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Detection of Impurity in Liquids Using Electronic Sensor Based System with Infrared Camera and The Real Time Monitoring of Water Qualityin 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 servicesin various fields such as environmental monitoring, foodscience, and point of care business. The concept ofelectronic tongues is more recent, and much less researchhas been undertaken on the development of liquid sensorsand classification algorithms.By combining sensor systems e.g. Electronic noses andtongues together with a enhanced image processingtechniques, the classification accuracy can be increased.

With the rapid development of the economy, more and more serious problems of environment arise. Water pollution isone 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 tocollect samples manually and then send them to laboratory for detecting and analyzing. This method wastes too muchman power and material resource, and has the limitations of the samples collecting, long-time analyzing, the aging ofexperiment equipment and other issues. Sensor is an ideal detecting device to solve these problems. It can convert nopower information into electrical signals. It can easily transfer process, transform and control signals, and has manyspecial advantages such as good selectivity, high sensitivity, fast response speed and so on. According to thesecharacteristics and advantages of sensors, Monitoring of Turbidity, PH & Temperature of Water is designed anddeveloped.The following will be the steps under taken for theresearch work,

- Detailed study of the concept, application andimplementation of sensor networks.
- To design and develop an electronic sensorbased system that can extract the informationabout the properties of the liquid.
- Identify and analyse the effect using sensorbased system, due to the liquid or any otheringredients present in liquid.
- PC interface will be developed for online testingand monitoring.Evaluation results will be made available on display,displaying the quality of liquid under test.

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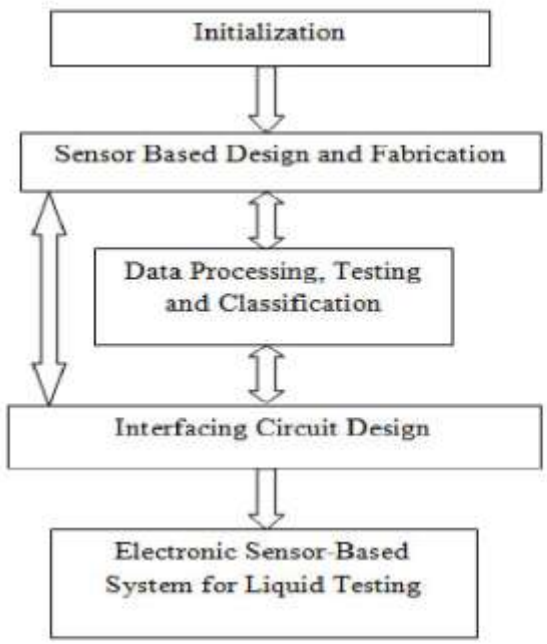

Figure 1: System representation

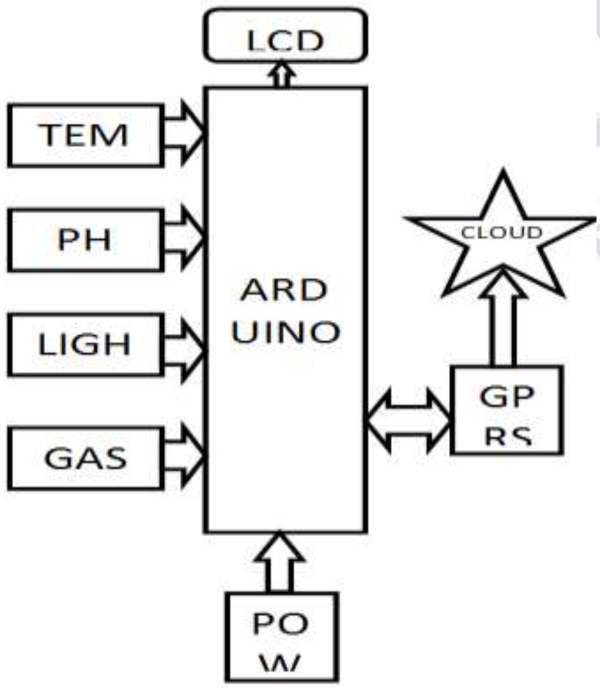

Figure 2: Block diagram of monitoring of water using various sensors.

Image enhancement has became a very popular fieldin image processing . The main aim of Enhancementis to improve the visual quality of image and this isachieved by reinforcing edges and smoothing the flatareas. Several researches have adopted varioustechniques in past such as simple filtering , adaptivefiltering , wavelet de-noising , homomorphicenhancement etc.,[8-15] and all these techniquesconcentrate on reinforcing the details of the imagesto be enhanced.Apart from all these techniques mentioned above , anew technique that is Infrared image processing hasemerged 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 slightlydifferent from traditional image enhancement becausethis infrared image have large black areas and smalldetails. So, our proposed methodology aims atseparating the details in different subbands andprocessing each subband separately.It is found that additive wavelet transform is a verypowerful tool in image decomposition and the detailscan be separated into the higher frequency subbands ,if the images is decomposed using the additivewavelet transform.In addition to all these we also use the homomorphicenhancement algorithm for transforming these detailsto illumination and reflectance components and thenthe reflectance components are amplified showing thedetails clearly. In the final step , to get an enhancedinfrared image with much more detail , a waveletreconstruction process is performed.The enhancement of infrared images is slightlydifferent from traditional image enhancement becausethis infrared image have large black areas and smalldetails. So, our proposed methodology aims atseparating the details in different subbands andprocessing each subband separately.It is found that additive wavelet transform is a verypowerful tool in image decomposition and the detailscan be separated into the higher frequency subbands ,if the images is decomposed using the additivewavelet transform.In addition to all these we also use the homomorphicenhancement algorithm for transforming these detailsto illumination and reflectance components and thenthe reflectance components are amplified showing thedetails clearly. In the final step , to get

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an enhancedinfrared image with much more detail , a waveletreconstruction process is performed.

II. ADDITIVE WAVELET TRANSFORM

The main role of additive transform is thatit decomposes an image into the subbands using the"a' trous" filtering approach in several consecutivestages. The low pass filter is used in this process .Each difference between filter outputs of twoconsecutive stages is a subband of the original image.We can use these subbands for further processing usinghomomorphic enhancement.

III. HOMOMORPHIC IMAGE ENHANCEMENT

An Image can be represented by the followingequation which is a product of a tow component :
f(n1, n2) = i(n1, n2) r(n1, n2) ……. (2)
where the obtained image pixel is given by f(n1, n2)and i(n1, n2) is the light illumination incident on theobject to be imaged and r(n1, n2) is the reflectanceof that object.
It is known that light falling on all objects isapproximately the same therefore due to this theillumination is approximately constant and the onlychange between the object images is in the reflectance component.The above mentioned equation 2 can be changed toaddition process from multiplication process byapplying logarithmic process to equation 2 and thenew equation form by applying the same is asfollows:

log(f(n1, n2)) = log(i((n1, n2)) + log(r(n1, n2)) … (3)
As shown in the above equation the first term hassmaller variations but the second term has largevariations as it corresponds to the reflectivity of theobject to be imaged.We can reinforce the image details byattenuating the first term and reinforcing the secondterm in equation (3).

IV. PROPOSED APPROACH

In this approach , firstly the image is decomposedinto subbands using the additive wavelet transformand then each subband is processed separately usingthe homomorphic approach to reinforce its details andby this way we merge the benefits of the abovementionedtechniques. In the experimental setup weconnect twenty infrared Light emitting diode (IRLED's) across camera and when this IR LED's is ONhuman eye cannot detect this but it can be easilycaptured by Camera.

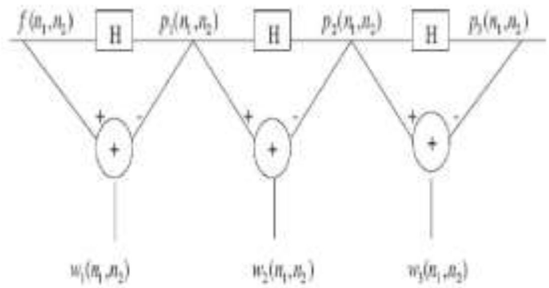


Figure 3:Additive wavelet decomposition.

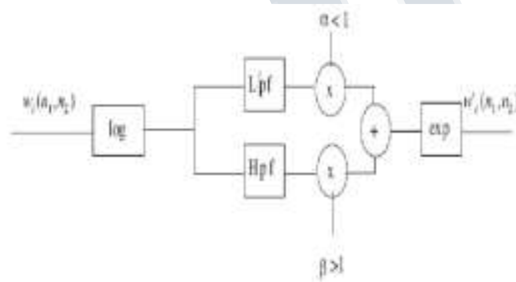


Figure 4: Homomorphic processing of subbands, i=1, 2, 3.

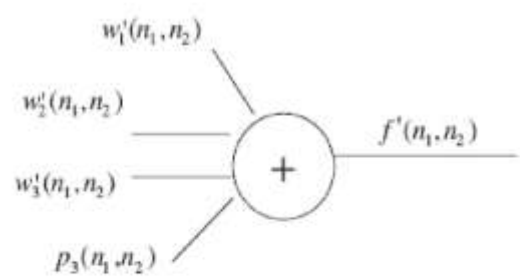
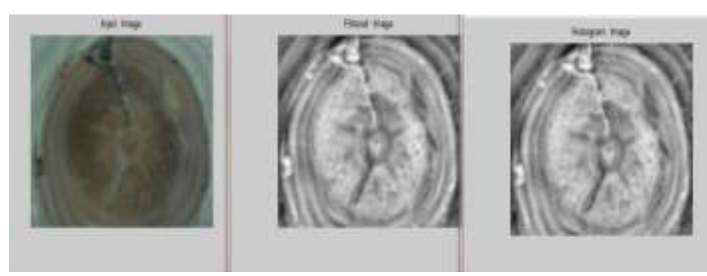


Figure 5: Wavelet Reconstruction.

SIMULATION RESULTS



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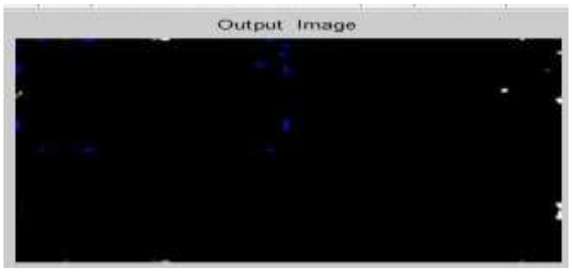
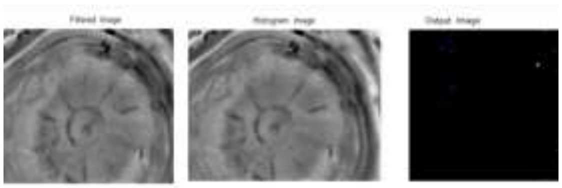
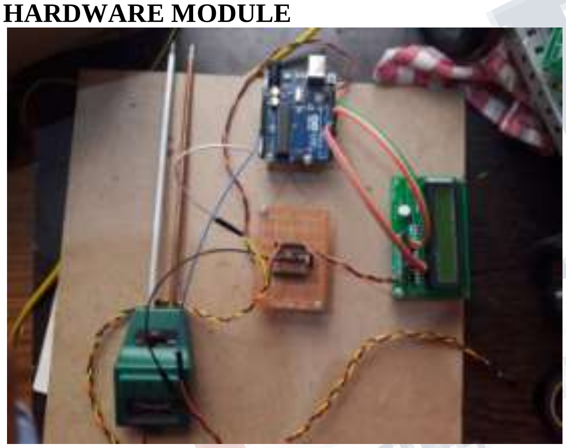


Water sample -1



Water sample-2

HARDWARE MODULE



V. CONCLUSION

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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