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A NOVEL APPROACH ON WATER LEVEL DETECTION BY RTIPES

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ABSTRACT

Water level detection is one of the most important tasks in industries. Accurate water level detection has been made possible through many sophisticated techniques. This paper proposes a very low cost model of a water level detection system made possible through embedded system image processing. A comparatively fast ARM Cortex M3 microcontroller is used in order to execute this processing task. Proposed image processing is practically implementable as it is shown further.

Key words: Level detection, Real time processing, Embedded system, Image processing.

INTRODUCTION

Water level detection is one of the most important tasks in industrial environment. Prior knowledge of rising level of a boiling liquid at any circumstances or any given industrial process prevents a huge catastrophe[5]. For this purpose various sophisticated method are used; such as special sensors and even supersonic waves are used in some cases[3]. This increases the complexity of the system. Hence a comparatively simpler instrument with features of portability and reusability will be more economically viable. The use of proximity sensors as a non contact method of water level detection might prove to be more costly and possibly less robust due to the extreme temperature and humid conditions that might arise in a boiler. In this paper proposed a novel, non contact method of water level detection[1]. The proposed system uses a camera microcontroller pair for the purpose. An image of the boiler walls is captured using a camera, and the image obtained is processed in the microcontroller to generate the proper signal for the appropriate height. Now, it is a well

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known fact that processing an image, would be a computationally intensive job to do for a microcontroller and the results might not be obtained in real time. For that purpose, the authors propose a novel approach, whereby a modified image processing algorithm for detection is used, which is tailor made for the proposed system. It has been shown later that such a tailor made approach has considerably reduced the computational burden of the microcontroller without affecting the system performance. The paper has been organized in the following ways, Section I addresses the specific problems that might come up in a real industrial environment and how it can be solved. In Section III the proposed system and the core Image processing algorithm has been developed.

Problems in normal industrial condition and their solution

Barrels used in industries are generally not transparent, so a manual vision feedback is absolutely unavailable. And in very cold as well as boiling conditions, the vapor coming out of the water level disrupts optical clarity. So, there are chances that incase of highly humid environment present inside the vessel, the lens can be obstructed of a clean image of the vessel walls. In that case the use of mechanical wipers can address the issue. If the lens can be wiped off at regular intervals the accumulation of moisture on the lens can be avoided. Hence an approximate estimation of level can be made possible. But, the image obtained even after such an arrangement may still not be suitable for the well known algorithms for level detection. Hence a setup is required which will address these problems as well while giving a very accurate idea of the water level. For that purpose, a laser source is used to create a straight line of light which falls on the walls of the vessel and water surface. A laser light source is fixed at the circumference of a wheel rotating at a high speed and the generated beam is allowed to fall on the vessel walls. Thus, the line of laser dots, created by such an arrangement makes the system robust to the moisture and other gaseous contents of the air inside the vessel. At the same time the detection of water level inside the vessel becomes quite simple now, as the water level can be easily detected by observing the laser line created. Since, laser suffers minimum scattering due to the intense nature of the beam, very accurate measurements can be made from the image obtained. The authors would also like to mention that, for this purpose a red laser light source is used.

Proposed system and arrangement

The proposed system consists of a laser pointer which in turn is continuously rotated by a high speed motor, which creates an impression in the level of water. A microcontroller based camera (Ov600) captures this impression on the level of the water and matches with pre calibrated pixel data height. Matched data in the memory displays the height of the water level[2]. As mentioned earlier a Cortex M3 ARM microcontroller is used as the processing unit. Arrangement includes the simulation of drum having a certain water level where the laser pointer is pointed in the water surface. As expected the laser line is deviated from the level of water surface due to refraction. This property is used to detect the height of the water level is in Fig. 1.

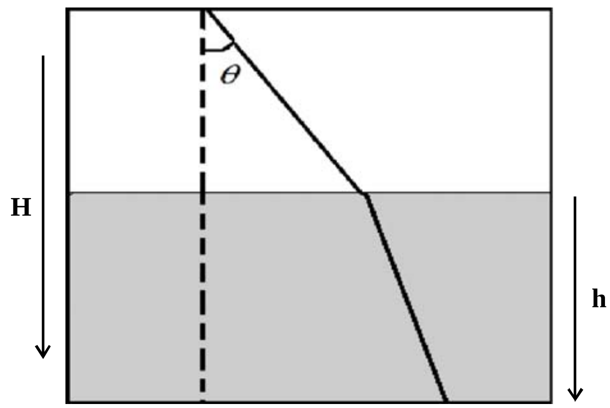

Fig. 1

θ = Known projection laser angle

h = Water level height

H = Total height

X = Threshold red pixel number

Calibration for pixel setting

Laser is pointed at the empty vessel. Actual number of pixels covered by the breadth of the laser is calculated. An average of the entire value is calculated. More or less certain threshold is determined for number of red pixels (say ‘x’), below which the laser line will not be considered as continuous; hence that would give us the break point. There is also a threshold ‘red’ value of pixel

(say ‘r’: $0 \leq r \leq 255$). $x = P_r + P_{r+1} + P_{r+2} + \ldots + P_{255}$

$$= \sum_{n=r}^{255} P_n$$

Where n P represents the total number of red pixels covered by the pixel value n (where $r \leq n \leq 255$).

Calibration for coordinate determination

On an empty vessel the laser is pointed making an angle θ. a_i is taken as a variable i represents the pixel height. A loop runs for row a_1, after row wise traversal, let the red value is found at K^{th} column. Let the first value is P_n. Then it store $a_i = K$. Hence an array of value for column is stored for a_i.

Measurement

Since a look up table has been made, same loop is run after the vessel is filled with fluid up to a certain height. Now for a particular row, $K_{i^{th}}$ column value is checked. If $(P_1, P_2,\ldots P_x) \geq P_r$: The next x pixels are checked. Water level is unchanged. Then the program checks the next $a_{i^{th}}$ row. Let discrepancy to the aforesaid condition is found for $(i + y)^{th}$ row, it denotes the breakpoint; ie the point where water level is detected. Let camera is focused at certain position such that H in meter denotes N pixels; then obtained height will be $\left(1-\frac{i+y}{N}\right)\times H = h$.

Hence an accurate value of h (water surface level) is obtained from a non contact method it is in Fig. 2.

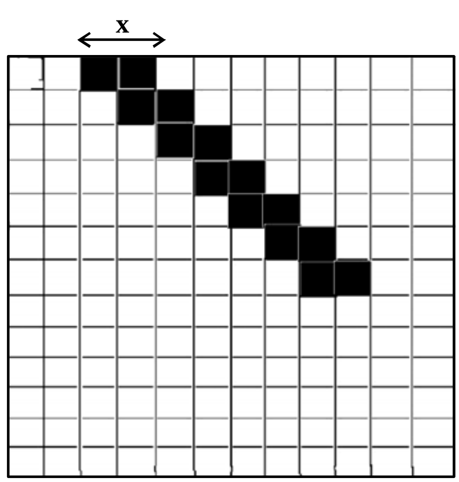

Fig. 2

CONCLUSION

Water is one of the most important basic needs for all living beings. But unfortunately a huge amount of water is being wasted by uncontrolled use. Some other automated water level monitoring system is also offered so far but most of the method has some shortness in practice. Here it can be easily observed that for detecting the water level, the program need not check all the pixels of the acquired image. But, by only checking a certain fixed and predefined number of pixels, a conclusion about the water level can be made. This is exactly where the computational burden on the microcontroller has been significantly reduced and hence a real time data can be obtained.

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