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# Smart Water Management System

Abstract

Water is one of the fundamental resources that aid life and there are speculations that estimate at 2025 almost half of the urban population will live under short supply and water stress. With the usage of new technological advancements in IoT (Internet of Things) powered smart devices for water management, it can become a worthy implementation towards avoiding the predicted water depletion. In the past years up until recently, water monitoring and management were manually carried out with intensive power requirements and high capital expense with low efficiency recorded. Overflow of water overhead tanks in residential, commercial, cooperate and educational settings, as well as broken pipes resulting in spillage, contribute to wastage at large. Regular reservoirs for water cannot monitor nor give analytics and automated water level detection in the tank. Vandalization or transmission blockages on distributions pipes may take so long to discover. The proposed model addresses problems mentioned above by the application of portable smart systems with interoperability and easily configurable to handle automated management of water supply with energy efficiency and a reduction in power cost in both homes and enterprise environment within smart cities as well as reduction of the rate of building degradation as a result of overflow from overhead tanks. Our model also integrates the application of Natural Language Processing for speech recognition as an alternate medium useful in operating the system.

Keywords

Internet of Things (IoT), Sensors, Smartphones, Transmitter, Wireless networks, Water management, Overhead tank.

## 1 Introduction

Overflowing tanks and reservoirs are arguably amongst the biggest cause of water wastage across urban and rural areas. Often time results from forgetful control of the pump switches and the absence of timely human presence to turn off the running motto when the overhead tank begins to overflow. Water which is one of the most important resources for daily existence [1][5] is fast depleting and falling in supply to meet the growing demand by rising population. Thus the need to proffer cost-effective smart automated systems for water management. A lot of buildings degrade over a short period due to consistent overflow of high rise tanks and reservoirs.

Other than the overall worries of freshwater shortage for a household reason, there are rising worries for the shortage of water for agrarian purposes [2, 3]. To handle the difficulties of water shortage, Smart water management and automation can greatly address the water crisis by eliminating endless running of pumping motors even after water tanks are filled to maximum.

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can enable automated water level detection and system controlled refilling of water storage tanks.

Incorporating a VL53L0X sensor module positioned at the topmost part inside the

reservoir
opposite the fluid level uses a laser-based time-of-flight (ToF) distance ranging technique. Invisible infrared laser rays are bounced from any surface thus measuring the time taken

for the
light to reach the detector. The values obtained from the sensor recordings at varying time intervals are transmitted to the cloud Ardafruit implementation.

A minimum threshold can be taken as V1 at time t1 and maximum water height defined

as V2 at
time t2, actualtime T taken to fill the tank when empty is determined by equation (1).

$T = V2t2 - V1t1$ (1)

In equation (2) the pump switch is activated Ai automatically when the water level in the tank
detected by the sensor is equal to V1.

$Ai = V1$ (2)

and deactivate Di in equation (3) when the water level equals V2.

$Di = V2$ (3)

Let the varying water level measured during fill up or usage time be n, thus Vnindicates the
current water level at time tn. Tank water level L in equation (4) at a particular time is

given by

$L = V2t2 - Vntn$ (4)

The values received from the laser sensor are communicated to the cloud platform from which
users can gain analytical insights of water status in the tank. The Adafruit dashboard

can also
indicate the pump status to users allowing for turn on/off of the pump remotely. Values received
from the sensor are transmitted to the pumping motor through the HC12 wireless

transmitter to
activate or deactivate the pump motor remotely. Power consumption is greatly reduced by using
automated switching dependent on the sensor values thus preventing the motor pump

from
running endlessly when the tank is filled to the defined maximum V2.

NodeMCU [11, 12, 13] which is useful for the deployment of IoT applications



connects the

system to cloud storage. The Adafruit cloud platform is a useful implementation for such a

This implementation ensures that water tanks and reservoirs do not overflow continuously thereby wasting this precious resource. It automates water refill into tanks as well for continuous water availability to users. In using the Adafruit cloud platform, users can gain analytics of average daily quantity use and time taken for the water tank to be filled when the lower configured limit is reached.

Leakage can be assumed as well by comparing [7] the expected fill-up time at any

given level

against the wait time to fill up if it exceeds outrageously then a leakage notification can be

prompted.

Conclusion and future scope

We proposed a flexible, economical, easily configurable portable system for water management and wastage reduction. The implementation described above can be expanded to smart agricultural processes of watering plants and gardens. In present days liquid level monitoring is essential in oil sectors, automotive, and many others. The proposed solution can automate the process of liquid detection and optimum management as well as use analytics with insights for detecting leakages, vandalism, or any form of damages along supply tracks. A high percentage of wastage can be greatly reduced and accurate billing reading for the used resource can be achieved. In the future, we look forward to integrating speech recognition using the Adafruit IO web interface. This will extend the remote activation or deactivation of the motor using voice commands.

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## 2 Literature Survey

In [26] the authors pointed out the lack of standardization of IoT devices to allow smooth interoperability amongst varying vendors. My proposed model combines low-cost and low- power hardware that interoperates seamlessly. An ultrasonic sensor was used by [27] for water level sensing with reliance on the sound bombarding the water surface from the sensor consisting of a speaker which generates ultrasonic sound waves and a mic to detect the resonance from the water surface; this approach is prone to erroneous reading as surrounding sound external to the tank could trigger the sensor reading. I proposed in this paper the use of a laser sensor which gives a more reliable water level sensing independent of the external environment of the overhead tank.

## 3. Proposed Work

Proposed in this paper is a description of the setup of a smart water management system using an IoT control console connected to a cloud management dashboard as illustrated in Fig.2 Showcasing IoT devices like water level indicator sensors, smart switch for the pumping motor hardware, wireless transceivers for device connectivity, and a management dashboard that can be accessed and controlled from a user's smartphone or PC. The dashboard shows real-time analytics on water level and usage metrics.

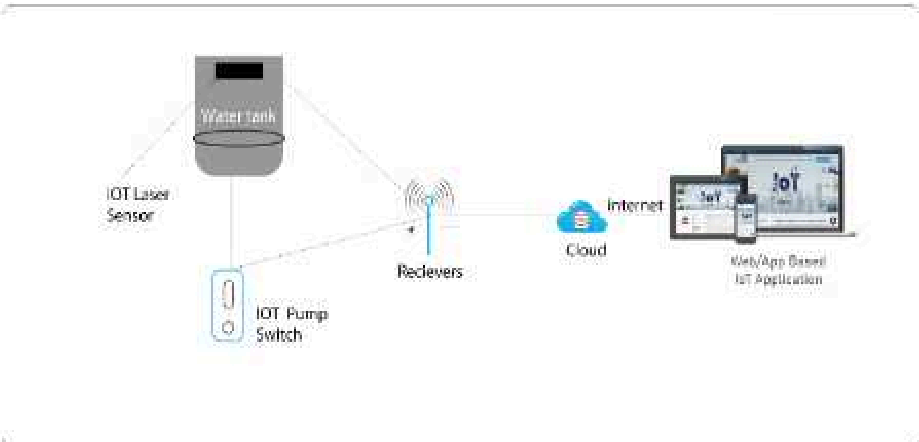


Fig.2 Block Diagram for Proposed Smart Water Management System

### 2.1 Hardware and Software Requirements

A laser sensor of VL53LOX for precise water level indication in storage tanks can be utilized. This type of sensor can sense the water level in real-time and with an attached HC12 transmitter for data transfer to the cloud platform.

Components within the transmitter can comprise of an Arduino and NodeMcu utilizing low power and transmitting data using any of the wireless technology such as Zigbee, Low Power Wide Area Networks (LPWANs), RFID or Wi-Fi / Wi-Fi HaLow. The use of such transmitters combined

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This smart management model is conceivable principally by constant observing of water level and quantity. [8] Constant water level observation can essentially decrease the wastage of water subject to flooding from tanks or reservoirs. The smart management framework [13, 14, 15, 16, 17] can likewise assist with identifying water spills in a savvy home by examining water levels during various hours of the day. A smart water management framework as such is a desperate requirement for the drive toward green IoT on our planet.

Several years ago, the high cost of implementing automated water management

systems led to

the low adoption of such technologies. Lately, with the advent of the Internet of Things (IoT) for

smart urban areas [4], the expense has decreased altogether. Web 2.0 and [6] the

development of

low-powered smart devices at relatively low prices has made associated gadgets with the capacity to exchange information accessible to just anyone.

Fig.1 presents an outline of functionalities obtainable with IoT based water management

system.

It, by and large, indicate tank state sensing capability using sensors [9, 10], the ability of smart

meters useful in measuring usage over time, real-time analysis is also a notable function obtainable in smart water management, spillage or hardware damage can also be detected as well

as remotely controlling the pumping motto through a web interface or automated

switching of

the motor based on water level [18, 19, 20, 21, 22, 23, 24, 25]. Smart valves for schedule irrigation is another exciting functionality possible with automated water management.

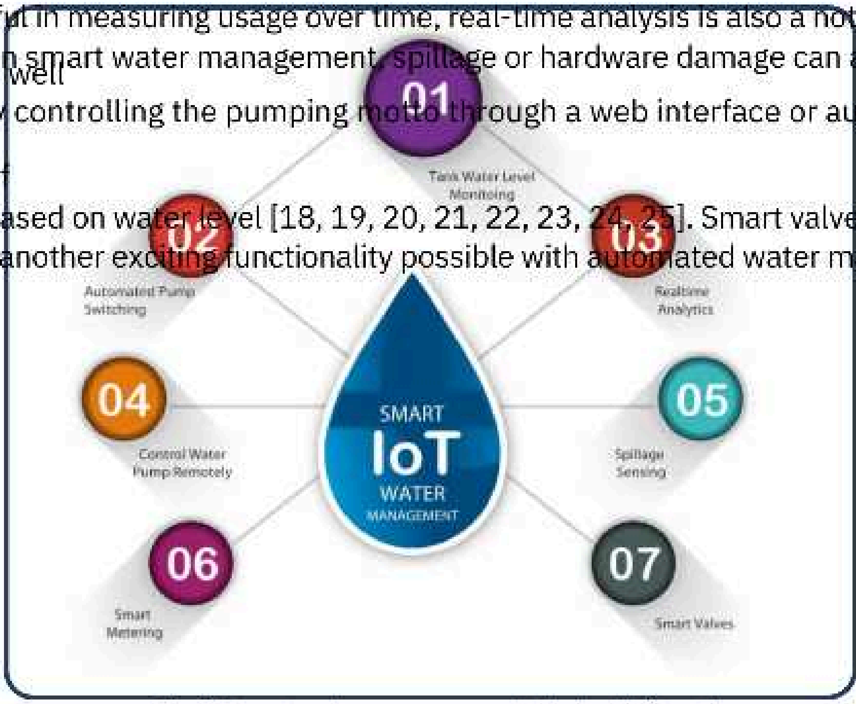



Fig.1 Smart water management obtainable functions

This process is done using two algorithms they are random Forest and SVM (Support Vector Machine) which is written in python programming language. The processed image is sent to theuser as a notification message

through the android application. Figure 5, represents image processing which is done by raspberry pi. **VI.**

## RESULTS

An android application is developed for user visualization. A user gets notified with alert messages about water presence in storage tank and overhead tank. User is also notified with quality of water as well as images of storage tank can be viewed. Based on these images user can take any action. User has full control of toggling motor on/off. Motor is automated when tank is empty or overflow. Some of the snapshots of android application of our proposed system are shown in the following figures


Fig 6 Android application (Status ON)

Existing System,water level monitoring andautomatic water control through sensor technology.Previously people were notified by message throughGSM module about water flow status but people were not able to know the status of inner view of the storage tankand to check the quality of water, it only notifies the on andoff status of the tank. The disadvantages here are: noreal time data monitoring, no waterflow control enabled from outside of home and water quality checking is neglected. In present system the web application developed does not support the user interactions. Few systems were not applicable for tank with depth more than 10m. More energy consuming and time consuming is the major problem faced here. Only water level was monitored but quality of water was not monitored. Design and implementation are complicated and more expensive. In Proposed System, water monitoringsystem with sensors. A sensor is a hardware device that produces ameasurable response with respect to a change in physicalconditions. The continual analog signal sensed by thesensors is digitized by an analog-to-digital converter andsent to the embedded processor for further processing. Themodel is consisting of different sensors like Water levelsensor, Pi sensor and PH sensor. Initially the Node MCUconnects to the internet through Wi-Fi, which helps insending the notification to the user. When the connectionis established it starts reading the parameters of sensors. The threshold levels for the required sensors areset previously as per the user

requirement. The sensed data is sent to the webserver and stored in the server. **IV. DESIGN**

The designed system is used for water monitoring and checking the quality of water. Initially, sensor in the base tank checks for the presence of water. In the presence of water, pump starts automatically and it starts pumping water to overhead tank. Over head tank is monitored for different water levels. Once the water reaches the threshold specified, it notifies the user. If the water level reaches the maximum threshold, pump stops automatically. If water is flowing continuously than the expected time then it will be detected by water flow sensor and data will go to IOT server.

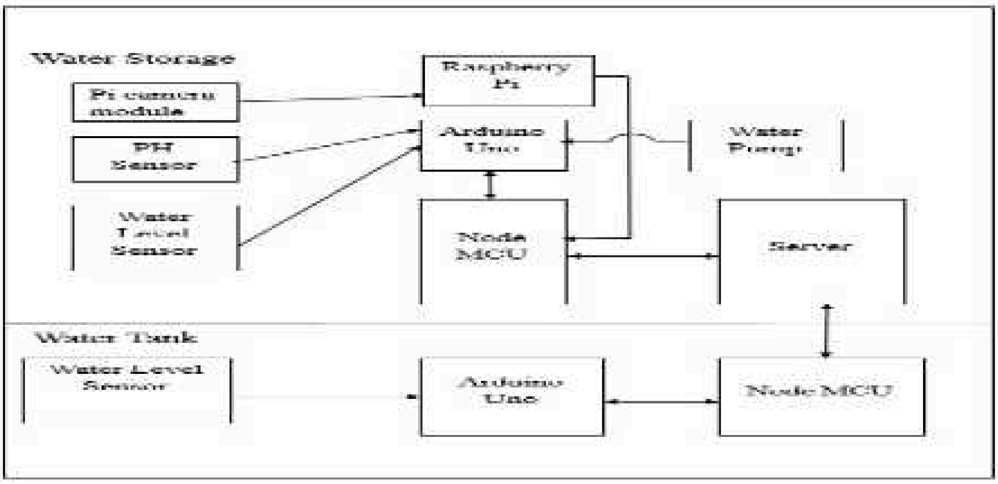



Fig 1. System Architecture

User can see the real time data in IOT server and in this condition one notification will be sent to mobile App from IOT server. If the water PH level or dirt level is not good then the water will not be pumped into the tank. User can control water flow through mobile app by interacting with the server.

# SMART WATER MANAGEMENT SYSTEM

In present world all of us are facing global warming crisis of water. Main causesfor these issues are growing population, improper management of water utilization. This problem is quietly related to poor allocation, inefficient use and lack of adequate water management system. Therefore, the efficient use of andmonitoring the same is essential for home, office etc. In this paper, anandroid application is developed that wouldmonitor the level of water in the cistern or any storage tank and automatically turns the motor on/off based on user requirement.This project can be implemented in any storage medium like well, cistern, etc.The purity of the water is measured using various sensors.Major advantage ofour system is that it detects any obstacles/solid particle present inside the storage tank. The obstacle or any object if found on the surface of water or even in sink, the image of the obstacle gets captured by the pi camera and image of the object will be sent to android application.By seeing these images user can take action. An alert message about water level as well as quality of water is sent to – IoT (Internet of Things), Android Application, Image Processing. **I. INTRODUCTION**

Internet of Things is a network of computing devices which are able to collect and exchange the data. Sustainability of available water resourceproblem is related to poor water allocation, inefficient use, and lack of water management is a dominant issue. Water is used for agriculture, industry, and domestic consumption. Therefore, efficient use and water monitoring are potential constraint for home or office. Measuring water level is an essential task for government and residency. It is possible to track the implementation and usage of such initiatives with integration of various controlling activities. Therefore, water controlling system implementation makes potential significance in home applications. The main objective is to overcome water supply related problems and make system efficient. And there is need of proper monitoring and controlling system. In this project, we are focusing on continuous and real time monitoring of water supply in IOT platform. Water supply with continuous monitoring makes a proper distribution so that, we can have a record of available amount of water in tanks, flow rate,

ab

Checks water level in overhead tank. If there is not enough water in overhead tank, water starts filling in the tank from the sump through switching on the motor. As well as when tank is full, motor is switched off. Motor turns on/off automatically through android app. Figure 3, represents how information passed between storage tank and overhead tank.

Table 1 Proposed working of motor

| No | Condition of water level | Motor status |
|---|---|---|
| 1 | If water level in storage tank is minimum | Automatic off |
| 2 | If water level in overhead tank is maximum | Automatic off |
| 3 | If water reaches any of the level in overhead tank | Motor can be controlled by user |
| 4 | If water in overhead is tank empty | Motor is switch on still level 1 |
| 5 | If any objects present in storage tank | Images sent to user by android app. |

Conditions of the water levels and what actions are taken are given in Table 1. **B. Water quality**

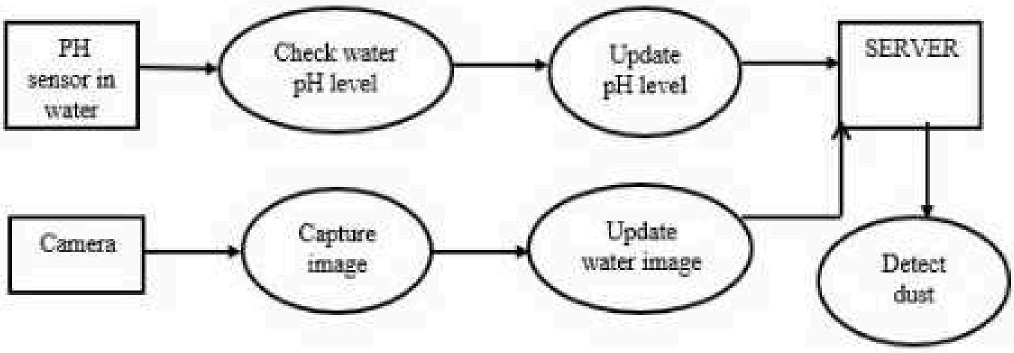



Fig 4 Checking Water Quality

pH sensor is placed in tank to check the purity of water. pH values are updated in server which is in turn updated in the android application. Image processing is also done in sump by using Raspberry Pi. Any solid particle present in water is detected through capturing images. The pH values whether it is pure or impure and the image that is been processed is sent to user android application. Figure 4, represents how quality of water is maintained. **C. Image processi**

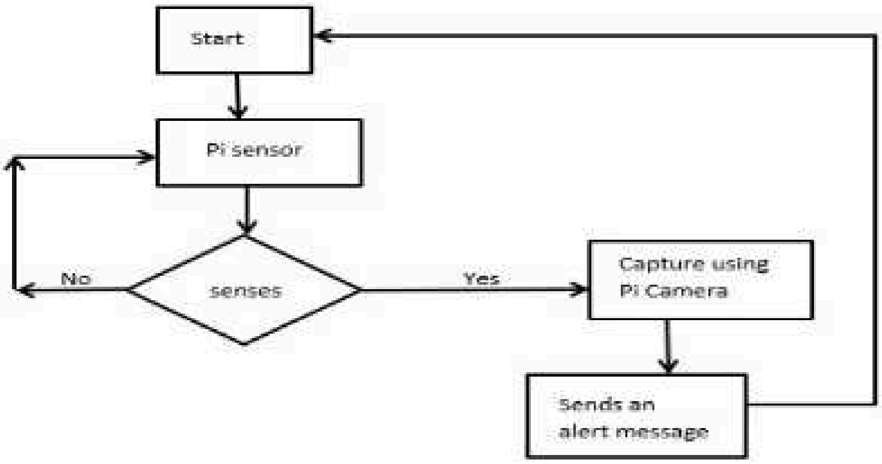



Fig 5 Image Processing

Pi sensor senses the solid particle if it is found inside the storage tank and sends signal to Pi camera. Pi camera is connected to raspberry Pi board. Pi camera captures the images and sends to the raspberry pi server to process the image. For processing the image through three steps first it resizes the image, trains the image and finally it tests the image to notify whether solid particles present.

Overall design i.e .System architecture is represented in Figure 1, which provides information of about how the components are interconnected and how components interact with each other. Sensors are placed in storage tank and overhead tank. In overhead tank three sensors are placed indicating levels of water along with thesesensorspH sensor is also placed for checking purity. Any impurities present in storage tank are detected by using image processing concept. Pi camera module will capture the images and sends to server. Server willprocess the image and determines the status as either pure water or dirty water and then sends to the user android/mobile application. It also notifies the same to the user. The water from the water tank and in sump is monitored through android application via server connection.Presence of impuritiesin storage tank is detected by using image processing concept with Pi camera module. The workflow of the system is shown in Figure 2.

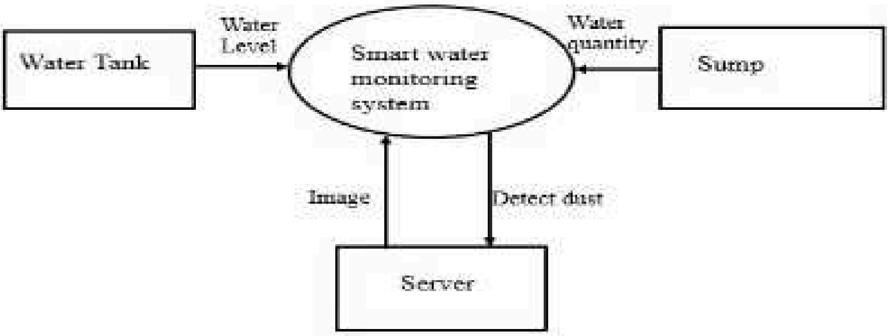
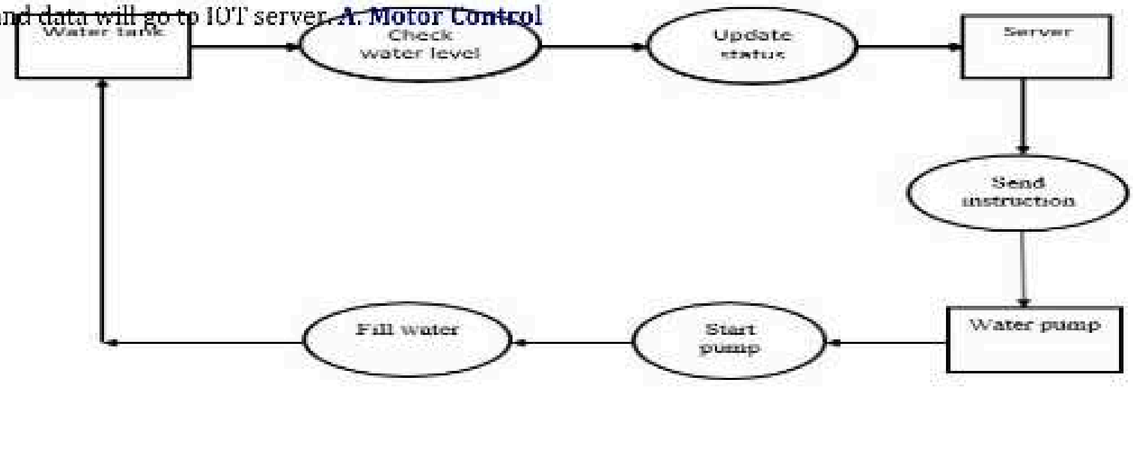



Fig 2 System Workflow **V. METHODOLOGY & IMPLEMENTATION**

Majority of the water wastage takes place because of overflowing water tanks. In most of thecases, water tanks are manually controlled by an operator. In absence of the person, waterkeeps on overflowing until the motor is switched off. Therefore, smart water tank system is used forwater monitoring and checking the quality of water. In storage tank and overhead tank, water level sensors are placed. Sensor in overheadtank is used to detect presence of water. If there is no water present in storage tank the motorautomatically stops. If water is detected, water is sent to overhead tank based on userrequirement. pH sensor is also inserted to check the quality of water. In overhead tank, three sensors are placed indicating three levels in the tank. If waterreaches the top of tank, motor turns off automatically. If water presence is detected in any ofthe sensors, motor turns on/off based on user requirement. An android application is developed for user interface. In storage tank image processing is done by using raspberry pi. On top of storage tankpi camera is placed. If any object found inside the storage tank pi camera is used to takeimages. pi camera is also been interfaced with the raspberry pi kit. All the automation is programmed such that the system will run automatically as programmed.Image processing is done using python. All the sensors are interfaced with Arduinoboard and programming is done in Arduino software. The Node MCU board connects to theinternet through Wi-Fi. When connection is established it will start reading the parameters of sensors. The threshold levels for the required sensors are set to some values. The sensor data are sent to the web server and stored in the server. If water is flowing continuously than theexpected time then it will be detected by water flow

sensor and data will go to IOT server. **A. Motor Control**



commands.

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and deactivate Di in equation (3) when the water level equals V2.

$Di = V2$ (3)

Let the varying water level measured during fill up or usage time be n, thus Vnindicates the current water level at time tn. Tank water level L in equation (4) at a particular time is given by

$L = V2t2 - Vntn$ (4)

The values received from the laser sensor are communicated to the cloud platform from which users can gain analytical insights of water status in the tank. The Adafruit dashboard can also indicate the pump status to users allowing for turn on/off of the pump remotely. Values received from the sensor are transmitted to the pumping motor through the HC12 wireless transmitter to activate or deactivate the pump motor remotely. Power consumption is greatly reduced by using automated switching dependent on the sensor values thus preventing the motor pump from running endlessly when the tank is filled to the defined maximum V2.

NodeMCU [11, 12, 13] which is useful for the deployment of IoT applications



connects the system to cloud storage. The Adafruit cloud platform is a useful implementation for such a

This implementation ensures that water tanks and reservoirs do not overflow continuously thereby wasting this precious resource. It automates water refill into tanks as well for continuous water availability to users. In using the Adafruit cloud platform, users can gain analytics of average daily quantity use and time taken for the water tank to be filled when the lower configured limit is reached.

Leakage can be assumed as well by comparing [7] the expected fill-up time at any given level against the wait time to fill up if it exceeds outrageously then a leakage notification can be prompted.

## 3 Conclusion and future scope

We proposed a flexible, economical, easily configurable portable system for water management and wastage reduction. The implementation described above can be expanded to smart agricultural processes of watering plants and gardens. In present days liquid level monitoring is essential in oil sectors, automotive, and many others. The proposed solution can automate the process of liquid detection and optimum management as well as use analytics with insights for detecting leakages, vandalism, or any form of damages along supply tracks. A high percentage of wastage can be greatly reduced and accurate billing reading for the used resource can be achieved. In the future, we look forward to integrating speech recognition using the Adafruit IO web interface. This will extend the remote activation or deactivation of the motor using voice commands.

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capacity to exchange information accessible to just anyone.

Fig.1 presents an outline of functionalities obtainable with IoT based water management system.

It, by and large, indicate tank state sensing capability using sensors [9, 10], the ability of smart meters useful in measuring usage over time, real-time analysis is also a notable function obtainable in smart water management, spillage or hardware damage can also be detected as well as remotely controlling the pumping motto through a web interface or automated switching of the motor based on water level [18, 19, 20, 21, 22, 23, 24, 25]. Smart valves for schedule irrigation is another exciting functionality possible with automated water management.

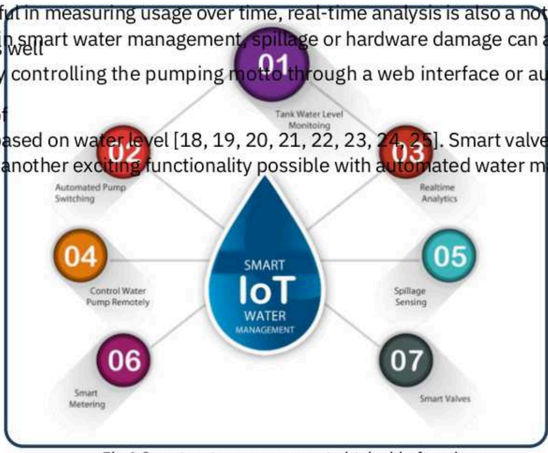

Fig.1 Smart water management obtainable functions



2 Literature Survey

In [26] the authors pointed out the lack of standardization of IoT devices to allow smooth interoperability amongst varying vendors. My proposed model combines low-cost and low- power hardware that interoperates seamlessly. An ultrasonic sensor was used by [27] for water level sensing with reliance on the sound bombarding the water surface from the sensor consisting of a speaker which generates ultrasonic sound waves and a mic to detect the resonance from the water surface; this approach is prone to erroneous reading as surrounding sound external to the tank could trigger the sensor reading. I proposed in this paper the use of a laser sensor which gives a more reliable water level sensing independent of the external environment of the overhead tank.

3. Proposed Work

Proposed in this paper is a description of the setup of a smart water management system using an IoT control console connected to a cloud management dashboard as illustrated in Fig.2 Showcasing IoT devices like water level indicator sensors, smart switch for the pumping motor hardware, wireless transceivers for device connectivity, and a management dashboard that can be accessed and controlled from a user's smartphone or PC. The dashboard shows real-time analytics on water level and usage metrics.

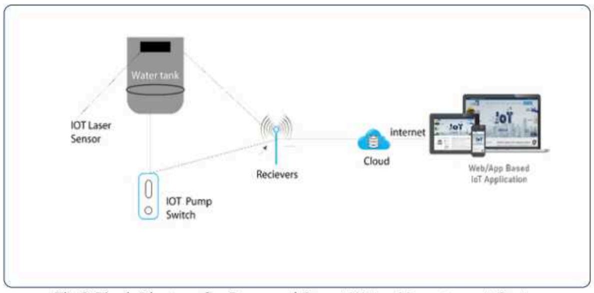

Fig.2 Block Diagram for Proposed Smart Water Management System

2.1 Hardware and Software Requirements

A laser sensor of VL53LOX for precise water level indication in storage tanks can be utilized. This type of sensor can sense the water level in real-time and with an attached HC12 transmitter for data transfer to the cloud platform.

Components within the transmitter can comprise of an Arduino and NodeMcu utilizing low power and transmitting data using any of the wireless technology such as Zigbee, Low Power Wide Area Networks (LPWANs), RFID or Wi-Fi / Wi-Fi HaLow. The use of such transmitters combined



can enable automated water level detection and system controlled refilling of water

# Smart Water Management System

Abstract

Water is one of the fundamental resources that aid life and there are speculations that estimate at 2025 almost half of the urban population will live under short supply and water stress. With the usage of new technological advancements in IoT (Internet of Things) powered smart devices for water management, it can become a worthy implementation towards avoiding the predicted water depletion. In the past years up until recently, water monitoring and management were manually carried out with intensive power requirements and high capital expense with low efficiency recorded. Overflow of water overhead tanks in residential, commercial, cooperate and educational settings, as well as broken pipes resulting in spillage, contribute to wastage at large. Regular reservoirs for water cannot monitor nor give analytics and automated water level detection in the tank. Vandalization or transmission blockages on distributions pipes may take so long to discover. The proposed model addresses problems mentioned above by the application of portable smart systems with interoperability and easily configurable to handle automated management of water supply with energy efficiency and a reduction in power cost in both homes and enterprise environment within smart cities as well as reduction of the rate of building degradation as a result of overflow from overhead tanks. Our model also integrates the application of Natural Language Processing for speech recognition as an alternate medium useful in operating the system.

Keywords

Internet of Things (IoT), Sensors, Smartphones, Transmitter, Wireless networks, Water management, Overhead tank.

## 1 Introduction

Overflowing tanks and reservoirs are arguably amongst the biggest cause of water wastage across urban and rural areas. Often time results from forgetful control of the pump switches and the absence of timely human presence to turn off the running motto when the overhead tank begins to overflow. Water which is one of the most important resources for daily existence [1][5] is fast depleting and falling in supply to meet the growing demand by rising population. Thus the need to proffer cost-effective smart automated systems for water management. A lot of buildings degrade over a short period due to consistent overflow of high rise tanks and reservoirs.

Other than the overall worries of freshwater shortage for a household reason, there are rising worries for the shortage of water for agrarian purposes [2, 3]. To handle the difficulties of water shortage, Smart water management and automation can greatly address the water crisis by eliminating endless running of pumping motors even after water tanks are filled to maximum.



This smart management model is conceivable principally by constant observing of water level and quantity. [8] Constant water level observation can essentially decrease the wastage of water subject to flooding from tanks or reservoirs. The smart management framework [13, 14, 15, 16, 17] can likewise assist with identifying water spills in a savvy home by examining water levels during various hours of the day. A smart water management framework as such is a desperate requirement for the drive toward green IoT on our planet.

Several years ago, the high cost of implementing automated water management

systems led to

the low adoption of such technologies. Lately, with the advent of the Internet of Things (IoT) for

smart urban areas [4], the expense has decreased altogether. Web 2.0 and [6] the

development of

low-powered smart devices at relatively low prices has made associated gadgets with the capacity to exchange information accessible to just anyone.

Fig.1 presents an outline of functionalities obtainable with IoT based water management

system.

It, by and large, indicate tank state sensing capability using sensors [9, 10], the ability