Autonomous Robot with High Range Wireless Technology for Water Quality Sensing

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Abstract— ***Water quality monitoring is very essential in recent years since many factors pollute the water resources. The robots that are in use for monitoring the water quality that is unable to protect itself from damage. The data provided by the existing robots enable the experts to identify the preferability of the water resource. In the proposed methodology the IR sensor in robot is used for obstacle identification and automatic path deviation is provided for self-prevention from damage. This robot also has the capability of updating data which makes any person to identify about the preferability of various water resources. By implementing this robot even the cause for pollutant can also be identified which is not possible in existing robots. At various points of time the pollutant level in a desirable location can be analyzed. The robot also have the capability of taking necessary actions for overcoming pollutants. This analysis can be done through the graph that are plotted automatically using the data sent by this robot. In addition, determining robot location using GPS, enabling manual control of motors highly needed to monitor the pollutant level at desirable location makes this project to be more advantageous.***

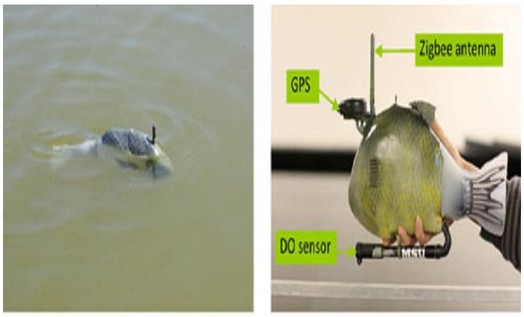
Keywords— ***IR(Infra Red),GPS(Global Positioning System), Sensor, Robots, Motors***

I. INTRODUCTION

Freshwater is a finite resource, essential for agriculture, industry and even human existence. Without freshwater of adequate quantity and quality sustainable development will not be possible. Water gets polluted in many ways. Some industries are discharging their waste water in to rivers, lakes or ponds etc. The Acid rain flow may pollute the water resource. Discharge of toxic chemicals, over-pumping of aquifers, long-range atmospheric transport of pollutants and contamination of water bodies with substances that promote algal growth (possibly leading to eutrophication) are some of today's major causes of water quality degradation. Humans and Aquatic ecosystems are threatened on a world-wide scale by a variety of pollutants as well as destructive water-management practices. The fish species are highly affected due to the increase in temperature. Either the embryos may die; Fish become unable to spawn or even the fish may die. Similarly due to the increase or decrease in pH level the water becomes highly acidic or basic solution and causes severe threatens. Likewise several parameters of water like salinity, turbidity, chlorine, ammonia, chlorophyll etc when goes beyond the sustainable threshold causes problems. The problems have been present for a long time but have only recently reached a critical level, while others are newly emerging. Hence it is essential to monitor the pollutant level of water in order to determine whether the level of pollutant is acceptable for aquatic organisms survival, drinking purpose, etc. In this project a robotic sensor networks is implemented for water quality monitoring. The three main parameters that contaminates the water resource are considered. They are pH, temperature and turbidity level. This robot provides a way to identify the cause of pollutant, identify the location of water where pollutants appear etc. On implementing this project the efficient monitoring of the water quality is possible and also even the illiterate people can understand the preferability of water resource.

In earlier stages human is involved and manually tested the water in laboratory. Manned missions are generally expensive and tedious. It requires high effort for accurate determination of water quality parameters. This consumes labour cost and also it requires manpower for accurate analysis. Later buoyed sensors are developed [1] which is helpful in monitoring water quality. However, since buoyed sensors cannot move around, it could take a prohibitively large number of them to capture spatially inhomogeneous information. The past couple of decades have seen significant progress in developing robotic technologies for aquatic sensing. Autonomous underwater vehicles (AUVs) [2] and sea gliders [3] are notable examples of such technologies. However, because of their high cost (over 50;000 US dollars per unit [4]), weight (over 100 pounds), and size (1-2meters long), it is difficult to deploy many AUVs or sea gliders for temporally and spatially resolved measurement of diffusion processes. Recent advances in computing, communication, sensing, and actuation technologies have made it possible to create untethered robotic fish [5] with onboard power, control, navigation, wireless communication, and sensing modules, which turn these robots into mobile sensing platforms in aquatic environments. Fig. 1a shows a prototype of robotic fish swimming in an inland lake. Fig. 1b shows the close-up of a robotic fish prototype, equipped with GPS, ZigBee antenna, and dissolved oxygen (DO) sensor.

Due to the low manufacturing cost, these platforms can be massively deployed to form a mobile sensor network that monitors harmful diffusion processes, providing significantly higher spatial and temporal sensing resolution than existing monitoring methods. Moreover, a school of robotic fish can coordinate their sensing and movements through wireless communication enabled by the onboard ZigBee radio, to adapt to the dynamics of evolving diffusion processes. The overhead of cross-sensor coordination occurs due to its inability of identifying the obstacle. Hence it doesn't have the capability to deviate from the path if obstacle is identified. This robot also has no way of monitoring the environment. The overhead of cross-sensor coordination occurs due to its inability of identifying the obstacle. Hence it doesn't have the capability to deviate from the path if obstacle is identified. This robot also has no way of monitoring the environment.



(a) (b)

Fig. 1 (a) Swimming robotic fish (b) Robotic fish components

There should be some way of knowing the pollutant level of water resource at earlier points of time for analysis. The robotic fish has no such capability of providing the above requirements.In this project a robotic sensor networks is implemented for water quality monitoring. The three main parameters that contaminate the water resource are considered. They are pH, temperature and turbidity level. This robot provides a way to identify the cause of pollutant, identify the location of water where pollutants appear etc. On implementing this project the efficient monitoring of the water quality is possible and also even the illiterate people can understand the preferability of water resource.

II. IMPLEMENTATION

The temperature, pH, turbidity and chemical are the parameters considered to measure. In real time additional parameters can also be included.The robot moves with the help of motor provided.IR sensor is provided which emits the IR rays and if there is an obstacle in front of the robot the rays will get reflected and observed by the photodiode within the sensor. On identifying the obstacle the motor direction deviates from its path. Gps measures the location of the robot .The camera is provided to capture the live videos around the water resource and transmits to the control station. The values of temperature, pH, turbidity, GPS value are transmitted via ZigBit module to the control station. If the parameter goes beyond the threshold level an alarm will be sounded and also an alert message is provided via GSM. A display regarding the preferability of water resource is provided in HyperTerminal software installed in computer.

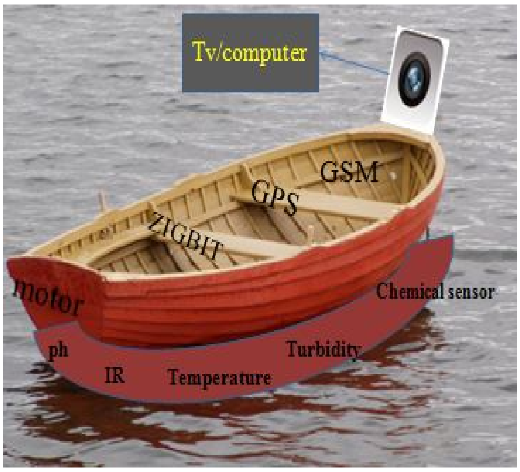


Fig. 2 Robotic boat module

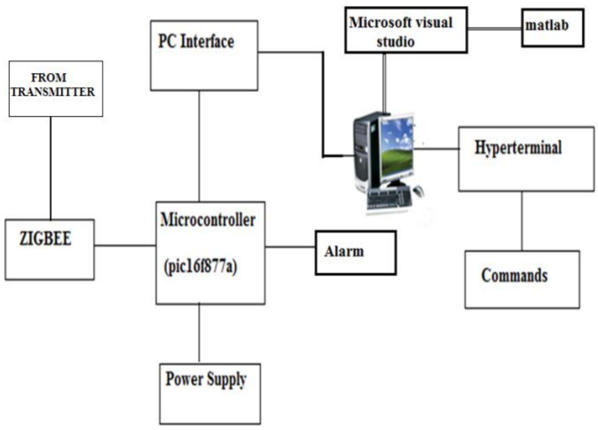


Fig 3 Control station

The commands for manual control of motor are provided in HyperTerminal and correspondingly motor direction deviates which facilitates the movement of robot in desirable direction. The camera is provided for capturing live videos around the water resource. It is useful for identifying whether the industries is letting their waste water to the lake or pond without any authorized permission from the government and also the environmental conditions revealing around it.

The pH value of water is determined by the relative concentrations of H+ ion and OH- ion. Water with a pH of 7 has equal concentrations of H+ ion and OH- ion and is considered to be a neutral solution. If a solution is acidic (pH<7), the concentration of H+ ion is greater than the concentration of OH- ion. If a solution is basic (pH>7), the concentration of H+ ion is less than the concentration of OH- ion. A change from pH7 to pH8 in a lake represents a ten-fold increase in the OH ion. The Table I shows the preferability range of PH that is programmed to the microcontroller. This shows whether the rain water is acid rain or not. Turbidity is the amount of cloudiness in the water. This can vary from a river full of mud and silt where it would be impossible to see through the water (high turbidity), to a spring water which appears to be completely clear (low turbidity). Turbidity can be caused by :

- silt, sand and mud ;
- bacteria and other germs ;
- chemical precipitates.

It is very important to measure the turbidity of domestic water supplies, as these supplies often undergo some type of water treatment which can be affected by turbidity. The threshold values for turbidity level are shown in Table II. The unit of turbidity is Nephelometric Time Unit. The temperature of a body of water influences its overall quality as it can harm aquatic organisms if it is outside the normal range.Temperature should be measured at different locations and a change in temperature should be determined. Temperature of the air above the water body may affect water temperature depending on the depth of the water. Shallow water bodies are more susceptible to temperature changes than deep water.

TABLE I
THRESHOLD FOR PH

PH RANGE	
6.5-9	Preferable for aquatic organisms
4-11	Drinking water
5.65	Normal rain water
<5	Acid rain(High level of CO_2)

TABLE II
THRESHOLD FOR TURBIDITY

TURBIDITY	
Waste water	70-2000NTU (unfit for drinking)
Well water	0.05-10NTU
Potable water	0.05-1.5NTU
Drinking water	<=5 NTU (turbidity is highly visible)
Chlorination	<0.1NTU [Highly effective] 20NTU

TABLE III
THRESHOLD FOR TEMPERATURE

	TEMPERATURE (DEG CELCIUS)
FISH WILL NOT SPAWN	9-10
FISH EMBRYOS DIE	13-20
FISH GROWTH STOPS	22-28
FISH DIE	>35

The threshold values of temperature of water resource which is preferable for fish species is as shown in Table 3. For analysis, the parameters value from hardware is read by Microsoft visual software which is installed on computer and it is stored in that software. Matlab reads the values automatically from Microsoft visual through the commands and graph is plotted. The graphical display enables the researchers for ease analysis of the parameter variations over a period of time.

The above threshold values for all the three parameters are programmed in microcontroller and when the measured parameter goes beyond the threshold values an alarm is provided in control station together with the display that shows that water resource is unfit for aquatic or drinking. The display enables any person to easily identify about the preferability of water resource. If the water is exceeded in certain type of pollutant then the corresponding chemicals which reduces that pollutant can be spreaded by controlling the lid of chemical package.

The fig 4 shows the techniques involved for identifying location and border. GPS receiver receives signals from GPS satellites and extract the latitude and longitude values which provides location information. For identifying border the microcontroller is preprogrammed with the values of GPS location and it compares the current value of GPS with the preprogrammed value .

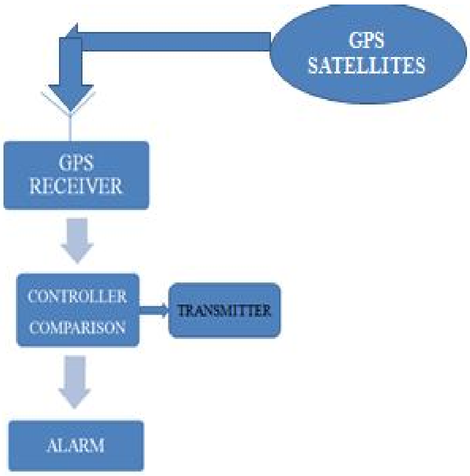


Fig 4 Location and border identification

When both the vaues are same , then alert is provided in the control station. Then the user will emply manual control of motor by providing the commands in hyperterminal software and prevents the robot from border crossing .

III. SIMULATION

The simulation of the features of robotic boat can be done by the proteus software. The tools provided by the ISIS schematic capture enables the developer to design the circuit schematic. The program is compiled by MPLAB IDE and hex file is generated for programming the microcontroller. Hex file is the format which the microcontroller can be programmed. MPASM assembler within the MPLAB IDE facilitates in generating the hex file. Microsoft visual studio is used for receiving the data from the hardware (i.e. Transmitter side) and storing data Matlab reads the stored data and plots the graph automatically. This enables the researchers to analyse the parameter values. The increase or decrease in parameter can also be found from the graph. The fig 5 shows the flowchart for simulation of this project. Proteus, matlab, MPLABIDE are the softwares involved in simulation. Before implementing in hardware it is intelligence of simulating in software. This ensures correctness of the implementation.

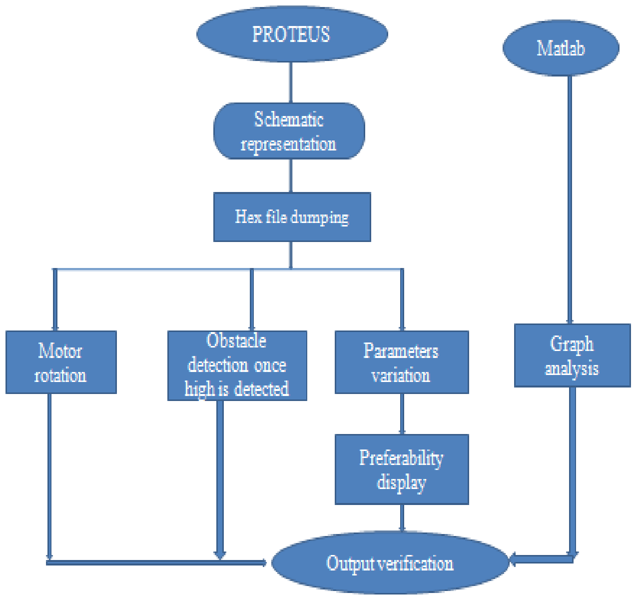


Fig 5 Flowchart of simulation in proteus

IV. RESULTS AND DISCUSSIONS

The results of simulation can be seen in fig 6 below. The hardware implementation provides the user a robot with full featured facility that overcomes the drawbacks existing in the earlier developments of robots.The MPASM assembler within the MPLABIDE enables to create the hex file.HEX file generation is essential because it is the format that is acceptable by microcontroller for programming. By using PICKIT2 the programming of microcontroller can be done. The microcontroller can be erasable and reprogrammed .

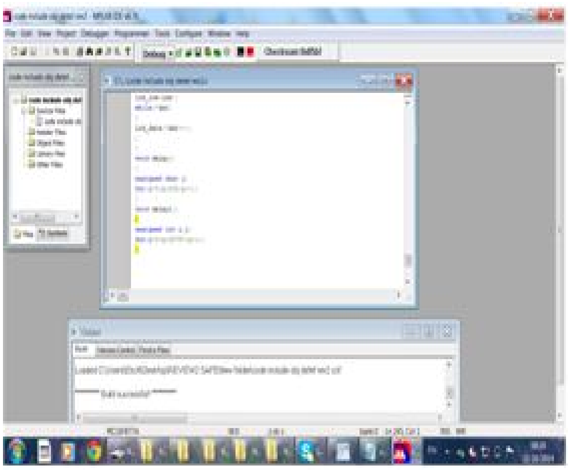


Fig 6 Program compiled in MPLAB IDE

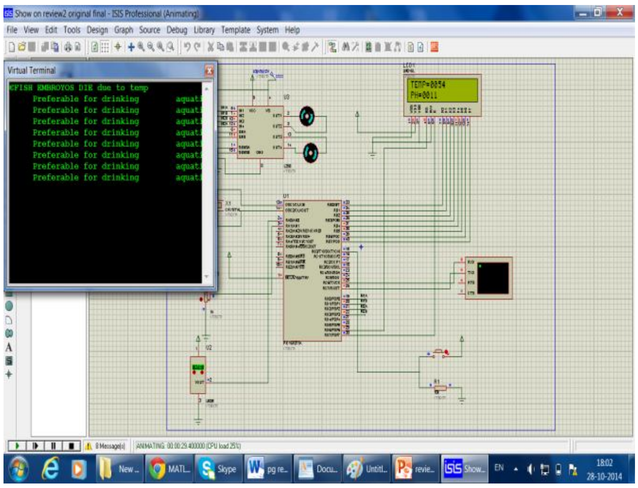


Fig 7 Circuit designed in proteus

The circuit designed in Proteus is as shown in fig 7. The preferability display is provided in virtual terminal software.The obstacle is detected when a high signal is detected. L298 Motor driver is used for simulating the motor rotation.LCD displays all the values of parameters which are considered for measurement.

V. CONCLUSION

The robotic boat enables the user for effective monitoring of water quality. It can be implemented in all kinds of water resource. Any person can handle this robots and can know about their preferability of water resource without any assistance. The developing technology facilitates taking necessary actions if water pollution goes beyond the acceptable limit. Location identification, manual control from remote location, border identification, etc several such enhanced features of this proposed robot is highly attractable.

REFERENCES

[1] S. Ruberg, R. Muzzi, S. Brandt, J. Lane, T. Miller, J. Gray,S.Constant, and E. Downing, “A Wireless Internet-Based Observatory: The Real-Time Coastal Observation Network (ReCON),” IEEE, 2007.

[2] Hydroid, LLC, “REMUS: Autonomous Technology for Your World,” http://www.hydroidinc.com, 2014.

[3] C. Eriksen, T. Osse, R. Light, T. Wen, T. Lehman, P. Sabin, J. Ballard, and A. Chiodi, “Seaglider: A Long-Range Autonomous Underwater Vehicle for Oceanographic Research,” IEEE J. Oceanic Eng., vol. 26, no. 4, pp. 424-436, Oct. 2001.

[4] D. Rudnick, R. Davis, C. Eriksen, D. Fratantoni, and M. Perry, “Underwater Gliders for Ocean Research,” Marine Technology Soc. J., vol. 38, no. 2, pp. 73-84, 2004.

[5] X. Tan, “Autonomous Robotic Fish as Mobile Sensor Platforms: Challenges and Potential Solutions,” Marine Technology Soc. J., vol. 45, no. 4, pp. 31-40, 2011.

[6] S. Murray, “Turbulent Diffusion of Oil in the Ocean,” Limnology and Oceanography, vol. 17, no. 5, pp. 651-660, 1972.

[7] Y. Wang, R. Tan, G. Xing, J. Wang, and X. Tan, “Accuracy-Aware Aquatic Diffusion Process Profiling Using Robotic Sensor Networks,” technical report, CSE Dept., Michigan State Univ., 2011.

[8] K.Gowthami, E.Nagamani “Industrial devices controlled with USB” International Journal of Science, Engineering and Technology Research (IJSETR) Volume 2, Issue 1, January 2013.

[9] Marco Grossi, Roberto Lazzarini, Massimo Lanzoni, Anna Pompei, Diego Matteuzzi, and Bruno Riccò, “A Portable Sensor With Disposable Electrodes for Water Bacterial Quality Assessment”, IEEE sensors journal.,vol 13.No5,May 2013