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User Friendly Operation of Remotely Operated Underwater Vehicle Using Android Application

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Abstract: This paper reports and describes the development of an unmanned underwater vehicle that can be controlled by mobile app. The design and development of the unmanned under water vehicle, the onboard communications, the instrumentation system, the unidirectional communications platform from mobile app, the vehicle automation, the navigation strategies, as well as the vision systems to help navigation and to carry out the planned surveillance missions, are addressed in this paper. One of the main innovative issues of this platform is the distributed onboard wireless network, based on Bluetooth technology by developing android application. Already existing models are based on remote controlled technique and it needs more training to operate the vehicle. Any confusion occurs while operating the vehicle it may damage the vehicle. To avoid these limitations we are going to create a user friendly android application to control the vehicle in an efficient way without much training. This proposed work simply used by any user that can be utilized for underwater surveillance.

Keywords: ROV, RF, TMS, WSN.

I. NTRODUCTION

Unmanned Systems:
An unmanned system is a machine or device that is equipped with necessary data processing units, sensors, and automatic control and communication systems and is capable of performing missions autonomously without human intervention. Un manned Systems (US) aims to cover all subjects related to the development of automatic machine systems, which include advanced technologies in unmanned hardware platforms (aerial, ground, underwater and unconventional platforms).

Remotely Operated Vehicle:
This paper deals with ROV (Remotely Operated Underwater vehicle), is a tethered underwater mobile device. ROVs are unoccupied, highly maneuverable, and operated by a crew aboard a vessel. In general, ROVs are controlled by RF technology but in this paper it is controlled by mobile application interfacing with arduino via Bluetooth.This mobile application is developed by using Android platform. The Arduino board is a microcontroller board, which is a small circuit (the board) that contains a whole computer on a small chip (the microcontroller). There are different versions of the Arduino board: they are different in components, aim and size, etc. The process is the signal from mobile app is sent via Bluetooth and is received by Bluetooth module which is connected with arduino board and this arduino board is connected with driver module and this runs the motors of the underwater vehicle.

Bluetooth Module:
Here for connecting the mobile application and the Arduino board HC05 Bluetooth module is been used in the proposed work. The control signal generated in the Android mobile application will be sent as characters to the Arduino microcontroller through HC05 Where the micro controller will have decisions of controlling the motors of vehicle controlled by the driver module called LM293D.

Android Application:
The reason we opted for Android application is user friendly and easy to communicate with any hardware interfaces. Then it is widely used. The application developed in the Android studio platform and the code developed in such a way that it'll auto pair with the HC05 whenever it is been ON state. It is a default connection between the devices.

Driver Module:
Driver module is used for the external power supply for motor support. It consists of 16 pins, phoenix connectors which are used for motor connection, PWM (Pulse Width Modulation) selection switch. The module used here is L293D, it is quad push-pull drivers which has the ability to deliver output current up to 1A for each channels. TTL compatible logic is used to control the channels and so each pair of drivers (a full bridge) is enhanced with an constrain input available at p in 1 and pin9 The motor can run only when chip curb is at high logicchip inhibit is enabled The power supply is 12-40V.
The pin configuration of driver module is shown in the picture
After the Arduino processing the control signal will feed to the driver module. From the driver module the motors are directly connected. When we go for real time experiments, if the required input voltage is not sufficient relays can be connected for obtaining certain voltage level.

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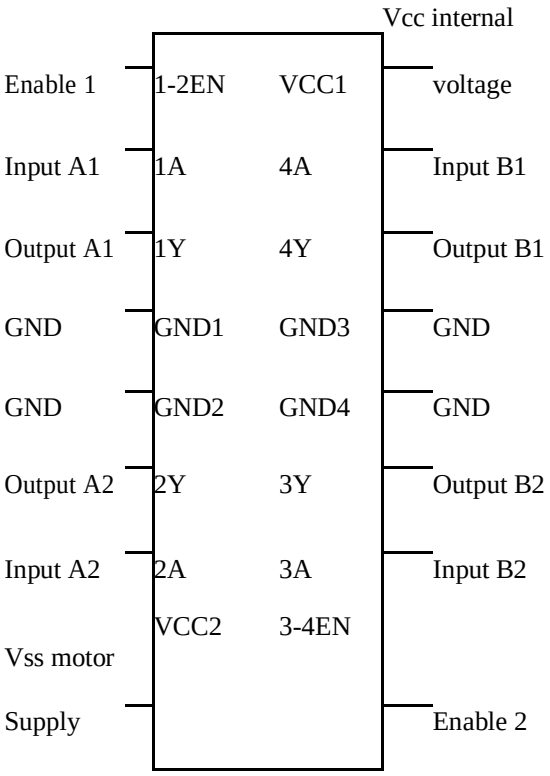


Pic 1: Pin diagram of L239D module

If we need to run 4 motors, we need to connect 4 relays directly with each motor. The ROV having Bilge pump as motors creates thrust under water and moves accordingly from the input of mobile application transferred through Bluetooth technology.

II. EXISTING METHODS

So many researchers are working in this emerging field and developing solutions for unmanned systems. Particularly designing the unmanned system itself having lot of issues of maintaining stability and endurance

Tethered Control for vehicle movement:

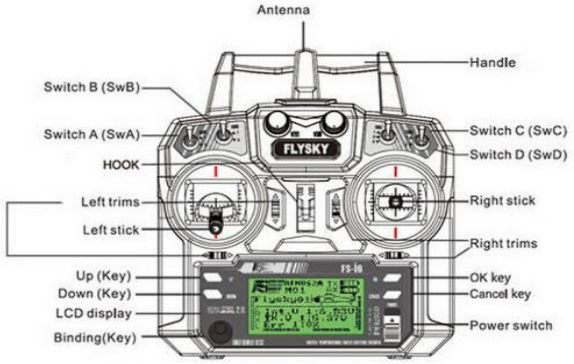
The tethered underwater vehicle is common in deep water missions such as offshore hydrocarbon extraction, study of habitation of sea lives, examining the pipeline under sea, analysis of water quality and so on. Linked to a host ship by a neutrally buoyant tether or, often when working in rough conditions or in deeper water, a load carrying umbilical cable is used along with a tether management system. TMS is either a garage-like device which Contains the ROV during lowering through the splash zone or, on larger work-class ROVs, a separate assembly which sits on top of the ROV. The purpose of the TMS is to lengthen and shorten the tether so the effect of cable drag where there are underwater currents is minimized.

ROVs are equipped with at least a video camera and lights. Work-class ROVs are built with a large flotation pack on top of an aluminum m chassis to provide the necessary buoyancy to perform a variety of tasks. ROVs are also used extensively by the scientific community to study the ocean. A number of deep sea animals and plants have been discovered or studied. Another possible way of connecting ROV is by using tethered cable; these cables supply the vital link from the ROV to the surface or control module. Either directly or via the tether management system (TMS) through main lift umbilical. The total services provided by the tether are power, signal, and communications via optical, coaxial, or twisted pair conductors. The problem in tether is, it cannot travel for long time since the control signal can be transferred through the tether can reach the vehicle for a certain distance. If it increases, the vehicle will not have even power for operating the vehicle.

RF Controlled ROV:

The RF transmitter is used for controlling the unmanned systems. The transmitter having multiple channels so that we can increase the additional applications by having all the controls through the channels.

This can be handled professionally by the trained people and definitely not with the normal user. Controlling though RF controller is bit difficult particularly for the underwater vehicle. During underwater controlling the vehicle is not easy. Because we cannot stop the vehicle at the moment since it goes through with the water flow. So simple user friendly application or device is required while controlling the vehicle under water.



Pic 2: RF Transmitter with multiple channels

Our proposed work has the solution of developing simple application controlled the whole vehicle movement in an easy way. All the android mobile will support this application in such a way any lay man can easily operate the vehicle through this application.

Autonomous Path navigation using WSN:

This proposed work is about the vehicle moves autonomously using the wireless sensor networks. The vehicle have hydrophones at the bottom of the design and the WSN emits the acoustic signal which is been deployed under water. So using SONAR technology the sound waves produces underwater and both WSN and receiver part of vehicle communicates. By having sequence of multiple sensors the submarine or ROV traces the signal and travels under water continuously without human interface.

The Wireless sensor networks will have the components of transceiver so that it can transmit and receive the acoustic

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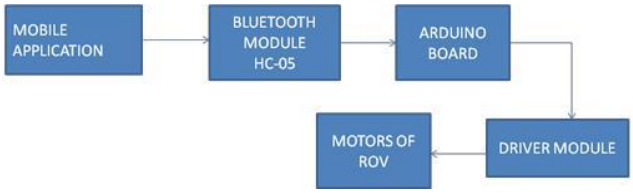
signals. The signal transmitted continuously and the unmanned underwater vehicle traces the acoustic signal. And it travels by tracing the next signal transmitted by next WSN. The quality of water content, habitation of underwater lives can be studied in a constant place using this project. This proposed work can be applied for a constant path where the vehicle can travel and come back. It is not flexible for moving all around the places where the human wants to. For regular monitoring in a constant path underwater this proposed work can be applied.

III. PROPOS ED MET HOD

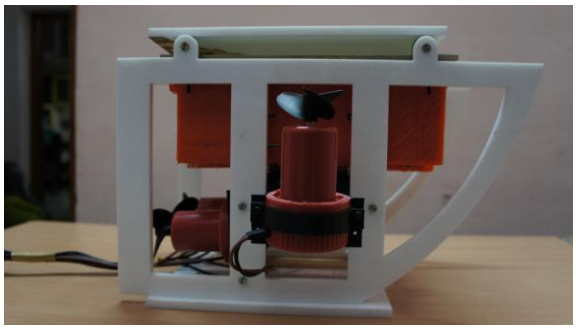
As mentioned in the existing method the underwater ROV vehicle is controlled by tethered cables but in this paper the underwater vehicle is controlled by android mobile application.



Pic 3: Block diagram of Proposed work

Phase-I: Design & Fabrication of ROV

The material used in this research was the chassis of ROV made from acrylic sheet and using some electronic components. The propeller made from alloy -copper material The first thing to building the frame of ROV, have to cut Plexiglas windows and sanded them to Fit inside the pipe. This is schedule 40 ABS pipe sewage. Using the CATIA Software the ROV parts are designed and cut by the laser for getting the perfect finishing of vehicle.

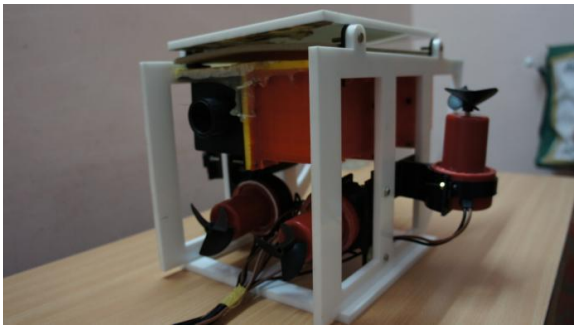


Pic 4: Side view of the designed ROV

The side part of ROV has the 5cm square gap in order to connect the Bilge pump. The Bilge pump top portion is been replaced with the propeller. The propeller having the capable of 600 RPM and can create better thrust under the water. There are four Bilge pumps are connected in the vehicle. Two are connected horizontally for vehicle direction, forward and reverse. By giving the reverse current the vehicle can create thrust against the normal flow and vehicle gets moving backwards. This is how the vehicle can be controlled forwardly and reversely. the thrust in terms of volumetric flow rate can be calculated

F = 4*Density*Q^2/(Pi*D^2)

The two pumps connected vertically used for creating thrust upward and downward so the vehicle can move upwards and downwards vice versa. While giving the reverse current to the vertical motors the vehicle can create thrust against upper flow and moves down. The chamber is a water proofed box can contain all the electronic components. The chamber parts are designed and printed using he 3D printer. The chamber having a whole for tether coming out of the circuit which is connected with the buoy floating on the water surface. The whole is connected with 'O' ring belt for Making the chamber water proofed.



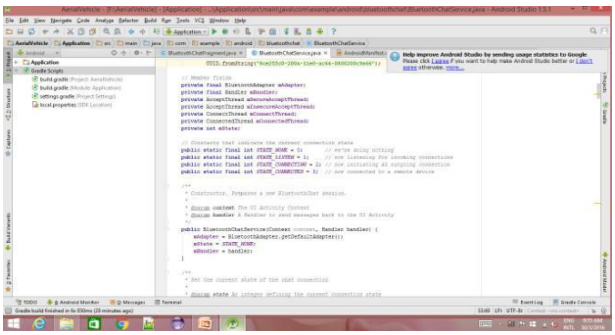
Pic 4: ROV contains the chamber and Bilge pumps

The top part of the vehicle having a plain acrylic sheet covers the whole top surface. Since the design of vehicle is a miniature type the upward thrusters are connected at the outside of the vehicle. All the Bilge pumps can work effectively with the 12V input. So if the output of the driver module not having the 12V it can be connected with the relays for increasing the voltage level. This ROV is a cost effective efficient vehicle having a great design which includes the consideration of movement in under water.

Phase-II: Android Application Development

Android powers hundreds of millions of mobile devices in more than 190 countries around the world. It's the largest installed base of any mobile platform and growing fast—every day another million user's power up their Android devices for the first time and start looking for apps, games, and other digital content. Android gives you a world-class platform for creating apps and games for Android users everywhere, as well as an open marketplace for distributing to them instantly.

Design:



Pic 5: Android studio software

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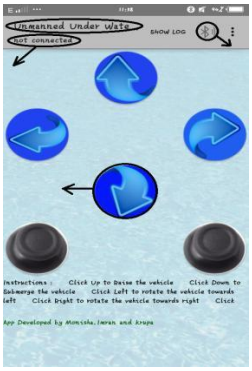
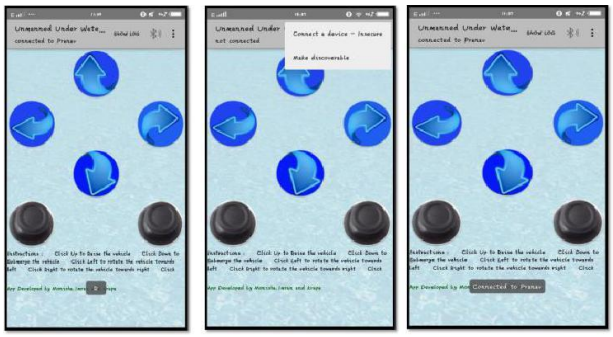
Before you write a single line of code, you need to design the user interface and make it fit the Android user experience. Although you may know what a user will do with Your app, you should pause to focus on how a user will interact with it. Your design should be sleek, simple, powerful, and tailored to the Android experience.
For the proposed work Android studio is been used for developing the code. Our aim of the proposed work is create an user friendly application to navigate or control the underwater vehicle. Right now we tried with Bluetooth enabling software or application for interfacing with Bluetooth Module using the android studio software.



Pic 6: Mobile Application

Develop:
Once your design is finalized, all you need are the tools to turn your app ideas into reality. Android's framework provides you the APIs to build apps that take full advantage of device hardware, connected accessory devices, the Internet,software features, and more With the power of Android, there's no limit to the power of your apps. Initially the mobile application having multiple buttons of right, left, upward, downward, forward and reverse for controlling the vehicle.



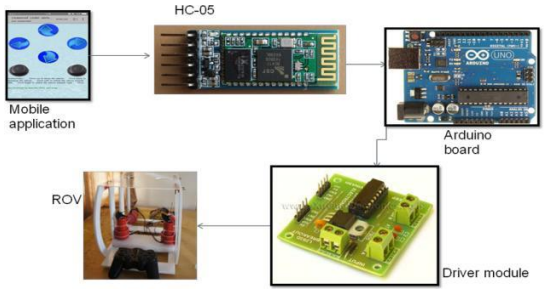
Pic 7: Connecting through Bluetooth

Each button having the unique characters of D, U, R, F, L While pressing it. After connecting with the Bluetooth module if we press the button that unique character will be transferred to the module or device.

Phase-III: Bluetooth Module Interfacing
HC-05 Bluetooth module is an easy to use Bluetooth SPP (Serial Port Protocol) module, design for transparent wireless serial connection setup. Hardware Features - 80dBm sensitivity, up to +4dBm transmit power, PIO control UART interface with programmable baud rate.

Pic 8: HC05 – Bluetooth module

Software Features -auto connect to the last device on power as default, auto reconnect in 30 min when disconnected as a result of beyond the range of connection.
In our module, The MAC address of HC05 is embedded in the module is **98:D3:31:30:A1:2B**. Once it is connected manually for the first time, then whenever the application through mobile searching for signal, if the Bluetooth module HC05 gets power, it will connects with the mobile application automatically So the auto pair algorithm also added in the coding.



Pic 9: Hardware Diagram of Project layout

The Bluetooth module is connected with Arduino board for processing the data. Arduino is an open-source Platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environ ment) that runs on your computer, used to write and upload computer code to the physical board for doing certain actions.
Now have to interface Bluetooth module and arduino have to do basic connections using software serial library to make p in D10&D11 as TX and RX instead of using default RX and TX. After the connections program

Pic 10: Receiving control signal to the Arduino

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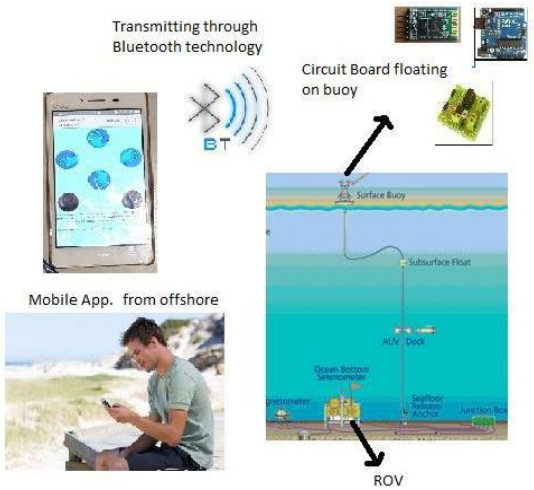
to be uploaded in arduino then the mobile and the Bluetooth module can be paired automatically.
The Arduino board gets the control signal as characters from the Bluetooth and sends the control signal to L293D driver module for controlling the motors of underwater vehicle. The control signal is in another form of enabling the pins of driver module. The driver module gives the power for motors when it gets the voltage on the corresponding pin. The voltage require for each motor consumes 12v.

Phase-IV: Controlling the ROV
The L293D is a 16-p in motor driver IC which can control a set of two DC motors simultaneously in any direction. The L293D is designed to provide bidirectional drive currents of up to 600mA at voltages from 4.5V to 36V. The connections are given as per the circuit diagram which is given by the driver module.

Pic 11: Proposed work

Then the external power source is given to L293D pin 8. The code has to be written for connecting the motor driver with the arduino module. Then as per the directions mentioned in the interfacing code the vehicle is operated in the underwater. If right button is pressed in the mobile application, the alphabet will be transferred to the arduino board through the Bluetooth module HC05. Then Arduino process the character and according to the character 'R' it will run the right horizontal Bilge pump alone. So the ROV vehicle gets right turn while moving under water with the water current flow.



Pic 12: Project work flow

Similarly while pressing the reverse button, The Driver module sends the reverse voltage to the horizontal bilge Pumps. So it started sucks the water inside and getting moved backwards. For forward direction, Horizontal pumps with positive voltage. The vertical bilge pumps are used to move upward and downward by changing the voltage positive and negative getting from the driver module and controlled by Arduino board. The program in Arduino being interface between mobile application and the Vehicle ROV.

IV. CONCLUSION

The proposed work can be implemented in a small pond; because of we have gone with the Bluetooth technology. So the distance from the offshore to the buoy cannot be extended over 10 meters. The work is about; the user friendly mobile application will be handled by the user from the offshore. The Bluetooth module along with Arduino and driver module will be in buoy which is floating on the water surface. The tethered ROV will be underwater and move along with the camera. So the user can by seeing the path captured by ROV and can navigate the vehicle through mobile application.
In future, rather having Bluetooth technology the distance between offshore and buoy can be extended by implementing Wi-Fi technology. And this can be extended to the real time ocean by having Wi-Fi or Wimax wireless technology.

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