the water pump is automatically ON. These operations are automatically performed as a cycle.

In ‘Liquid Level Monitoring System Using IoT’[8],leakage detection in the liquid transmission system is done using volumetric technique. Four leakage detectors are present in four different chambers which detect the leakage and send the information to the microcontroller with the help of zigBee transceiver. The microcontroller is also interfaced with the leakage detectors and GSM communication module. There are also four electric valves present for the respective four zones. As soon as the microcontroller gets the information of leakage, it will send electrical signal to the electric valve of respective zone. After getting the electrical signal from the microcontroller, the respective valve will be opened to allow the transmission of liquid to the reserved tank from the zone that has the leakage. Load sensor is also placed in the reserved tank to measure the volume of the transferred liquid so that the microcontroller sends the information regarding the quantity of liquid.

In ‘water level monitoring system in real time mode using WSN’[11], A microcontroller, water level sensor and a pair of Raspberry pi and DAS are used .Water level is detected using the sensors and is transmitted and received through Raspberry pi. DAS module which is attached to Raspberry pi transmits the sensor data .And on the other hand, Raspberry pi at the receiving side receives the sensed data. An integrated Light Emitting Diode (LED) is used for real time display of water level sensed data indicating different level of water. An alarm is also fired in the case of overflow and empty level of the water.

In IoT based water level monitoring system for smart village’[13], the system consists of Arduino with the Ethernet shield above it and the liquid level sensor connected to it. It uses Arduino software and carries thereby providing the user interface to register the devices. Arduino based sensor node uploads the data stream to carriers in JSON format .The data stream uploaded to carriers serves as the data source to the freeboard to visualize the sensor data in real time. Data source once configured allows freeboard to receive data from carriers and to visualize, the data stream widget is selected and configured .Widget is thus updated in real time as the water level changes.

In ‘ Low-Power Wireless Liquid Monitoring System Using Ultrasonic Sensors’[5], the system consists of base station which includes server for displaying changes on webpage, telemetry unit which includes microcontroller and the sensors ,GSM module inside the tank as shown in Figure 7. The microcontroller measures the amount of liquid inside the tank by using ultrasonic sensors. C programming is used. The power consumption in each of the low power consumption modes are used and are tested using n6715B DC power analyser to check the current drawn and hence low power wireless liquid monitoring system is designed.

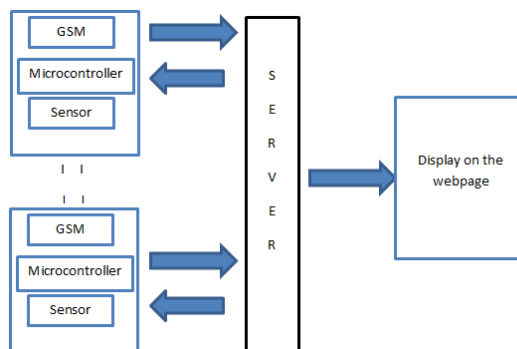


Figure- 7: Block diagram of low power wireless liquid monitoring system

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In ‘smart water monitoring system using wireless sensor network at home/office’[4], water level indicator and led light sensor are used in automatic water level sensing. And with the ph sensor, turbidity sensor, temperature sensor placed inside the tank, water quality parameters are monitored. All sensors are connected to the wireless network and so sensors send the report to the system through the network. And to monitor the water on the system , Mat tools are used. And pipe leakage detection is also done with the help of ultrasonic leak detector and FSR(Force Sensitive Resistor).The program to control the entire system is written by PIC16F84A assembly language and actions in GUI are done by mat lab software.

In ‘real time monitoring of water quality in IoT environment’[2], Raspberry pi B+ is used as the controller and to read the data, the sensors such as turbidity sensor ,ph sensor, dissolved oxygen sensor, conductivity sensor are attached to it as shown in Figure 8. Python is used as the programming language. Thus Raspberry pi sends the data to the IoT module which then sends the data to the internet using WI-FI and cloud computing to access in mobile. Thus the monitoring parameters are transmitted from sensors through IoT module to gateway which is then sent to the server. Thus the sensed data can be read anywhere in the world using separate IP address.

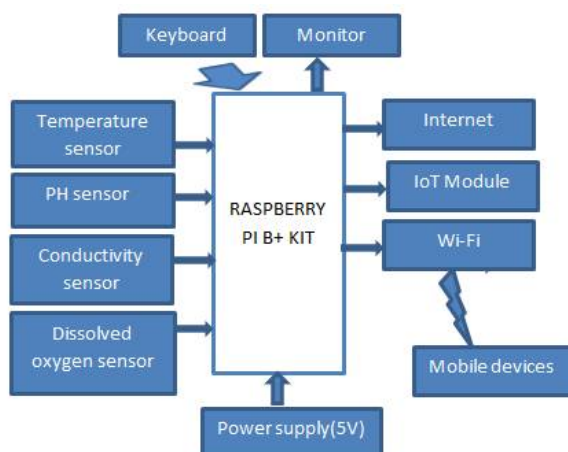


Figure- 8: Block diagram of real time monitoring of water quality

These different ways through which water can be monitored and controlled in different contexts using different hardware and software requirements are tabulated and is shown in Table 1.

Paper	Context	Microcontroller	Sensors	Display	Cloud server	Other Technologies
[7]	To measure the water level of the sand	Arduino	Water level sensor, PH sensor, Turbidity sensor, Moisture sensor	LDR	-	GPRS,GSM
[6]	To measure the water level of water in sump or tank with automatic on off control	Raspberry pi, Arduino	Level sensor, Flow sensor, Turbidity sensor	LCD	Adafruit	GSM, Relays as actuators

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[6]	To measure the water level of water in sump or tank with automatic on off control	Raspberry pi, Arduino	Level sensor, Flow sensor, Turbidity sensor	LCD	Adafruit	GSM, Relays as actuators
[9]	Monitor the water level remotely through website/app	Raspberry pi	-	LCD	Node.js	MQTT
[3]	To alert based on the water level	ATMEGA328P	Ultrasonic sensor	LCD	Bespoke cloud server	Twitter handle ,GSM
[10]	Create a mobile app that monitors the water level	Arduino	Ultrasonic sensor	LCD	Blynk server	LED Indicator
[12]	To measure the green house parameters to improve crop production	-	Water level sensor	-	-	WSN
[1]	To control water pump based on the water level	-	Water level sensor	-	-	LED
[8]	Leakage detection	-	Load sensor	-	-	ZigBee
[11]	Water level monitoring	Raspberry pi	Water level sensor	-	-	LED, GSM, DAS,WSN
[13]	Water level monitoring for smart village	Arduino	Liquid levels sensor	-	Carriots	-

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[6]	To measure the water level of water in sump or tank with automatic on off control	Raspberry pi, Arduino	Level sensor, Flow sensor, Turbidity sensor	LCD	Adafruit	GSM, Relays as actuators
[5]	To create low power wireless liquid monitoring system	-	Ultrasonic sensor	-	-	GSM, Dc power analyzer
[4]	Smart water monitoring in home/office	-	Water level sensor, Led, Light sensor, Turbidity sensor, Temperature sensor, PH sensor	-	-	FSR
[2]	Monitoring of water quality	Raspberry pi	Turbidity sensor, PH sensor, Conductivity sensor, Dissolved oxygen sensor	-	-	-

Table 1-Different implementation techniques used in IoT based water monitoring and controlling system

IV. CONCLUSION

A brief study on various water monitoring and controlling system using IoT technology is conducted. This study shows the importance of IoT in monitoring the water level and the various software and hardware involved in it. Since IoT is almost used in all the fields nowadays, the study shows the how to implement the system in various environments to control and monitor the level of water.

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ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

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