WATER LEVEL MEASUREMENT AND DETECTION OF FLOW DIRECTION USING IMAGE PROCESSING

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ABSTRACT
Water level measurement is one of the hydraulic study necessities especially in lab researches. In most common methods, water level is directly measured. It is also important to measure reservoirs water level in research related with water depth. There are varieties of ways for water level measurement compatible with different situations with some structural or financial disadvantages. For instance ultrasonic sensors are very accurate. However, it is often very costly to purchase these sensors.
The purpose of this project is to represent a new method of water level measurement using image processing. For removing some limitations of devices invented previously according to requirements of different experiences, we commenced building an affordable device for water measurement. The device operation is based on an image processing program written on MATLAB. High Defination webcam takes pictures needed for image processing from a built in stand connected to a main reservoir.

KEYWORDS: MATLAB, Thresholding, Segmentation, Dilation

INTRODUCTION

Water level measurement is widely used in hydraulic studies, agriculture, petroleum, chemical, food processing and in many other fields. Water level is measured to assess how much water is available for a supply or to check quantity of water available in a reservoir or to check amount of water flowing in a channel or flume. This measurement might be used to check water level changes in specific intervals.
Sometimes it is important to measure water level in places where there is no human resources. Water level can be measured in variety of ways. Different types of sensors are the most common devices for measuring water level. Devices capable of measuring water surface slope and monitoring water level changes with advantages like easy operation, non-contact with water and low cost of building can be very helpful. The purpose of this project is to represent a new method of water level measurement without limitations of some expensive device.
In the paper proposed system, the water will be measured level using image processing with the help of camera, it will also help to indicate the direction of water flow.
The scope of the project is to develop an inexpensive, camera-based system to measure and track the level of water in streams, lakes, rivers, ponds and places where there are no human resources. It can be used for measurement of level of other fluids also.

LITERATURE REVIEW

Measurement of water is one of the important issues for big tanks, dams, rivers. By knowing the water level, one can come to know how much water is remaining and when to fill tank. In the cases, where it is impossible for a person to go and check the water level, various water level measurement techniques are used. Each technique has its own advantages and disadvantages. A water level meter is used to measure the water level in a well through a coaxial wire that emits a sound.
Water level measurement is a fundamental component of almost all ground water monitoring programs, normally performed before every purging and sampling event. These measurements provide important insight into a site's hydro geological characteristics, and how they may be changing due to natural or man-induced causes. Most commonly, the water level data from a set of wells can be used to define the direction of ground water flow across a site.

THE PURPOSE OF THIS PROJECT IS TWO FOLD

To examine existing standards and methods of ground water level measurement in light of the new challenges they face. To describe a new water level measurement system that applies an old operating principle in an updated form.

BLOCK DIAGRAM DESCRIPTION

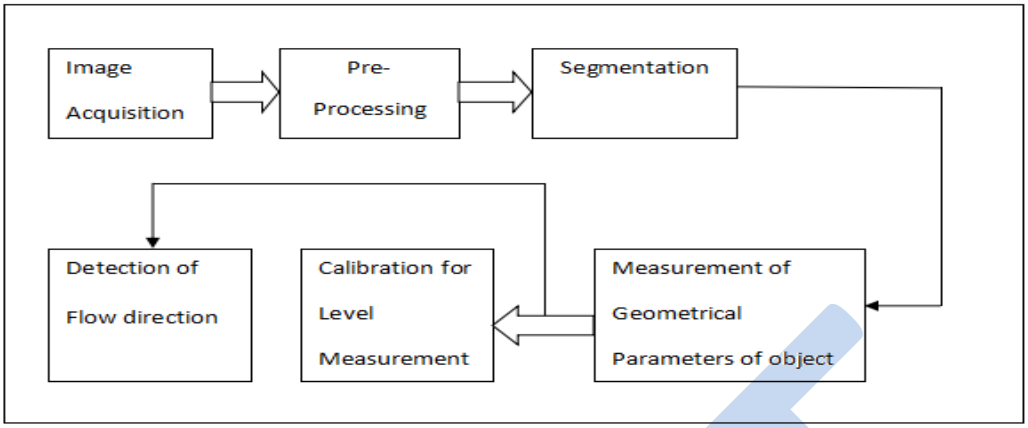

Fig. 1: Block Diagram

Acquisition:

Digital imaging or digital image acquisition is the creation of photographic images, such as of a physical scene or of the interior structure of an object. The term is often assumed to imply or include the processing, compression, storage, printing, and display of such images. One of the forms of image acquisition in image processing is known as real-time image acquisition.

Pre-processing:

Pre-processing images commonly involves removing low frequency background noise, normalizing the intensity of the individual particles images, removing reflection and masking portions of images. Image pre-processing is the technique of enhancing data images prior to computational processing.

Image Segmentation/ Thresholding:

Image segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyse. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images.

Measurement of geometrical parameters:

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

Calibration for water level measurement:

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

Detection of flow direction:

To get the flow direction arrow will be placed on Airfoil. Airfoil is used for proper flow alignment. Arrow orientation is determined in the geometrical parameter calculation, which is used to determine the water flow direction.

METHODOLOGY

In this proposed system, the water level and detection of water flow is measured. A rectangular container having two inlets and two outlets on opposite side is used to change the direction of water flow using the inlets and outlets. A stand is placed at the centre of the container to hold the arrow and camera. Airfoil is used along with the arrow for the proper flow alignment. Image is captured by the camera is in the RGB colour space. Camera is initialized by the user using the MATLAB code by user. From the RGB colour space only red colour plane is used for conversion to grey scale image. The basic purpose of colour space conversion is to detect only red colour and avoid any other colour interference. This grey scale image is further converted into the binary image using thresholding algorithm. To detect the object, BLOB (Binary Large Object) analysis is used. It computes the statistical values for labelled region. Under the BLOB analysis, following parameters are included :

1) Orientation: Arrow orientation is determined 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 object is calculated by 'regionprops(BW,'Area')' 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.

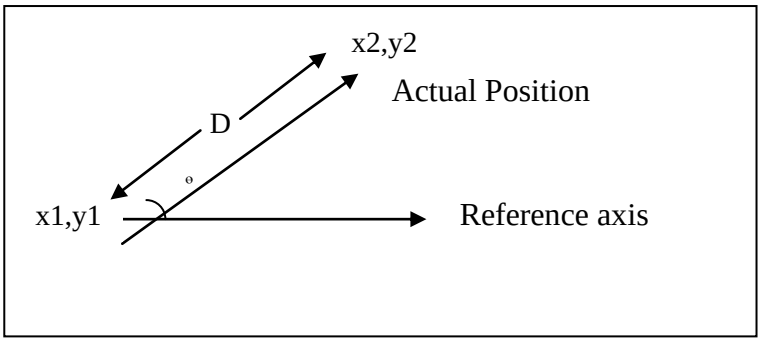

Fig. 2: Prototype for Angle Measurement

Actual direction of arrow is found by comparing actual position of arrow with reference axis. The deflection of arrow from reference results in the angle between arrow and reference axis. Fig. 2 shows prototype for the same.

RESULTS

Measurement of water level is calibrated from the area of arrow image captured by the camera. The area calculated is in terms of pixel. So in Figure. 3 shows that, if area of object is large then water level is high.

Fig. 3: Image Captured at maximum level.

1. As the water level decreases, area of arrow also decreases. It is shown in Figure 4 and Figure. 5.

Fig 4: Image Captured at lower level

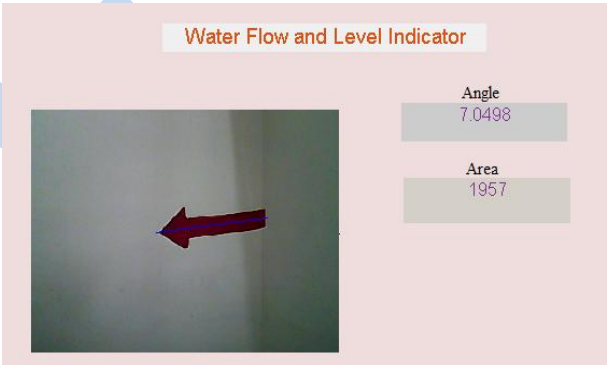

Fig. 5: Image Captured at lower level.

2. Similarly Figure. 5 shows that, when the area of arrow is very small, it indicates that the water level is decreased.

Fig. 5: Image Captured at minimum level.

CONCLUSION

In this project, we measure the water level using image processing with the help of camera and also indicate the direction of water flow using various image processing techniques such as pre-processing, segmentation, boundary extraction. Advantages of this project are it has better efficiency compared to previous methods and as hardware requirement is less it is less costly. Changes can be easily made according to our requirement. The limitation is MATLAB is slower and images quality depends on various atmospheric condition. The project can be further extending by including Raspberry-pi and cloud programming results can be made available from remote location. GSM module can be used to receive the message on cell phone. Applications of this project are measurement in big water tanks, dams where water continuously flows and water level needs to be measured.

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