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Autonomous Wireless Water Tank Monitoring System

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Abstract: Underwater Sensor Network(USN) are emerging research field, with applications ranging from military to environment monitoring. Raspberry Pi is the key for connectivity. In this paper, we use advanced sensors and analyze the data collected by them. Each of the sensors provide us with information about the quality of water. The sensors used are pH sensor, turbidity sensor, oxygen sensor, temperature sensor and electrical conductivity sensor. Other hardware used are display device, routers to exchange data, gateway platform, motor and cables.
Keywords: Underwater sensors, HSI, Wireless network, Sensors.

I. INTRODUCTION

Underwater Sensor networks is a field that is potentially growing. It allows us with the applications that can provide water monitoring, environmental conditions. This field takes essential efforts to prove the existence of applications.

Water monitoring is one of the field of USNs and is coming into picture with its increasing growth. This field can be used for commercial purpose and even for the human living. The water monitoring can be done is various ways like: pH, turbidity, temperature and dissolved oxygen.

In this article, we represent autonomous wireless water tank monitoring system. Overall architecture and overview of system including sensors and its communication is explained. The data is gathered using USNs with the different sensor nodes and the gathered data is routed and then forwarded to network and sent to the Internet. Data can be stored in database system and retrieved by users.

A. Water Monitoring

Water monitoring is one of the essential need of human source. Usage of water must be calculated along with its properties and need for every update is necessary. Using the sensors, these calculations can be achieved.

B. Wireless Networking

"Wireless Networking" is one of the most required technique from recent domains. It prove us with a choice for various application areas like: smart phones and other applications. Wireless networks unites various small hardware devices scattered across the web without any fixed infrastructure to form a system. It can be used in water monitoring., Wireless Sensor networks are being used on a flourishing scale.

II. LITERATURE SURVEY

A. Luiz Filipe M. Viera, Marcos Augusto M. Viera, Jose Augusto M. Nacif, Alex Borges Vieira : The autonomous lake monitoring system explains about the use of sensors to gather all the water samples and its properties along with its reading and give it to the internet.
B. P. Ghosekar, G. Katkar, P. Ghorpade : The Mobile Ad Hoc networks enables the user to gather the information and give it to the internet., here we are supposed to send the data to the user on its mobile applications.
C. J. Heidemann, W. Ye, J. Wills, A. Syed, Y. Li : The research challenges and applications of USNs like water treatment plants and oceanographic data collection and also the involvement of pisciculture.
D. I. Vasilescu, K. Kotay, D. Rus, M. Dunbabin, P. Corke : The storage and the data collection for the reference to the previous recorded data and the accumulation of new data on daily basis is involved including the retrival of data by user from same database.

III.PROPOSED SYSTEM

Water surroundings can create many barriers for human and commercial usage of water. The water needs to be monitored on a time schedule and review the updates for the further operations on water. The data to be gathered is done using the sensors : pH, turbidity, temperature, dissolved oxygen and electrical conductivity. The gathered data is evaluated on Raspberry Pi 3 and sent to user via the wifi module and the user will get the data on the mobile application which is the android system and every data is supposed to be notified to the user.

The gathered data is stored in the database of android application and can be used to compare it whenever necessary. The data is stored on hourly or daily basis and retrieved while comparison.

Usage of camera is also done on the embedded work so as to help user to check the qualities of water using its color properties. The vision provided by the camera gives the RGB image but the user needs to check the minute changes in water which is time consuming. So the android application that collects the image captured by camera, image converted from RGB image to HSI that gives different intensities. This is done in project to check the availabilities of the other stuff present in water i.e., bacteria or bad water influencers or the objects that has drained in water. This will notify the user with the impurities and rest properties of water and ask to change the water.

The user then gathers the data from sensors, images and if the water is turbid or not good for human resource or commercial use then it gets pumped out fromnm the Water Tank using the pumping motor and new water is allowed to fill the tank.

System is divided into three modules:

1) Sensors as Input
2) RPi3 for processing
3) GUI

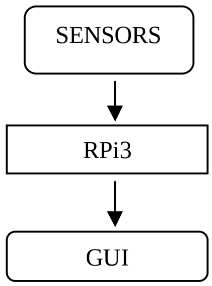

Figure: Flow Diagram

A. Raspberry Pi 3

RPi3 is the motherboard of the system. It acts as a interface between the sensor nodes, camera and user application. The data gathered from sensors and the camera is processed by RPi and then sent to the android application. The RPi3 parts we used are:

1) *100 Base Ethernet:* The connectivity of WiFi module is done via Ethernet. The wifi is used to sent data over the Internet to the android application.
2) *40-pin Extended GPIO:* These are the I/O pins for the connectivity of sensors to the RPi module. The breadboard is also used for sensors pin connectivity where the breadboard is connected to GPIO pins of RPi.
3) *Full Size HDMI:* The HDMI port is used to connect the RPi over the PC for generation of code format.
4) *CSI Camera Port:* This port is used for the connectivity of camera node to RPi which will capture image and RPi will process it and sent over the Internet.
5) *Micro SD Port:* Here we use 32GB SD card for loading Operating Sytem of RPi and storing data.

B. Sensors

1) *pH Sensor :* The pH sensor is used in the system to measure hydrogen-ion activity to indicate the acidity or alkalinity of water.

pH < 7 : ACIDITY
pH > 7 : BASE
pH = 7 : NEUTRAL

2) *Temperature Sensor:* The temperature is degree of hotness, this sensor is used to measure the high or low temperature of water.

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3) *Turbity Sensor:* The turbidity sensor is used to measure the amount of light that is scattered by suspended solids in water. If the solids in water increases, turbidity also increases
4) *Dissolved Oxygen Sensor:* The sensor is used for the measurement of oxygen in water. The oxygen level is to be set neutral for the purpose of aquatic creature's livelihood. The dissolved oxygen levels are related to good water quality.
5) *Conductivity:* In this, we are trying to check whether the water is able to conduct electricity. The conductivity can also be obtained using iron rods.

C. Graphical User Interface

GUI is the actual outcome of the system. The visual results of all the input data is done in this section. GUI consists of an Android Application in the system and the actions are being performed using GUI. The application helps out user to note the readings for the changing properties of water and the actual conclusions are recorded and stored.

The image captured by the CSI port of RPi3 captures the image and its displayed over an android application. As the image is in RGB format its not possible for user to get an idea of abnormalities present in water., this is why, the RGB to HSI conversion comes into picture and due to HIS conversion, different intensities are known and the objects or presence of dust or bacteria is known.

D. RGB Model

RGB model is used for image processing.

The origin of RGB space (Red=0, Green=0, Blue=0) represents black while the opposite corner (Red=max, Green=max, Blue=max) represents white.

The total work in this model is carried out by each pixel.

E. HSI Model

HSI stands for Hue-Saturation-Intensity.

This model reflects the way human see colors.

Hue specify attributes of colors and intensity specifies light effects. Saturation gives the measure of degree to which pure color is diluted by white light.

Decoupling of Hue and saturation is done by Intensity.

F. RGB to HSI Conversion

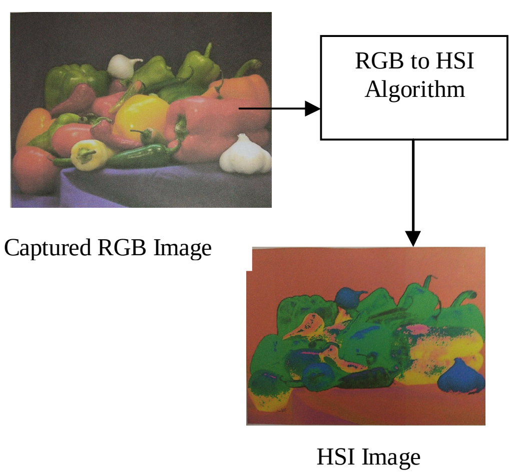


Figure: RGB to HSI Conversion

The image captured in RGB format is claimed to convert into HSI to check the intensities of color level and user may understand the properties of water just by its visible appearance.

RGB-to-HSI Conversion:

Hue= Θ if Blue<=Green

$360-\Theta$ if Blue>Green

$$H = \cos^{-1}\left(\frac{(R-G)+(R-B)}{2\sqrt{(R-G)^2+(R-B)(G-B)}}\right)$$

The several intensities from the RGB Image is calculated by the formula :

$$I \triangleq \frac{1}{3}(R+G+B), \quad \text{i.e.} \quad R-G+B=3I$$

The saturation is to give the measure of degree of pure color of water and is calculated by formula :

$$S = 1 - 3\ \min(R, G\,B)/I$$

G. Naïve Bayes

Naïve Bayes is a classification algorithm based on Bayes Theorem and the Maximum A Posteriori hypothesis. It makes an assumption that the effectof an attribute value on a given value on a given class is independent of values of the other attributes. This assumption is know as class conditional independence.

Bayes' Theorem is stated as:

P(h|d) = (P(d|h) * P(h)) / P(d)

Where

P(h|d) is the probability of hypothesis h given the data d. This is called the posterior probability.

P(d|h) is the probability of data d given that the hypothesis h was true.

P(h) is the probability of hypothesis h being true (regardless of the data). This is called the prior probability of h.

P(d) is the probability of the data (regardless of the hypothesis).

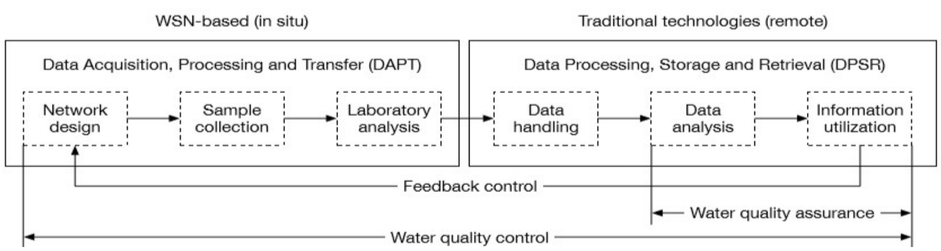
After calculating the posterior probability for a number of different hypotheses, you can select the hypothesis with the highest probability.

This is the maximum probable hypothesis and may formally be called the maximum a posteriori (MAP) hypothesis.

This can be written as:

MAP(h) = max((P(d|h) * P(h)) / P(d))

IV. SYSTEM ARCHITECTURE



V. RESULT AND DISCUSSION

Following is the output of image conversion and the representation of sensor data on android application:

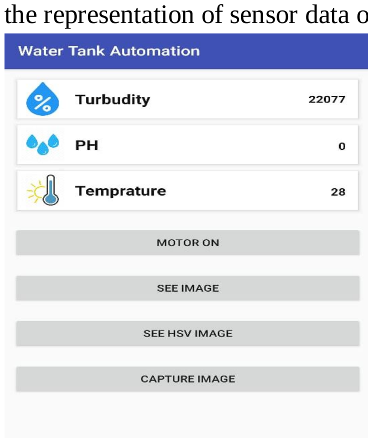


Figure: Data of sensors on android

VI. CONCLUSION

The paper has summarized ongoing research in underwater sensor network. So far, most of the research done is focused on terrestrial sensor network. Many researchers are currently engaged in developing technologies to satisfy and to develop marine sensor network. Since, the constraints such as cost, hardware, topology change, power consumption are stringent and specific for underwater sensor networks; therefore, new wireless ad hoc networking techniques are required for such an environment. We plan to extend sensor network platforms with low power and cost, short range devices so that large scale underwater experiments and applications become possible in future.

For detection of bacteria in water, this model can be used with laser. With the help of laser, camera image will be captured on which precedence rule can be applied for detection of bacteria in water. Each and every bacteria has its own property. Using HIS algorithms the movement of the bacteria can be observed and they can be detected. Hence there is a huge scope in wireless water-tank management system.

VII. ACKNOWLEDGEMENT

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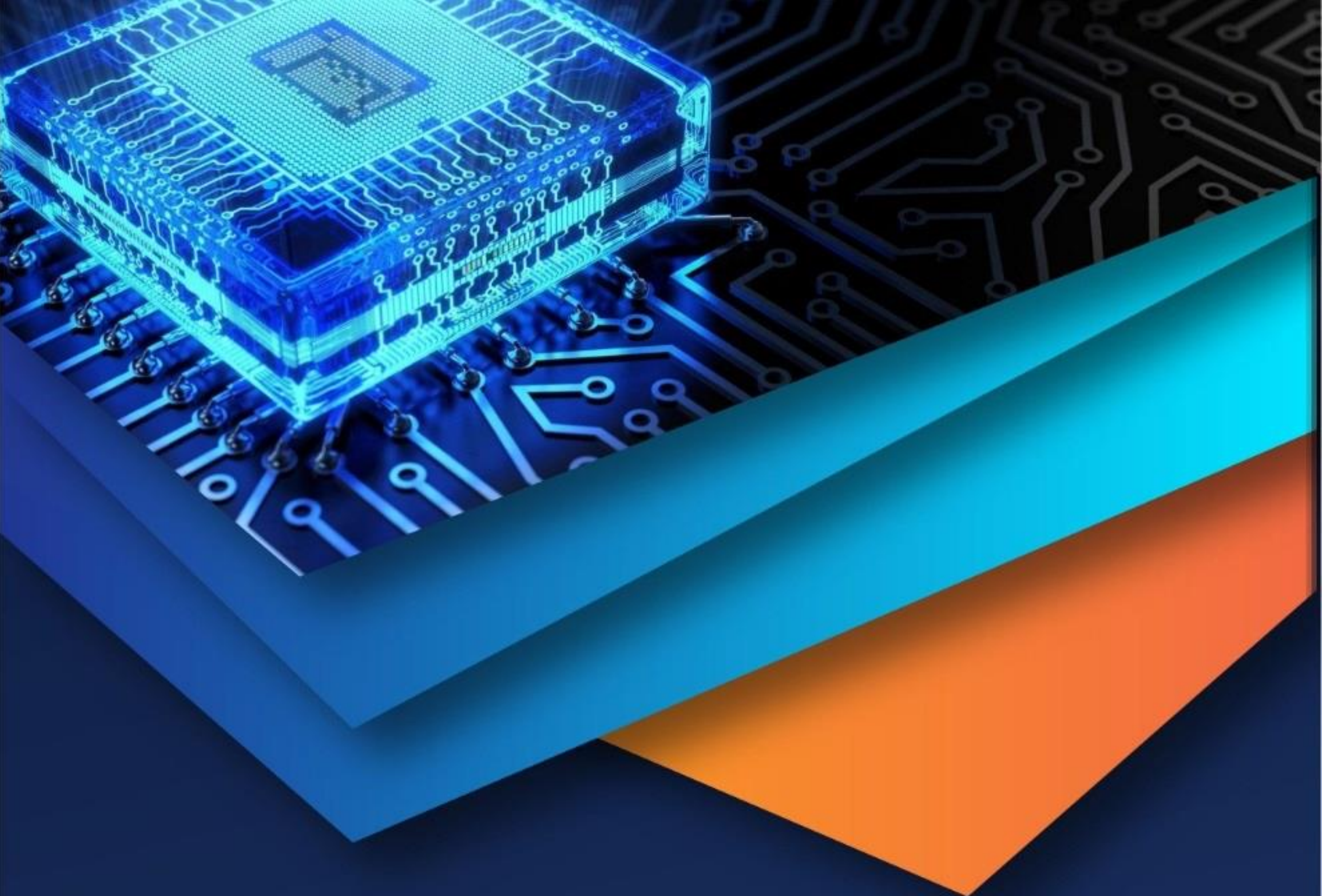

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