Coral Reef Monitoring System Using Internet of Underwater Things (IoUT)

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Abstract- *Coral monitoring has become very essential nowadays to prevent the extinction of coral reefs. The major focus is to prevent coral bleaching, so that various methods have been developed by researchers to analyse coral reefs health. This Paper proposes an optimized method of building a coral monitoring system based for shallow water based on IOUT architecture. The health of the coral reefs is analysed using various sensors like pH sensor, RGB Colour sensor, Temperature sensor and the data is transmitted to the smartphone using GSM technology. There are various factors for the bleaching of the coral reefs. In order to save the coral reefs from extinction, we have designed an efficient coral monitoring system.*

Keywords- monitoring, remote sensing, bleaching, IoUT, Sensors.

I. INTRODUCTION

Coral reefs play a diverse role in ocean ecosystem. They not only look beautiful but also supports living organisms. Coral reefs take many important roles to support underwater life. It provides feeding, spawning and nursery ground for underwater existences. Moreover, coral reefs also provide coast protection from damaging wave, help nutrient recycling, assist carbon and nitrogen fixing, and habitation for approximately 25% of diverse biotas. As the result, the livelihoods of 500 million people and income worth over $30 billion are at stake.

There are many challenges to keep coral reefs healthy, such as global climate change, sea temperature elevation, and solar radiation and coral diseases. One of the most influential factor is coral bleaching. Coral bleaching is defined as expulsion of coral's pigment algae, causing coral reef become pale and allows the skeleton to become visible through transparent tissue. When it happens, coral reefs will starving. If bleaching is prolonged, it causes death to coral. A prevention act is needed to avoid damage to coral reefs. Coral monitoring has become a major focus to prevent bleaching. There are numerous approach to monitor coral to prevent from bleaching. Collecting sample manually, conducting surveys, and map it into color index are no longer considered as effective. Study of showed that lack of coordination, ineffective cost and scaling issue still remains as challenges. Using remote sensing to perform monitoring program potentially addresses many of those caveats.

II. CASE STUDY

[1] Emma V. Kennedy, Alexandra Ordon and Guillermo Diaz-Pulido, "***Coral bleaching in the southern inshore Great Barrier Reef***" a case study from the Keppel Islands.

A combination of El Nino and rising sea surface temperatures triggered a thermal heat stress event that caused coral bleaching in many parts of the world throughout 2014–17. On the east coast of Australia, summer sea temperatures peaked in March 2016, causing an unprecedented bleaching event along the length of the Great Barrier Reef, NOAA Coral Reef. The Keppel Island archipelago, situated on the southern inshore GBR off the east coast of Australia, supports 525 of fringing coral reefs of significant economic and social value to the region Dominated by fast-growing species such as acroporids, pocilloporids and poritids, coral populations are genetically isolated and persist at the extreme end of their environmental tolerance range in terms of water quality, making these shallow reefs both of scientific interest and of high conservation importance, documenting variability in both spatial extent and severity of bleaching has proved important in shedding light on causal relationships and understanding bleaching thresholds and trajectories on the GBR.

[2] Robert W. Buddemeier, Joan A. Kleypas, Richard B. Aronson, "***Potential Contributions of Climate Change to Stresses on Coral Reef Ecosystems***", a case study from coral reef and Global climate change.

Coral Reefs and Global Climate Change is the tenth in a series of Pew Center reports examining the potential impacts of climate change on the U.S. environment. It details the likely impacts of climate change over the next century to coral reef ecosystems both in U.S. waters and around the world. "CORAL REEF CRISIS" is well-documented and has stimulated numerous publications on the future of coral reefs and their vulnerability to environmental change. The causes of this crisis are a complex mixture of direct human-imposed and climate-related stresses, and include factors such as outbreaks of disease, which have suspected but unproven connections to both human activities and climate factors. By 1998, an estimated 11 percent of the world's reefs had been destroyed by human activity, and an additional 16 percent were extensively damaged in 1997–98 by coral beaching. Widespread coral bleaching, unknown before the 1980s, has brought recognition that reefs are threatened by global-scale climate factors as well as by more localized threats, and that different types of stress may interact in complex ways.

[3] Joanne Wilson, Alison Green, "***Biological monitoring methods for assessing coral reef health and management effectiveness of Marine Protected Areas in Indonesia***" , a case study from THE NATURE CONSERVANCY.

Marine Protected Areas (MPAs) are an effective tool to protect biodiversity and sustainable fisheries on reefs from overfishing and destructive fishing practices. MPAs in Indonesia are usually managed through the development of multiple zoning and management plans to protect biodiversity, reef health and populations of key fisheries species. Biological monitoring described in this protocol is designed to determine if MPA zoning plans have been successful in achieving these objectives and to provide a basis for adaptive management. The results of biological monitoring programs also provide information on changes resulting from improved management which can be reported to government agencies, local communities and other stakeholders. Monitoring information can also contribute to regional and world wide databases to assess trends in reef health across geographic regions and over time.

III. EXISTING SYSTEM

Fig 3.1 shows the block diagram indicating the main parts of the system. The diagram shows the components are interfaced to a PIC microcontroller and a camera these are connected by a wired system and the captured image is send to the LCD by wired connections. An underwater camera is used to take picture of the coral.

This method of monitoring is the primary mode of monitoring using an underwater camera. The Power Supply is given to the microcontroller and is controlled by a computer. The underwater camera is connected through coaxial cables. The picture of the coral reefs is captured and then it displayed. Depending on the picture, the health of the coral reefs is analyzed.

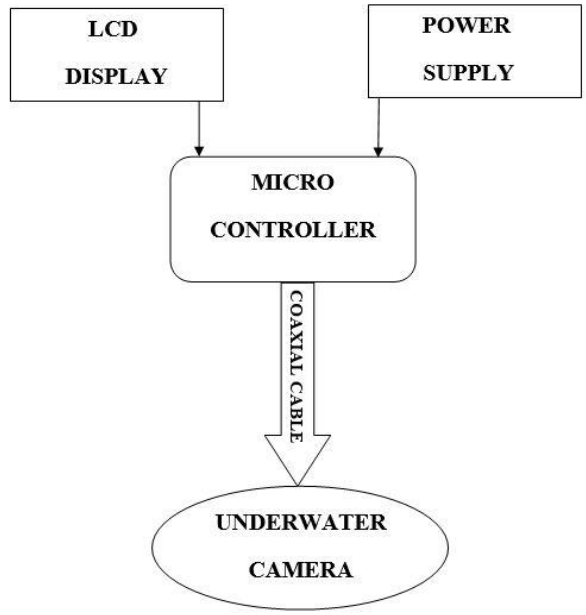

Fig 3.1

1) Results of the Existing Method

The pictures taken by the underwater camera is shown and the healthy and bleached coral reefs are also displayed below

Fig 3.1.1 Comparison of Corals

IV. PROPOSED SYSTEM

This System proposes the design of underwater monitoring system, using low cost, low power and portable sensor to monitor coral reefs on shallow water. By using Internet of Underwater Things (IoUT) architecture, deliver a prototype that has portability, modularity, nearly real-time data transmission, and integration into Big Data architecture. In particular, the contribution of this project is the development of low-cost networked embedded system which monitors the main causes for the coral bleaching. They are Acidification, Color bleaching and Temperature Rise. With the development of this project shows the value or the level of the factors causing damage to the coral is remotely accessed on the mobile.

Sustainable level of factors for Reef-building Corals

- Temperature - (23°C-29°C)
- Color - (olive green, brown, paleyellow)
- pH value - (7.7 – 8.4)
- Salinity Range - (32 – 42 parts/thousand)

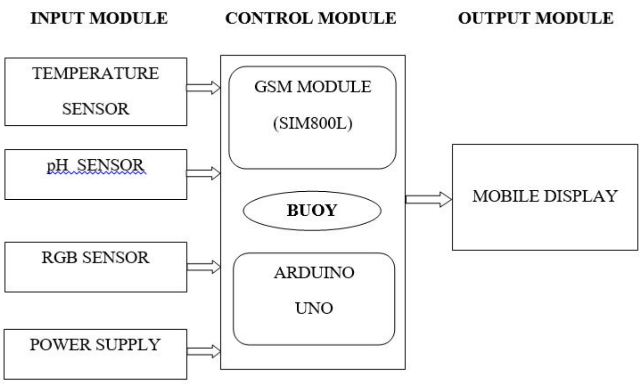

Fig 4.1 Proposed System Architecture

In the Ocean ecosystem, Coral reefs prevent storms and erosion, a source of food for aquatic animals, and a medicine for treating various diseases like leukemia, HIV, ulcers, etc. This project deals with the new optimized method for monitoring the coral reefs in shallow water. A Buoy is used as a base component that floats and carries the receiver, transmitter and control unit. The bleaching of the coral reefs can be noted by the change in the color, rise in the ocean temperature, and change in the pH value, salinity range. So we have used a pH sensor, LDR sensor, Temperature sensor, RGB color sensor. The data obtained from the above sensors are processed by Arduino Uno microcontroller and transmitted to the smartphone through GSM technology. Wireless transmission technique would be incorporated for data transfer. The user would be available with mobile can receive information about the sensed values.

V. SYSTEM DEVELOPMENT

1) Arduino Uno

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

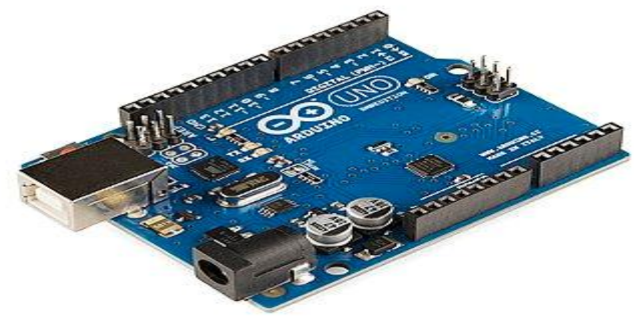

Fig 5.1 Arduino Uno

Pin Configuration

- LED: There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it is off.
- VIN: The input voltage to the Arduino board when it is using an external power source (as opposed to 5 volts from the USB connection or other regulated power source).
- 5V: This pin outputs a regulated 5V from the regulator on the board.
- 3V3: A 3.3 volt supply generated by the on-board regulator.
- GND: Ground pins.
- IOREF: This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source, or enable voltage translators on the outputs to work with the 5V or 3.3V.
- Reset: Typically used to add a reset button to shields that block the one on the board

2) TCS-3200 colour sensor

The sensor has four different types of filter covered diodes. In the 8 x 8 array of photodiodes, 16 photodiodes have Red filters, 16 have Blue filters, 16 have Green filters and the rest 16 photodiodes are clear with no filters. Each type can be activated using the S2, S3 selection inputs. Since each photodiodes are coated with different filters each of them can detect the corresponding colours. For example, when choosing the red filter, only red incident light can get through, blue and green will be prevented. By measuring the frequency, we get the red light intensity. Similarly, when choose other filters we can get blue or green light.

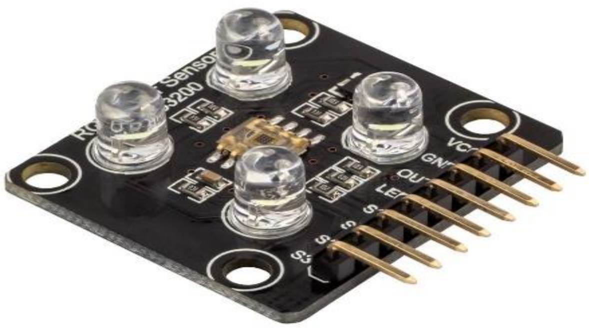

Fig 5.2 RGB Sensor module

Pin Configuration

•	VCC	-	5V	
•	GND	-	GND	
•	S0		-	
•	S1		-	
•	S2		-	Digital Pins
•	S3		-	
•	OUT	-		

3) Temperature Sensor

A temperature sensor is an electronic device that measures the temperature of its environment and converts the input data into electronic data to record, monitor, or signal temperature changes. They are usually infrared (IR) sensors. They remotely detect the IR energy emitted by an object and send a signal to a calibrated electronic circuit that determines the object's temperature.

4) pH Sensor

pH is a measure of acidity or alkalinity of a solution, the pH scale ranges from 0 to 14. It can accurately be quantified by a sensor that measures the potential difference between two electrodes: a reference electrode (silver / silver chloride) and a glass electrode that is sensitive to hydrogen ion. This is what form the probe. We also have to use an electronic circuit to condition the signal appropriately and we can use this sensor with Arduino

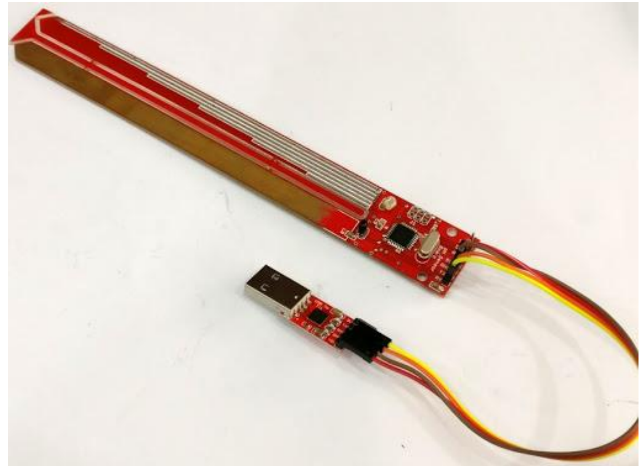

Fig 5.4.1 pH sensor module

5) GSM Module (SIM800L)

SIM800L is a miniature cellular module which allows for GPRS transmission, sending and receiving SMS and making and receiving voice calls. Low cost and small footprint and quad band frequency support make this module perfect solution for any project that require long range connectivity. After connecting power module boots up, searches for cellular network and login automatically. On board LED displays connection state (no network coverage - fast blinking, logged in - slow blinking).

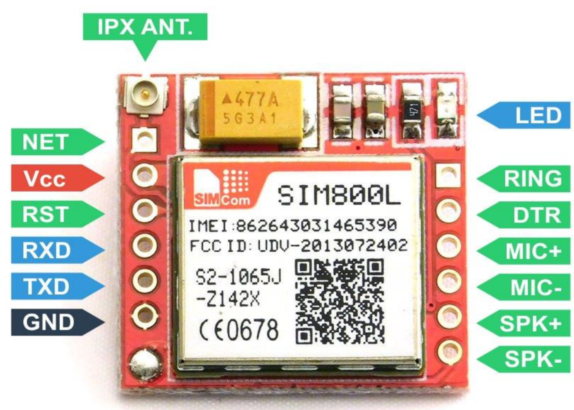

Fig 5.4 GSM Sim module

VI. ADVANTAGES

- By monitoring the coral reefs the coastlines are protected from storms and erosion.
- The life of the aquatic animals gets improved
- Medicines are developed from the corals for treating various diseases.
- By previously knowing the change in the factors the coral bleaching will be prevented.

- Monitoring the coral adds hundreds of million dollars to local business by Fishing, Diving and snorkeling.
- Diseases occurring on the corals will be previously monitored and will be useful for the researchers in protecting them in future.

VII. CONCLUSION

In this world of technological advancement and the need to protect precious coral reefs, the concept of surveillance will be more useful for saving the lives of precious coral reef. Coral reef monitoring supports process that contribute to monitor and communicate all the variation in factors thereby monitoring the reefs will be made easier The concept of shallow water coral reef monitoring can be extended to deep water coral reef monitoring by the use of deep water resistance mechanisms and the signal transmission can also be made faster by 4G network. In case of increased acidification, bacterial infection or other disease arising situation occurs, the coral monitoring can be fitted with respective bacterial.

Result

Fig 6.1 Photo of the prototype

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