WATER LEVEL DETECTION OF WATER TANK BASED ON SMARTPHONE USING INTERNET OF THINGS (IOT)

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Abstract

Water level measurements could also be a broader area of research where there are numerous manual methods and having smart sensors but applicable for tanks or for process industry only. The open area contains water is measured using visual methods with regard to ground. The water level in river is measured because the peak of water from its ground. The image processing is developed with some algorithm to measure physical dimensions of objects, this technique we are becoming to use for level measurements of river water. The bridge pillar are getting to be used as measurement background and thus the camera are getting to be installed beneath the road on bridge. This camera will capture the pillar image and using the algorithm the height are getting to be calculated. Before the prediction of results the calibration are getting to be done by measuring original height and assigning the price on image captured. the height of river water are often used to predict flood and should be use to predict water in several seasons. The rain fall and also we'll predict the damn release water. The water level value is then sent on ThingSpeak which can be a cloud storage as internet of things platform. By logins in to ThingSpeak we can check water level of any river at anywhere, giving enhanced water monitoring system or connected network to reinforce river network.

Keywords: bridge, camera, height of water, measurements, River, sensors, thing speak.

I. Introduction

The monitoring water level within the river or within the reservoir is critical within the applications associated with agriculture, flood prevention, and fishing industry, etc. The schemes developed for measuring water level are often categorized as four types supported the measuring features: pressure, supersonic waves, heat, and image.

The most popular methods use the concepts of pressure and supersonic waves. Since pressure which is force per unit area represented by a product of mass and acceleration of gravity of water can show the number of water over unit area, and it are often directly transformed to water level [1]. Although pressure sensor is straightforward to use, it's a limitation that it should be calibrated and replaced frequently due to possible breakdown by continuous water pressure. Supersonic wave sensor is contactless from water pressure because it measures the echo time of supersonic wave pulse from emitter to receiver reflected from water surface [2]. Since it doesn't contact water directly, its lifespan is more as compared to other sensor. However, supersonic wave sensor value is affected due to shortcoming of returning wave when temperature fluctuated between high and low value, during heavy rain or snowfall, or when water fluctuates very rapidly.

The principle of measuring heat is to use the characteristic of solids. If solid and fluid that has lower temperature are in contact, it’s temperature goes down. Since the data values of temperature drop of a solid is proportional to its contact area with fluid, during this case, the depth information of a solid during a water are often calculated from it’s natural action [3]. this type of measurement system features a plus of getting a brief lived lifespan, but it's as many disadvantages that it should be insulated and thus the temperature of the solid must be controlled at measurement area. because of these problems, heat type sensors are used for restricted applications a bit like the measurement of cooling water level in nuclear plants.

Use of image sensor for measuring water level is that the foremost up-to-date approach. Different from other forms of sensors, it can provide the encircling information round the sensor also because the water level so as that the measured data are often confirmed. It also features a plus that it's unaffected by weather [4]. Although this type of sensor has most prominent features in measurement of water level and control , it's several disadvantages; that its price is higher compared to other types. Moreover, it needs an outsized and secured space to put in data, and capacity to transmit large data size. That is, a real-time data transmission isn't guaranteed if a broadband channel isn't reserved [5]. Another problem of this sort of sensor is that the measurement accuracy is suffering from lighting conditions and minimum light is required during night.

For utilizing the advantages of image sensor in measuring water level by minimizing the aforementioned disadvantages, this paper proposes a foothold based water level detection scheme and a picture transmission technique using the JPEG of difference image.

The proposed system has been implemented and should be installed in River, in India for experimental evaluation. The measured data and image are often received at a far off station apart from the world. The performance is often evaluated by the experiments performed for particular time, throughout day and night.

II. Literature survey

Over the years, digital image processing has been a struggle for many programmers . This is because of several important reasons: First, digital image processing appeared late within the production of computers and thus, the necessity for computers which will support graphical operating systems arose. Second, it requires a cautious optimization for real-time applications (Patin, 2003). But because the years passed, different algorithms were introduced and therefore the use of digital image processing became more recognized within the development of recent technologies. Its applications surpass some simple practice; it can now be applied in television, security, movies, medical imagery, etc.

Another application of digital image processing are often seen in water level monitoring. Ken Chapman (2009) said," A universal solution to a category of problems could also be very desirable, but is usually impossible ."Due to known and unknown problems which will arise when using digital image processing, programmers using such technology are still during a struggle. One of the issues which will arise in determining the water edge is that the presence of waves disturbing the consistency of water edge. Methods like threshold and hyperbolic tangent function are utilized in wave detection. According to Hwung, Kuo, and Chien (2009), hyperbolic tangent function algorithm is best than threshold method algorithm after comparing each result with the measurement of the wave gauge. This is extremely helpful in continuous monitoring reservoir or artificial container located in an open area where waves are present. In Park's (2009) study shows, another algorithm were introduces accumulated histogram where it detects level changes, whether small or large, between previous and current images. Because of this, the algorithm is in a position to separate water and land. The physical and actual water level can be achieved by converting the image water value through the accumulated histogram algorithm with band pass filter. In Varonen's (2008) conference, water level data are transferred and therefore the validity of knowledge is checked to watch real time. Data is sent in simple data message.

There are other methods utilized in measuring water level. These methods are often generalized in two categories: contact and non-contact methods. Those methods that require contact with water belong to contact methods like electric depth gage or electric sounder, wetted tape and air line (Trimmer, 1991). These methods are more accurate and have less possibility of error but are difficult to use . Unlike contact methods, non-contact methods like digital image processing employing a simple camera are quite easy to utilize. However, it's susceptible to error in accuracy and processing.

III. Problem definition

Monitoring of surface water level are often administered by different methods. Floaters, Pressure sensors, , radar sensors and ultrasonic sensor techniques are a number of the foremost applied methods providing accurate and reliable data acquisition for water level measurement. A disadvantage of those methods is that the regular visual inspection of the location required thanks to environmental changes. The optical water level measurement may be a new method for this purpose, which has been investigated more widely within the recent years. There is no any access directly available to remotely monitor the water level and also continuously.

Technology

a. Internet of Things

Internet of Things is a technology wherein the devices get connected to internet. The connected devices likewise communicate either among one another or with the people. Finally they provide the sensed data to the cloud. The data can bring out an insight to the info Therefore, the smart connected devices find applications in health monitoring, home automation, predictive analysis, industrial monitoring to call a couple of . The smart devices are connected to the data aggregator i.e., the cloud.

b. ThingSpeak support toolbox in Matlab

ThingSpeak is a web service hosted by MathWorks to collect, analyzes and act on sensor data, and develop Internet of Things applications easily. The ThingSpeak Support Toolbox uses MATLAB to read data from ThingSpeak and write data to ThingSpeak platform. It also provides functions to visualize and access data stored on ThingSpeak.com as shown in figure 1. The ThingSpeak Support Toolbox has the functions: thingSpeakRead – Read data stored in ThingSpeak channel ThingSpeak Write- Write data to a ThingSpeak channel url Filter- Scrape numbers from web page ThingSpeakRead syntax and description [data,timestamps,chInfo] = thingSpeakRead(chId) thingSpeakRead(chId) reads the most recent data from all fields

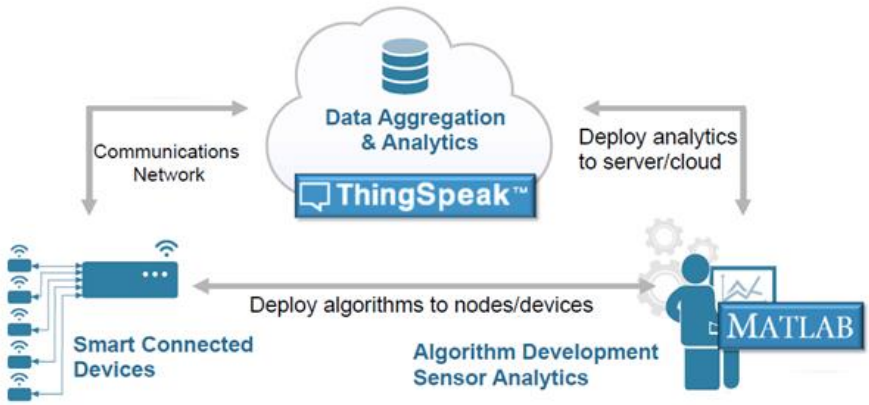

Figure 1. ThingSpeak with MATLAB and smart devices network

of the specified public channel on ThingSpeak.com and returns the data, times-tamp, and channel information. This will fetch the channel data that is the sensor values from Thingspeak.

[data,timestamps,chInfo] = thingSpeakRead (chId,Name,Value)

thingSpeakRead command with variables (chId,Name,Value) uses additional options specified by one or more Name, Value pair arguments. The sensors data is fetched with the time stamp which requires the specific channel ID of patient account. the fetched data comes in tabular form which practically shown in result.

c. Computer vision

"MATLAB It is a application-oriented language and interactive environment for computer computation, visualization, and programming. Image Processing Toolbox is an application available to be used in MATLAB, which provides a comprehensive set of reference-standard algorithms, functions, and apps for image processing, analysis, visualization, and a algorithm development stage." Using these tools provides a quick and convenient Methods to process and analyze images without the necessity for advanced knowledge of A very complex coding language.

Mathematical formulas and calculations with example

1. Object size measurement

This is done in two parts. The first part consists of taking visual information of the thing . We are employing a camera To acquire images and that we would use various image processing techniques to extract the thing from the image. The second part consists of taking the range information of the thing . We are using an ultrasonic sensor for this job.

For a hard and fast field of view in figure 2, the horizontal and vertical distance the camera can see is constant at a specific distance. If the angle of vision is understood , then we will find The value of area if We wanted to evaluate the distance.

x = distance between camera and object.

h = horizontal viewing length perpendicular to x on a 2D plane.

Θ = horizontal field of view

$$h = 2x \tan(\frac{\theta}{2})$$

…….. (01)

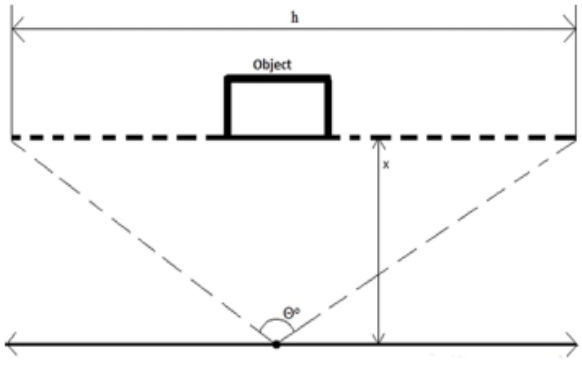

Figure 2: Field of view

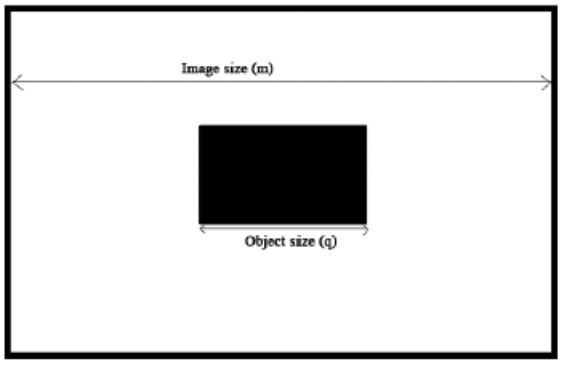

Figure 3: The image captured by the camera

This distance h is squeezed into the image. If the image is m x n pixels in size, m is the horizontal pixels and n is the vertical pixels. The camera can horizontally see as far h in reality. In the image h is represented as m as shown in figure 3.

If an object is present at distance x, and the horizontal length of the object is p in real life, in the image it takes up q pixels. As because, there exist a geometric similarity between the image and the real life scene, the ratio of object length in the image is equivalent to image length. Since we can calculate the values of q, m, h we can also calculate the value of p. If,

q = object length in image

m = image length

p = is the object length in real life, and

h = is the horizontal distance

then,

$$\frac{q}{m} = \frac{p}{h} \quad \text{…….. (2)}$$

hence,

$$p = \frac{hq}{m}$$

For vertical measurements, we use the same procedure with different values; the angle of vision becomes (alpha, α). The equation for vertical distance is:

$$v = 2x \tan\left(\frac{\alpha}{2}\right) \quad \text{…… (3)}$$

The similarity equation becomes:

$$\frac{s}{n} = \frac{t}{v} \quad \text{… … … (4)}$$

Where s is the vertical height of the object image in terms of pixel and t is the vertical length of the object in real life.

IV. Proposed system

In the proposed architecture includes:

Acquisition: Digital imaging or digital image acquisition is the techniques of creation photographic images, like of a physical scene same as the structure of an object. The term is usually assumed to imply or include the processing, compression, storage, printing, and display of such images. One of the sorts of image acquisition in image processing is understood as real-time image acquisition.

Pre-processing: Image Pre-processing means removing low frequency noise available in background, normalizing the intensity value of the individual particles images, removing the reflection and masking few portions of images. Image pre-processing is that the technique of enhancing data images before computational processing.

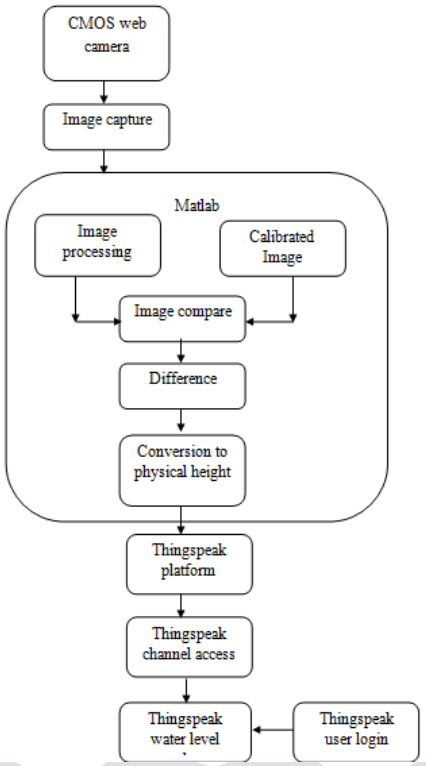

Figure-4. Architecture of proposed system

Image Segmentation/ Thresholding:

Image segmentation is that the process of partitioning a digital image into multiple segments. The purpose of the segmentation is to change the representation of an image into more meaningful and easier to analyze. Image segmentation is usually wont to locate objects and limits (lines, curves, etc.) in images.

Geometrical parameters measurement:

Measurement of geometrical parameters includes the measurement of length, centroid, arrow orientation and area of arrow using the MATLAB commands.

Calibration for water level measurement:

Measurement of water level is calibrated from the world of arrow image captured by camera. The area calculated is in terms of pixel. When the world of arrow is little water level is low, similarly when the world of arrow is large it determine that water level is high.

ThingSpeak provides platform as an open source for Internet of Things (IoT) application and API to store the data and retrieve stored data by using HTTP protocols via the available web or Local Area Network. ThingSpeak enables the creation of sensor accessibility applications, location tracking applications, and a multimedia network with status updates. The water level will be displayed over Thingspeak channel.

Algorithm with flow chart

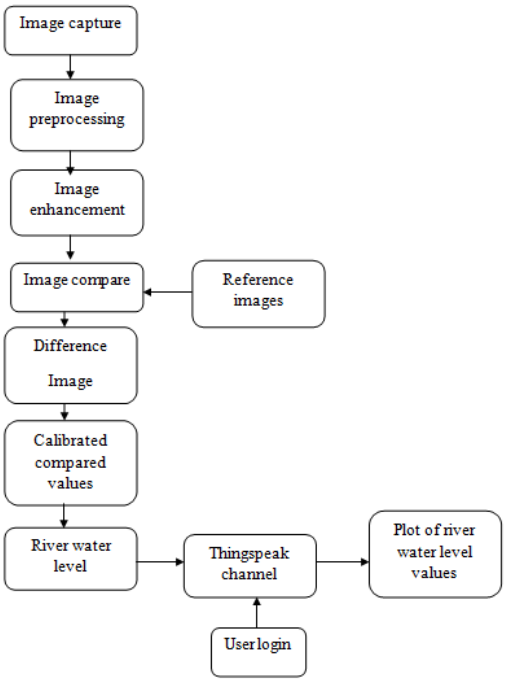

Figure 5. Flowchart of the proposed system

Data analysis (input output readings)

In this proposed system, the water level is measured using image processing and the level value will be sent on ThingSpeak. A stand is placed at the centre of the bridge to carry the camera. Image is captured by the camera is in the RGB colour space. Camera is initialized using the MATLAB code by user. From the RGB colour space only red colour plane is employed for conversion to grey scale image. The basic purpose of colour space conversion is to detect only red colour and avoid the other colour interference. This grey scale image of level is converted into the binary image using the thresholding algorithm. To detect the thing , BLOB (Binary Large Object) analysis is employed . It computes the statistical values for labeled region. Under the BLOB analysis, following parameters are included:

1) Orientation: Arrow orientation is decided by using „regionprops‟ MATLAB command in MATLAB. It calculates the angle ranging from -90^{o} to 90^{o} between x-axis and major axis.

2) Centroid: It specifies the centroid of mass object. Horizontal coordinate and vertical coordinate are elements of centroid and they are in order of dimension.

3) Area: Area of any targeted object is calculated by the command "regionprops (BW,‟Area‟)‟ which is standard MATLAB command. It returns the value in terms of actual pixels in the region.

4) Major axis length: Major axis length specifies the length of major axis of ellipse in terms of pixels.

Table 1 result of level measurement

ACTUAL LEVEL (ML)	MEASURED LEVEL (ML)	ACCURACY%	DIFFERENCE
1	0.989	98.863%	0.011
1.2	1.199	99.888%	0.001
1.4	1.393	99.479%	0.007
1.6	1.577	98.551%	0.023
1.8	1.913	94.118%	-0.113
2	2.014	99.330%	-0.014
2.2	2.181	99.136%	0.019
2.4	2.369	98.692%	0.031
2.6	2.536	97.519%	0.065
2.8	2.696	96.282%	0.104
3	3.062	97.966%	-0.062
3.2	3.223	99.283%	-0.023
3.4	3.487	97.494%	-0.087
3.6	3.693	97.490%	-0.093
3.8	3.821	99.458%	-0.021

Graphical analysis

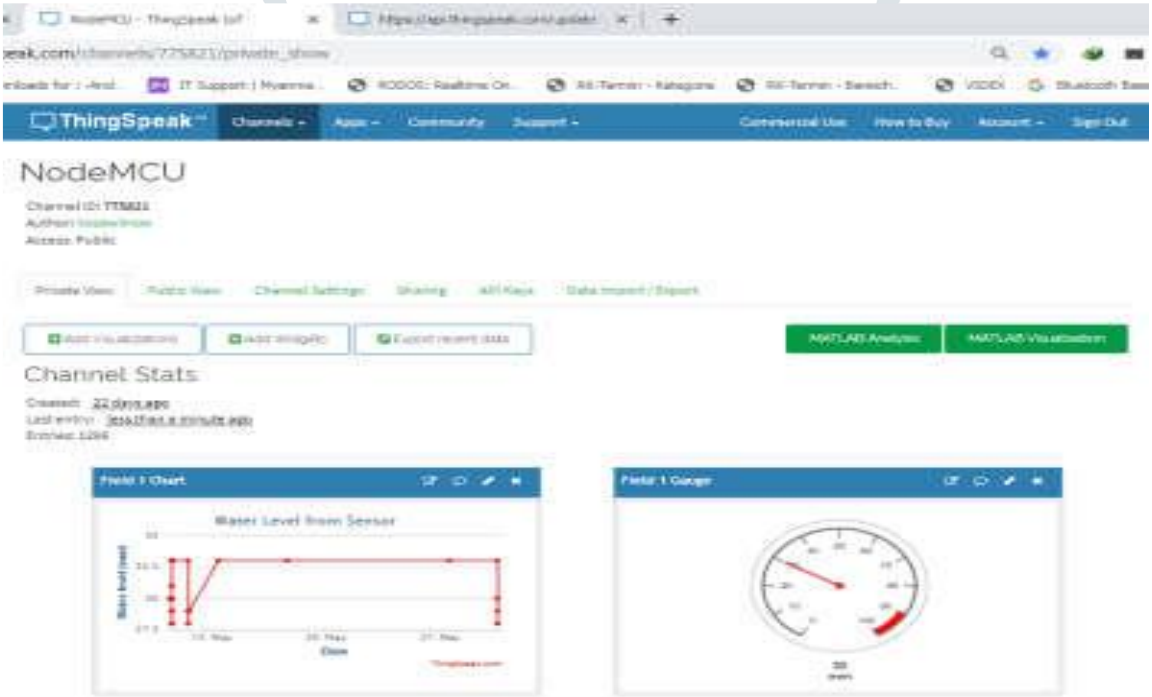

Figure-6. Graphical representation of result

Experimental setup

Figure-7.: image from webcam installed

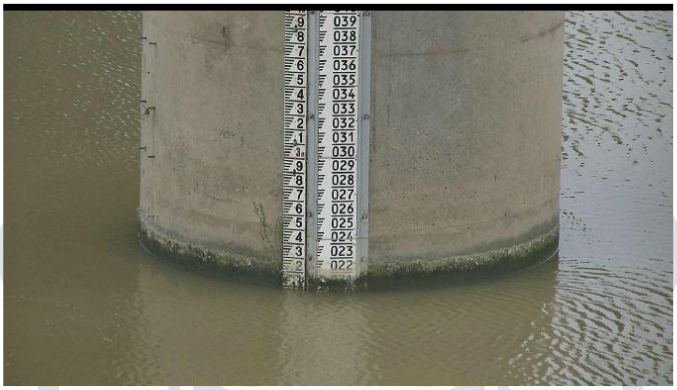

Figure-8. : Level measurement using scale

Conclusion

In this project, we measure the water level using various image processing techniques such as pre-processing, segmentation, boundary extraction, the value of water level in river is then sent via IoT on ThingSpeak which can be accessed from anywhere. Advantages of this project are it has better efficiency compared to previous methods and as hardware requirement is less and it is less costly. Changes can be easily made according to further requirement. The limitation is running MATLAB on slower system which itself make the processing slower and images quality depends on various atmospheric conditions. The project can also be further modified by using Raspberry-pi and cloud programming of which results as level value can be made available from any remote location. GSM module can be used to receive the message on cell phone. Applications of this project are level measurement in big water tanks, dams, river, channels and

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