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Detection of Impurity in Liquids Using Electronic Sensor Based System with Infrared Camera and the Real Time Monitoring of Water Quality in IoT Environment

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Abstract: This paper is based on new enhancement technique for infrared images which integrates the benefits of additive wavelet transformation and homomorphic image processing. The main motive behind this technique is to decompose the images into subbands in an additive fashion and the principle adopted to implement the same is using additive wavelet transform which produces the image as an addition of subbands of the same resolution. Drinking water varies from place to place, depending on the condition of the source water from which it is drawn and the treatment it receives, but it must meet EPA regulation. The traditional method of testing Turbidity, PH & Temperature is to collect samples manually and then send them to laboratory for analysis. However, it has been unable to meet the demands of water quality monitoring today. So a set of Monitoring of Turbidity, PH & Temperature of Water quality has been developed. The system consists of Turbidity, PH & Temperature sensor of water quality testing, single-chip microcontroller data acquisition module, information transmission module, monitoring center and other accessories. Turbidity, PH & Temperature of water are automatically detected under the control of single chip microcontroller all day. The single chip gets the data, and then processes and analyzes them. If the water quality is abnormal, the data will be sent to monitoring center and alert the public at the same time.

Keywords: Wavelet transform, Homomorphic processing, illumination component, reflectance component, subband, pH sensor, Turbidity Sensor, Temperature Sensor.

I. INTRODUCTION

Electronic Tongue and Electronic nose system provides more services in various fields such as environmental monitoring, food science, and point of care business. The concept of electronic tongues is more recent, and much less research has been undertaken on the development of liquid sensors and classification algorithms. By combining sensor systems e.g. Electronic noses and tongues together with a enhanced image processing techniques, the classification accuracy can be increased.

With the rapid development of the economy, more and more serious problems of environment arise. Water pollution is one of these problems. Routinely monitored parameters of water quality are temperature, pH, turbidity, conductivity, dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), ammonia nitrogen, nitrate, nitrite, phosphate, various metal ions and so on. The most common method to detect these parameters is to collect samples manually and then send them to laboratory for detecting and analyzing. This method wastes too much man power and material resource, and has the limitations of the samples collecting, long-time analyzing, the aging of experiment equipment and other issues. Sensor is an ideal detecting device to solve these problems. It can convert no power information into electrical signals. It can easily transfer process, transform and control signals, and has many special advantages such as good selectivity, high sensitivity, fast response speed and so on. According to these characteristics and advantages of sensors, Monitoring of Turbidity, PH & Temperature of Water is designed and developed. The following will be the steps under taken for the research work,

- Detailed study of the concept, application and implementation of sensor networks.
- To design and develop an electronic sensor based system that can extract the information about the properties of the liquid.
- Identify and analyse the effect using sensor based system, due to the liquid or any other ingredients present in liquid.

- PC interface will be developed for online testing and monitoring. Evaluation results will be made available on display, displaying the quality of liquid under test.

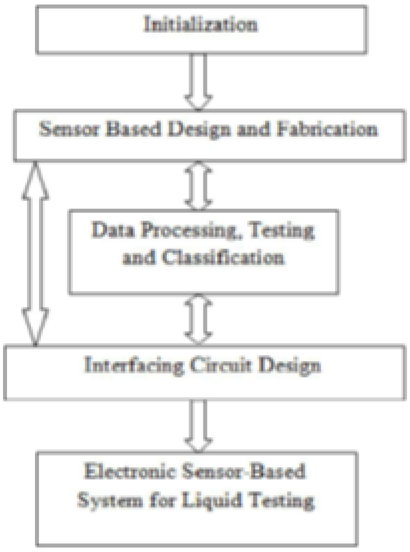

Fig 1. System representation

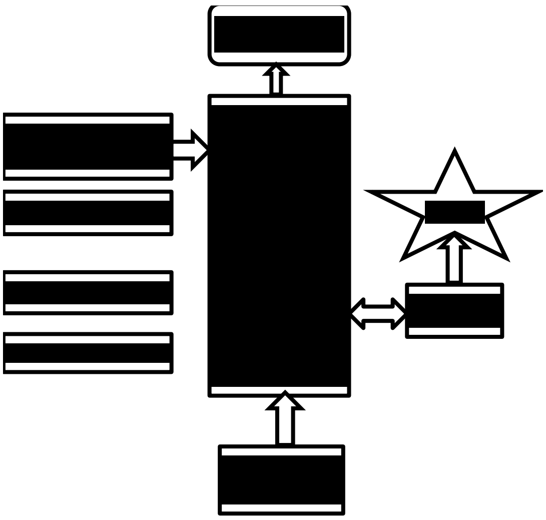

Fig 2. Block diagram of monitoring of water using various sensors.

Image enhancement has become a very popular field in image processing. The main aim of Enhancement is to improve the visual quality of image and this is achieved by reinforcing edges and smoothing the flat areas. Several researches have adopted various techniques in past such as simple filtering, adaptive filtering, wavelet de-noising, homomorphic enhancement etc.,[8-15] and all these techniques concentrate on reinforcing the details of the images to be enhanced. Apart from all these techniques mentioned above, a new technique that is Infrared image processing has emerged for the evolution of night vision cameras.

This technique has various advantages such as this technique has applications in thermal medical imaging. With the evolution of night vision cameras, more researches are being performed in infrared image enhancement for information extraction from these images. Due to the absence of appropriate amount of light required for imaging, these images have a special nature of large black areas and small details. Hence, the main objective is to reinforce the details to get as much details as possible. The enhancement of infrared images is slightly different from traditional image enhancement because these infrared images have large black areas and small details. So, our proposed methodology aims at separating the details in different subbands and processing each subband separately. It is found that additive wavelet transform is a very powerful tool in image decomposition and the details can be separated into the higher frequency subbands ,if the images is decomposed using the additive wavelet transform. In addition to all these we also use the homomorphic enhancement algorithm for transforming these details to illumination and reflectance components and then the reflectance components are amplified showing the details clearly. In the final step, to get an enhanced infrared image with much more detail, a wavelet reconstruction process is performed. The enhancement of infrared images is slightly different from traditional image enhancement because this infrared image has large black areas and small details. So, our proposed methodology aims at separating the details in different subbands and processing each subband separately. It is found that additive wavelet transform is a very powerful tool in image decomposition and the details can be separated into the higher frequency subbands, if the images is decomposed using the additive wavelet transform. In addition to all these we also use the homomorphic enhancement algorithm for transforming these details to illumination and reflectance components and then the reflectance components are amplified showing the details clearly. In the final step , to get an enhanced infrared image with much more detail , a wavelet reconstruction process is performed.

II. LITERATURE SURVEY

Liquids such as water, milk and juices are the major products that are adulterated. Consumption of these liquids is hazardous to health. Water which flows down carries minute particles like dust and algae which are at larger depth in tanks are invisible and not fit for consumption. The report of food safety and standard authority of India [FSSAI] said that adulteration of milk is a very serious problem in India with production of 121 million metric ton of milk production per annum. Urea, starch, glucose and harmful detergents are used as adulterants in milk. These adulterants are used to increase the thickness and viscosity of milk. Such adulteration of beverages is a significant problem which is due to high cost of fruit, conflicting with high consumer demand. The most common form of juice adulteration is dilution, addition of high fructose corn syrup (HFCS). Methods used for checking adulteration involves

1) Ultra high performance liquid chromatography for high resolution separation.
2) Photodiode- array detection.
3) Multi variant analysis.

III. PROPOSED APPROACH

The software used here is MATLAB. In this approach, firstly the image is decomposed into subbands using the additive wavelet transform and then each subband is processed separately using the homomorphic approach to reinforce its details and by this way we merge the benefits of the above mentioned techniques. In the experimental setup we connect twenty infrared Light emitting diodes (IRLED's) across camera and when this IR LED's is ON human eye cannot detect this but it can be easily captured by Camera.

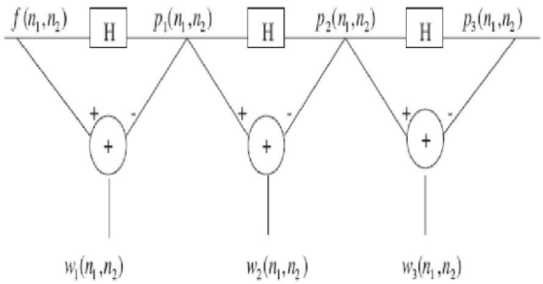

Fig 3. Additive Wavelet decomposition

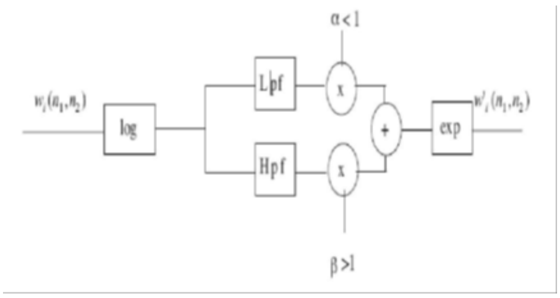

Fig 4. Homomorphic processing of subbands, i=1, 2, 3

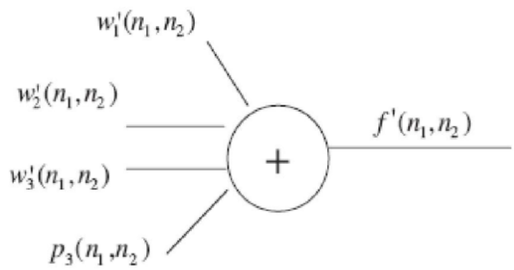

Fig 5. Wavelet Reconstruction

IV. ADDITIVE WAVELET TRANSFORM

The main role of additive transform is that it decomposes an image into the subbands using the "a'trous" filtering approach in several consecutive stages. The low pass filter is used in this process.

Each difference between filter outputs of two consecutive stages is a subband of the original image. We can use these subbands for further processing using homomorphic enhancement.

A. Homomorphic Image Enhancement

An image can be represented by the following equation which is a product of a tow component :

$$f(n1, n2) = i(n1, n2)\ r(n1, n2) \ldots\ldots (2)$$

where the obtained image pixel is given by f(n1, n2)and i(n1, n2) is the light illumination incident on the object to be imaged and r(n1, n2) is the reflectance of that object.

It is known that light falling on all objects is approximately the same therefore due to this the illumination is approximately constant and the only change between the object images is in the reflectance component. The above mentioned equation 2 can be changed to addition process from multiplication process by applying logarithmic process to equation 2 and the new equation form by applying the same is as follows:

$$\log(f(n1, n2)) = \log(i((n1, n2)) + \log(r(n1, n2)) \ldots (3)$$

As shown in the above equation the first term has smaller variations but the second term has large variations as it corresponds to the reflectivity of the object to be imaged. We can reinforce the image details by attenuating the first term and reinforcing the second term in equation (3).

V. FLOWCHART

The flowchart of the proposed system is shown in Fig 8.

VI. SIMULATION RESULTS

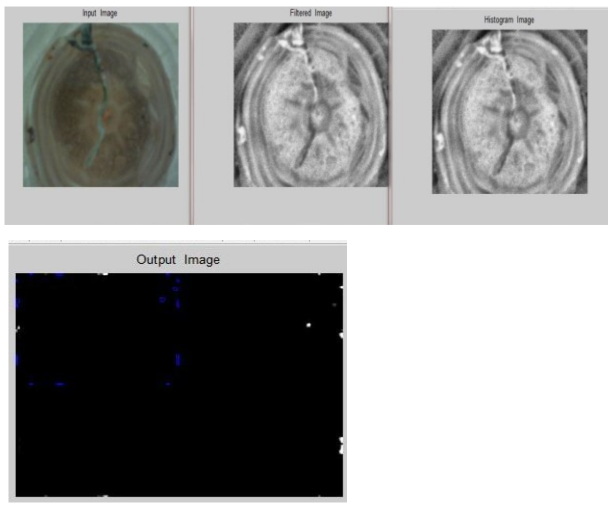

Fig 6. Water sample -1: Water with little amount of impurities

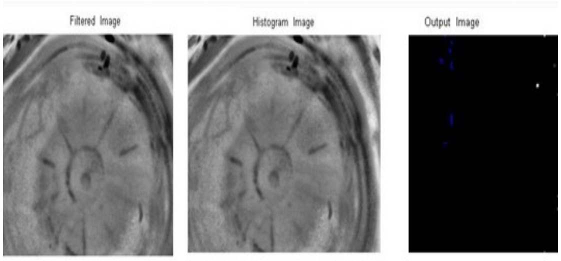

Fig 7. Water sample-2: Water with more impurities

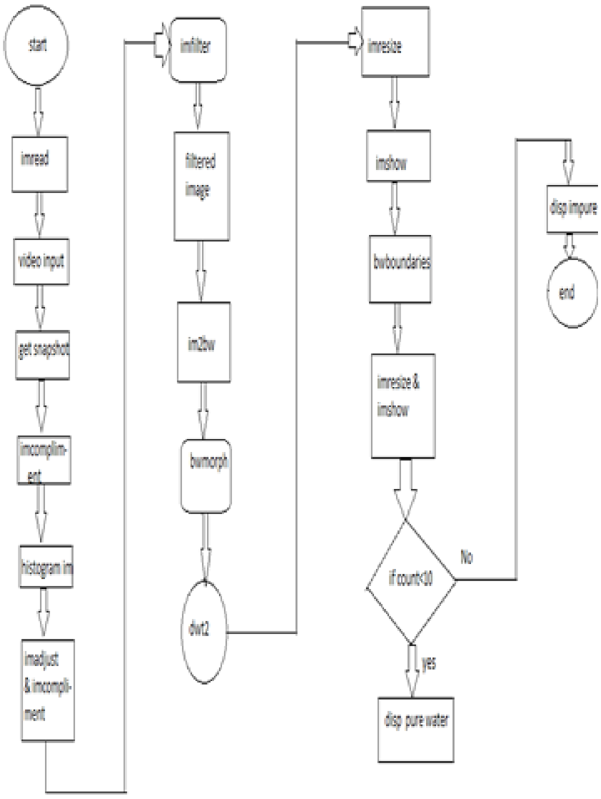

Fig 8. Flowchart

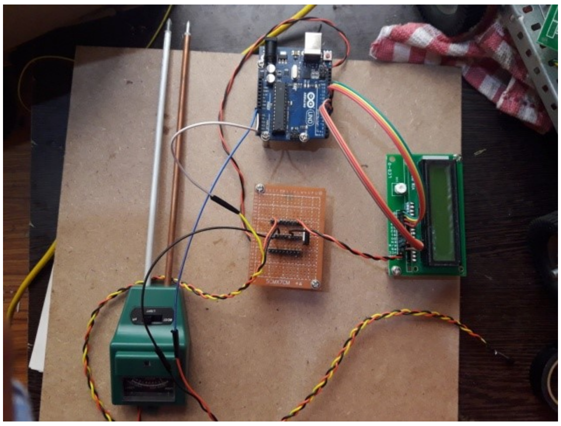

Fig 9. Hardware Module

VII. Applications

1) For health department to test potable water.

2) This system is used in commercial and domestic use.

3) Water purifiers.

4) To detect adulteration in liquids like milk, juices, oil etc.

VIII. Advantages

1) Classification accuracy can be increased.
2) Continuous monitoring of the liquids under test, and evaluation of properties of liquid and hence quality of liquid.
3) Very precise measuring of parameters.
4) Due to automation it will reduce the time to check the parameters.
5) This is economically affordable for common people.
6) Low maintenance.

IX. Disadvantages

1) Very minute and dissolved particles are hard to be detected.
2) High initial investment for sensors.
3) Complex functions for image processing.

X. Conclusion And Future Work

This paper draws our attention to a new approach for infrared image enhancement. This approach clubs the additive wavelet transform and the homomorphic enhancement features. Each infrared image subbands are subjected to homomorphic processing separately. To reconstruct an enhanced image these subbands are merged again. The results obtained using this algorithm reveal its ability to enhance infrared images.

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