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Aquatic Rover for Water Quality Testing and Helping in Pisciculture

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Abstract

We know that nowadays water pollution is very much common in Bangladesh. Two of the major sources are waste from industries and rubbish dumping. These cause much harm to farmers in their marine agriculture since it largely hampers the quality of water and affects fishes. This is a very serious issue and needs to be solved. Our focus is primarily in rural areas. We aim to solve these problems by building an underwater rover which would help to test the quality of water and detect water pollution. This would be done by measuring the pH level and the degree of Temperature which will determine the acidity or alkalinity of the water, and the availability of salts underwater. By sensing this we would get different readings of pollution in different areas by driving the rover all over the water body. Thus we can know which areas are good for what type of marine farming and can create awareness for the problem which would help reduce pollution in the future.

Keywords: Mapping; Synchronizing; pH; Temperature.

1. Introduction

Water is an essential part of our life. It is needed for us and all the other living organisms for sustaining their lives. Bangladesh is a land of rivers and it is estimated there are around 700 rivers in Bangladesh. These rivers contribute important socioeconomic functions; for instance, they provide water for drinking, washing, fishing, transportation and carrying merchandise across the city [1]. The fish farming sector of Bangladesh is huge and plays a big role in export businesses. It helps improve the economy of Bangladesh. Unfortunately, water pollution is affecting fish farming largely. Toxic chemicals from industries are being poured into the waters which affect the lives of fishes extensively. Moreover, nowadays it has become a common practice to dump waste and garbage into rivers due to which the level of pH and the temperature of the water body among others become unstable and go to extreme levels in the water. This causes harm to fish and also often prove to be fatal. The river Buriganga in Dhaka, Bangladesh is one of the many victims of such practices.

The level of pH is very important for fishes. It is seen that is the pH of water is very high or very low fishes living in the water will die. The pH affects solubility and also the toxicity of different chemicals and heavy metals in the water. In addition to biological effects, extreme pH levels tend to increase the solubility of elements and compounds, making toxic chemicals more mobile and increasing the risk of absorption by aquatic life [2]. Temperature is another very important and critical factor to consider when assessing water quality. In addition to its own effects, temperature influences several other parameters and can alter the physical and chemical properties of water [3]. An Aquatic rover is a vehicle that travels underwater by user control from the ground station, and has become an accepted tool for both scientific and military applications [4]. An autonomous underwater vehicle can be considered as a rigid body with six degrees of freedom [5]. Recently there has been interest in using mobile robots on water that carries sensors for performing sampling missions such as sampling water for knowing its properties [6]. As fishes are totally dependent upon water to breathe, feed and grow, excrete wastes, maintain a salt balance,

and reproduce, understanding the physical and chemical qualities of water is critical to successful aquaculture. To a great extent, water determines the success or failure of an aquaculture operation [7].

The three members of our team played individual roles in this overall thesis. Anas Shahab worked to acquire the data from the sensors to the database, and analyze the collected information, enabling the user to view it on a smart device. Rahatul Amin Ananto had the task of creating the hardware, and integrating it with the sensors. Md Jahan Ali Shohan dealt with the connectivity between the hardware and software, and creating a platform for them to communicate.

2. System Architecture and Design

For the frame and body of the Rover shown in the Figure 1, PVC pipes have been used which are connected with PVC connectors. It is designed in a way in which it can be able to take lots of load as well as surf underwater very smoothly. Some extra weights were attached to the right to cancel out the weight on the left. Weighting the rover correctly is important because when drifting in mid-water, we do not want to have to thrust too much upward or downward [8]. We attached some more weights to make the rover cancel out the upwards force of the water for the buoyancy of the whole body and also the downwards force of the gravitational pull. By doing this the rover can be easily moved underwater by simply giving it some force by turning on the middle motor. The rover can be kept in a still position underwater by managing the speed of the middle motor properly.

Figure 1. Rover which was made for the project.

The rover has a PVC framing which helps the devices inside it to be secure from external collisions or damages. The motors are perfectly tied up to the frame so the vibration from the motors is a minimum. There is a waterproof box where we stored our components and sensors. Most of the sensor probes are exposed to water to get readings from the water. Another vital part of our rover is a floating device containing the antenna of the GPS and Wi-Fi. The floating device is connected to the rover with a thin pipe holding the wires for the antenna. By this, the communication can be much easier since an underwater wireless connection is close to impossible with our present-day technology. All the components of the rover are kept in a plastic container right behind the middle motor. It contains these components: Arduino Mega, Motor Shield, Arduino Uno, Raspberry Pi, pH sensor Module, GPS sensor and antenna. The wires are driven out through small holes at the back of the plastic container. There is another plastic container attached to the body. This container is there for buoyancy (the ability or tendency to float in water or air or some other fluid). The pH sensor probe is attached to the front right leg and the temperature sensor is attached to the front left leg. We have enough space on the bottom of the rover if we want to attach more sensors like the Dissolved Oxygen probe, Conductivity probe, Ammonia detection probe and many more. The underwater camera is attached at the top of the rover as shown in

Figure 2. Only a long rubber pipe comes out of the rover to the surface. At the end of the pipe, there is the controller for the rover. We can replace it with a Bluetooth module to control it wirelessly.

The rover can get the GPS coordinates via A Geo 6m-0-001 GPS module. We used a pH Sensor Kit E-201 for measuring the pH value of the water at different depths. A temperature sensor (Figure 3) is used to measure the temperature.

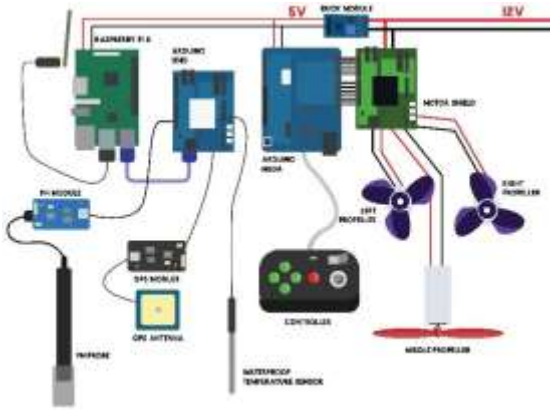

Figure 2. The block diagram of the circuit of the rover

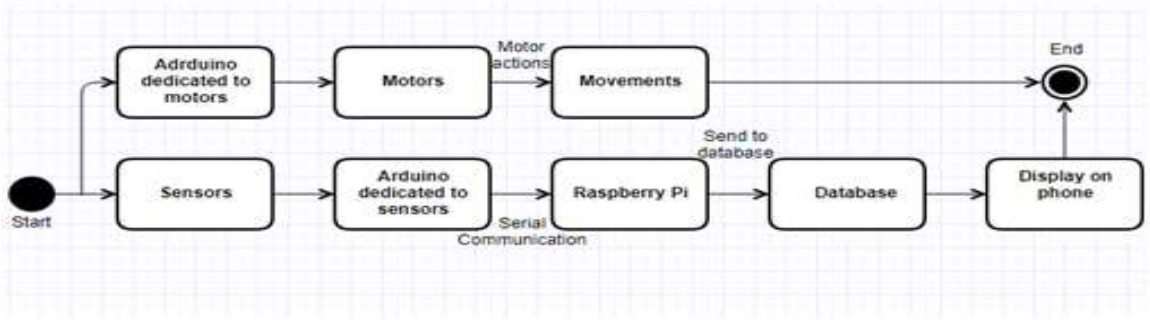

Figure 3. The block diagram of the circuit of the working process.

All the data from these sensors are taken with an Arduino Uno which is connected to a Raspberry Pi 3. The data is transferred from the Arduino to the Raspberry Pi through a serial connection. The Raspberry Pi is programmed with an APK of ThinkSpeak [9]. By this we are able to know the water quality of the selected water source and we can be able to conclude if the water is suitable for any fish to live, what type of fishes can live there and how can we be able to improve the water quality more. We used an Arduino mega and an Adafruit motor shield for controlling the motors. The motor shield is powered up by an external 12V power supply since the motors that we used are of 12V. To power up the Arduino Mega, we used a buck converter to convert the 12V power supply to 5V. The motor shield can be attached directly to the Arduino Mega from the top and the motor shield now can get information on how to spin the motors from the Arduino. An analog button controller is connected to the Arduino Mega. A potentiometer is also attached to control the speed of the middle motor. The Raspberry Pi 3 is powered up by the 5V input coming from the buck converter. The buck converter can give a constant output of 5V and 2A. The Raspberry is getting the exact amount of power which it needs to operate and safety from voltage spikes. The Raspberry Pi is then connected to an Arduino UNO which is powered up by the Raspberry Pi's serial communication port. The Arduino UNO can also be given an external power source if necessary when

more sensors would be attached to it. The pH Probe, GPS module and the temperature sensor are connected to the Arduino Uno. The Arduino has been coded to get all the information from the sensors.

3. Results and Discussion

The testing of water by the rover was done in two places: Clean Water and Pond Water.

Table 1. Readings obtained in clean water and in pond water.

CLEAN WATER										
TEMPERATURE in degree Celsius	24.7	24.7	25	25.4	25.4	25.4	25.4	25.4	25.4	25.4
pH in moles per liter	0	0	2.1	2.4	3.7	5.6	7.2	7	7.7	7.7
POND WATER										
TEMPERATURE in degree Celsius	25.6	25	24.7	24.7	23.9	23.7	23.7	23.6	23.6	23.6
pH in moles per liter	0	0	0	1.8	2.2	4.9	6.8	6.4	6.4	6.4

Table 1 shows the readings obtained in clean water and in pond water. Temperature profile shown in Figure 4 was plotted from the readings obtained in clean water. In clean water, it was seen that the temperature readings fluctuated a little initially. This was due to the fact that the temperature sensor needed some time to adjust. After adjusting, a stable reading of 25.4 degree Celsius was obtained. Figure 5 shows a pH versus Time graph plotted from the readings obtained in clean water. In clean water, it was seen that the pH readings fluctuated a lot initially during the testing. This was due to the fact that the pH sensor is very sensitive and responds to the slightest change. After 10 readings, the reading obtained was 7.7. This showed that the water was very slightly alkaline.

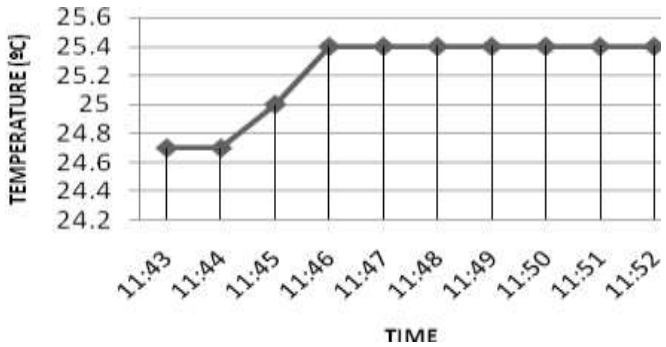

Figure 4. Temperature versus Time graph in clean water.

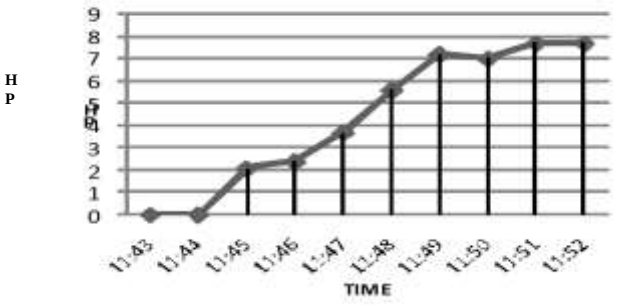

Figure 5. pH versus Time graph in clean water.

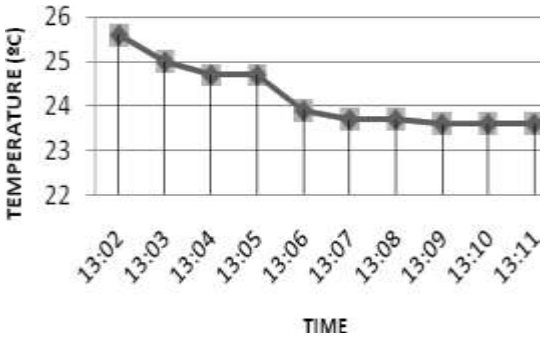

Figure 6. Temperature versus Time graph in pond water.

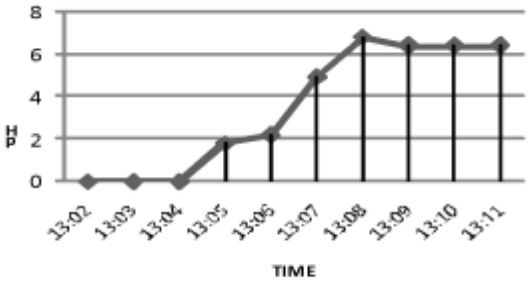

Figure 7. pH versus Time graph in pond water.

Figure 6 shows a Temperature versus Time graph plotted from the readings obtained in pond water. In pond water, the temperature at the surface of the water was different from that recorded underwater. It was seen that the temperature at the surface was around 24.7 degree Celsius. However, underwater a temperature of around 23.6 degree Celsius was obtained. This was due to the fact that the temperature below the surface was cooler than that at its surface. Figure 7 shows a Temperature versus Time graph plotted from the readings obtained in pond water. In pond water, it was seen that the pH readings fluctuated a lot initially during the testing just like in clean water. After 10 readings, the reading obtained was 6.4. This showed that the water in the pond was very slightly acidic.

4. Conclusion

Our work can help the fish farmers significantly. An important sector like fish farming deserves all the help it needs. They can solve the existing problems and boost up this sector. Our rover is simple and portable. This will cause ease for the farmers in using and carrying. All in all we would like to add that we have made the aquatic rover fully functional with all the promised sensors. But it is not yet autonomous. We plan to insert five micro switches in front of it. If the rover bumps into something, then one or more specific switches will send the signal to the processing unit, to process that whether or not there is something blocking the path. This will make the rover autonomous. We have a plan to replace the micro-switches with underwater sonar when we commercially produce our rovers for farmers and NGO's to use.

As the underwater rovers which are being made industrially are very expensive for the students to get their hands onto, making a rover that is cheap and affordable was the main goal, but it would not be any less functional than the industrial ones. It gets its cheap price owing to the fact of it being made from all sorts of scratch materials.

In our country, despite having a vast amount of water body and a huge ocean, the sector of underwater robotics is still a long way from being close to the modern world improvements. This is one of the reasons to start working in this field. Secondly, this type of research can be tremendously beneficial for our agriculture sector as well as marine lives. By determining the exact water quality, conductivity, clarity and pollution level of a particular area of a water body, we can increase the productivity of fishes in the agricultural sector. Endangered species of marine lives might also be very much benefited if we think more about the water and the pollution level. Thirdly, The Navy can use this technology to broaden their visibility underwater by using top quality underwater sensors and radars capable of searching a huge area very precisely.

This research is has an advantage of being less expensive over other similar works. This helps the research work to further extend into other broaden sectors. Students can easily start their research on this with a minimum amount of budget. It has to be said that, in our country there is a huge possibility for the future of this research work.

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