

Autonomy Underwater Drone-Detailed Literature Study

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Abstract: *Autonomy robots (AUDs) are controller submerged robots driven by a person or a group on the earth's surface level. A series of wires connects the administrator and the AUD, attaching these drones. Every AUD has been outfitted with a propulsion system, video camera and lights. A novel concept has been proposed. The AUD system is a ZigBee-based mobile robot that moves and controls the AUD.*

Keywords: *Autonomy underwater drones, sensor networks, information and communication technology, ZigBee*

I. INTRODUCTION

There is insufficient evidence to determine who invented the first AUD. Regardless, two people deserve a lot of credit for the idea [1]. In 1864, Luppis-Whitehead Automobile in Austria created the Programmed Underwater Vehicle (PUV), a torpedo [2]-[4]. The underwater environment has long been a difficult zone for human activity, both commercial and military [5]. The Indian Navy established a new dedicated Air Squadron to operate these UAVs as a component of maritime surveillance in several locations [6]-[11]. The Naval Squadron was designed for shoreline 'dispatch and recovery' of such UAVs, using UAV Directing orders from the ships [12]. They typically carried an electro-optic camera and Communication Intelligence payload [13]-[17].

The primary goal of this study is to develop data collection strategies [18]-[21]. The propulsion and dive concepts range from a single propeller with a rudder for control and a counterweight tank for driving, such as in Neptune drone, to a vectorial thruster configuration that allows movement in various directions, such as in BlueROV2 [22]-[27]. The robots seem to be either connected and connected to a live video stream or commanded remotely via radio signals [28]-[35]. It will enable capabilities such as establishing a fixed depth and/or orientation that is continuously maintained by the self-adjustment of thruster speed based on real-time processing of the pressure sensor and compass available locally [36]. Drones were launched from bridges, boats, and the margins of bodies of water. When the water isn't a direct approach, the tether rope can keep the vehicle at its stable weight [37]. This study presents a novel idea for an underwater autonomous vehicle system, which consists of two sections: an underwater mechanical robot and a ZigBee wirelessly based adaptable robot that controls and moves the first segment [38]-[42].

This work has grown three types of wireless control, including the Artemia movement controlled by light, underwater mechanic robot remote control utilizing magnetic field, and wireless sensor such as ZigBee standard-based mobile robot, as shown in Figure 1 [43].

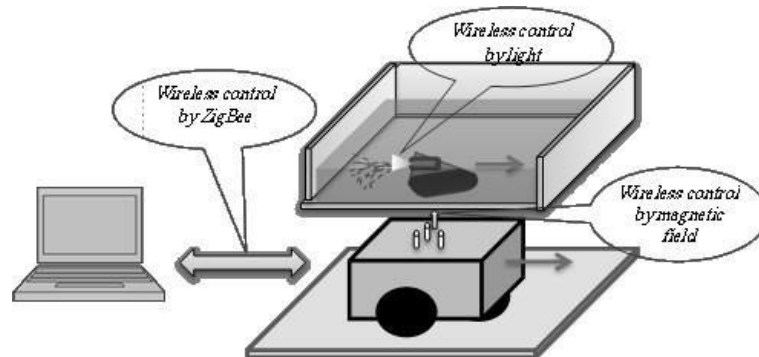


Fig. 1. ZigBee standard-based mobile robot

II. DESIGN MODEL

This plan utilizes two legs at the lower part of the AUD, giving various capacities [44]-[47]. The ability to place lead bars into the legs and add tenderly light material to the top guarantees that the AUD stays upstanding consistently [48]. One more justification for the unit's presence is that it will want to lay on the ground while doing its predefined capacities, assuming it is working at water profundities [49]-[55]. To wrap things up, append the hooks to these legs, which will be changed straightforwardly before the camera. This methodology additionally incorporates the utilization of four engines [56]-[61]. The ascent and jump will be given by the two found uniformly in the wing, while the versatility in the level plane will be given by the other two mounted closer to the finish of the wings [62]. The engines are housed in PVC pipes with a lower width formed into the body. Assuming the AUD goes excessively near a divider or crashes into any articles or trash, this will help to defend the engines (figure 2) [63]-[65].



Fig.2. Design Model

Material Alternatives

Various criteria, such as the safety aspect, substance, length, thickness and diameter, were investigated [66]. As a result, a spreadsheet was created to enter each of these factors and calculate the most extreme profundity with the corresponding expense. The autonomous submarine's wiring, circuitry, and cameras will be housed in a barrel [67]-[71]. The breakdown analysis focused on the behaviour of this cylinder as

the depth increases. The connected spreadsheet page employs the tests for circle, longitudinal, and axial stress to check the principal stresses [72-95]. It relates the primary stress to the Von Mises correlation to confirm safety. The equations are listed in the table below.

$$\sigma_H = \frac{p * r}{t}$$

$$\sigma_L = \frac{p * r}{2t}$$

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\frac{\sigma_x - \sigma_y}{2}^2 + \tau_{x,y}^2}$$

$$\sigma_{vm} = \left[\frac{(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2}{2} \right]^{0.5}$$

$$SF = \frac{\text{Yield strength}}{\sigma_{vm}}$$

The following investigation is based on a few assumptions. The cylinder, for example, will function as a pressurized vessel with negative internal pressure [96-117]. The pressure in the atmosphere will be 101.325 kilopascals [118-155]. As an alternative guess. The ocean water in which the submersible would be working to have a tensile strength of 1027 kg/m³. Some items will be acknowledged for the submersible, such that cost versus depth correlations 10 can be developed [156-171]. The materials mentioned are widely available and range in price from Rs.842 to over Rs 2,98,000. The listing below includes all of the materials that have been acknowledged [172-189].

- Stainless Steel 316
- Aluminium 7075
- Grade 2 Titanium
- Grade 5 Titanium
- 40 PVC Schedule
- 80 PVC Schedule

These expectations have various boundaries, and a couple has been brought to a predictable state because of the material connection's effortlessness [190-193]. The distance across, length, thickness, and profundity are the elements that can be adjusted for progression while keeping up with inside a security component. This empowers us to determine which of the six materials will bear the best profundity while keeping up with the boundaries of safety prerequisites. This also allows you to explore different avenues regarding different size mixes to perceive how they impact the end- product (tables 1 and 2).

Table 1. Factor of Safety at each Depth

PVC Sch. 40		Stainless Steel 316		Aluminum 7075		PVC Sch. 80		Titanium (Grade 2)		Titanium (Grade 5)	
Depth	FoS	Depth	FoS	Depth	FoS	Depth	FoS	Depth	FoS	Depth	FoS
50m	15.817	50m	15.887	50m	17.634	50m	24.403	50m	33.093	50m	66.199
100m	8.636	100m	8.675	100m	9.628	100m	13.324	100m	18.069	100m	36.145
200m	4.526	200m	4.546	200m	5.046	200m	6.983	200m	9.47	200m	18.944
300m	3.067	300m	3.08	300m	3.419	300m	4.732	300m	6.416	300m	12.835
400m	2.319	400m	2.329	400m	2.586	400m	3.578	400m	4.852	400m	9.706
500m	1.864	500m	1.873	500m	2.079	500m	2.876	500m	3.901	500m	7.803
600m	1.559	600m	1.565	600m	1.738	600m	2.405	600m	3.261	600m	6.524
610m	1.534	610m	1.541	650m	1.606	770m	1.881	900m	2.186	1300m	3.038
620m	1.509	620m	1.516	690m	1.515	900m	1.612	1100m	1.793	2000m	1.98
624m	1.499	627m	1.499	697m	1.499	969m	1.499	1317m	1.499	2644m	1.499

Table 2. Depth to cost Analysis

Cost Analysis	Percent of Budget	Depth to Cost Ratio
PVC Sch. 40	0.56%	55.4
Stainless Steel 316	3.64%	8.6
Aluminum 7075	4.82%	7.2
PVC Sch. 80	0.74%	65.2
Titanium (Grade 2)	17.07%	3.9
Titanium (Grade 5)	47.15%	2.8

III. MAJOR COMPONENTS

AUD moves across the water utilizing engines and propellers. Engines are a blend of engines and propellers. Spouts are engines with a cowling on them and extraordinarily moulded edges to acclimate to inside the cowling. Propellers have specific qualities that show what mix ought to be utilized for the assignment and size of the AUD. These attributes are as per the following:

- The hub is the centre of the propeller.
- Blade Filet: the radii defined by the cutting edge faces progressing into the centre.
- Pressure Face: the propeller edge's forward essence.
- Leading Edge: the side that runs parallel to the propeller centre's forward finish.
- Trailing-Edge: the sharp edge that runs parallel to the back of the propeller centre.
- Blade Tip: the sharp tip of the propeller's outer range.
- Emitter Holes: apertures bored along the main margin of a channel.

The size of the propeller to be used is represented by two sets of integers. These numbers determine the width and pitch. The breadth will always come first, followed by the pitch (figure 3).



- ## Thrusters

Special care was taken to ensure that the power output matched the motor's yield when selecting the motor. In this way, having a large motor may draw enough current to slow down execution while working at a lower power. But at the other extreme, if it is too low, the quantity of push produced will be inadequate. Following the selection of a motor, the best propeller for the job must be selected. While doing so, we should choose a propeller with a larger diameter than the motor's diameter. The diameter and rotational speed of the motor in RPMs will determine the sharp blade's pitch. The width of the edge decides the measurement of water it pushes accordingly lighter or more slender sharp edges are utilized for higher speed applications. Even though these attributes will assist us with figuring out which blend will be the most sufficient for our situation, the last mix could be perfect for experimentation. Following some research on the subject, Two motors were chosen as the best combination of propeller and engine to meet the AUD's requirements. Underneath, these engines will be recorded. Due to our speed regulators being assessed at 30 amps max and still delivering enough rpms, Engine 1 was chosen because of its minimal momentum need to work underwater (figures 4 to 5).

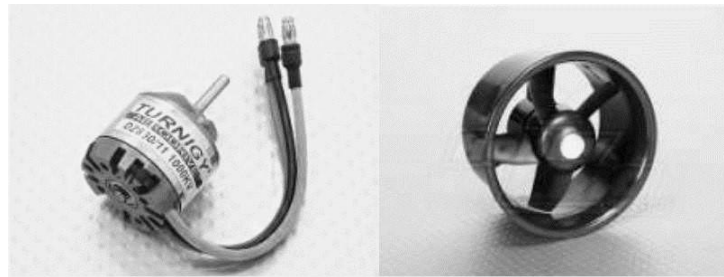


Fig. 4. EDF Ducted Fan Unit with Brushless Motor



Fig. 5. EDF65 Fan with Assembled Motor

Camera

The camera's essential objective is to work at low voltage, with a further developed goal and a low Lux light awareness rating: the lower the Lux rating, the more prominent the camera's low- light execution. Since the AUD will be diving to profundities of around 80 feet, the light will undoubtedly be a worry. The AUD has underlying lights, but the lower the Lux level, the better for cameras. The following is a rundown of the three cameras that were researched. The GoPro Hero2 would be the best since it has the most noteworthy goal and a battery-powered battery, which permits us to save power from the installed batteries that would be expected to drive the engines utilized to control the AUD (figures 6 to 8).

Advantages of the GeoVision CAMCCR25 camera module:

- Color video with a resolution of 380 pixels

Disadvantages:

- Sensitivity of 2.0 Lux

Advantages of the Sony SN555 Color Camera

- Lightweight aluminium housing for camera protection
- .1 Lux sensitivity rating

Disadvantages:

- A clean 12V power source is required because there is only a 10% tolerance.

GoPro Hero 2 camera

Advantages:

- 1080P resolution for recording
- 1100 mAh rechargeable battery to enable it a stand-alone system.
- Widescreen footage requires a 170-degree lens view angle. Disadvantages:
- Expensive



Fig. 6. Sony SN555



Fig. 7. GeoVision CAMCCR25



Fig. 8. GoPro Hero 2

Display Screen

The significant motivation behind the showcase screen is to introduce a camera stream from inside the vessel, where the camera is arranged at the front. The CAT3 Tether and a composite to RCA Adaptor will be utilized to get this feed. The screen's essential capacity will be versatility and reasonableness. Three showcases were picked for correlation, with the Axion 7" LCD TV AXN-8701 being one of them would be the best since it can offer the elements needed for the similarity with the camera installed of the AUD (figures 9 to 11)).



Fig. 9. Broadcast Monitor Aputure VS-1 7"



Fig. 10. Everfocus Electronics EN220 6" Monitor (\$209)



Fig. 11. Axion 7" Widescreen LCD TV (\$120)

Gripper Robotic

To finish the difficulties, the AUD should have the option to respond rapidly and handle the numerous things that should be moved while contending. Typically, a one-arm set-up is utilized a great deal by different robots testing since it ends up being less savvy, yet for being in the stable of the articles being taken care of and would be furnished with two mechanical grippers that would be controlled independently to boost the hold on the item and would be outfitted with two automated grippers (figure 12).



Fig. 12. Robotic Gripper

Remote Control

The AUD has many features that let it move about freely and control both robotic grippers. An aggregate of six methods will want to be constrained by the client at any second to accomplish each of the functionalities proficiently. The Futaba Skysport 6 channel controller is the best option because it allows for independent control of all four motors and robotic grippers, depending on the application (figure 13).



Fig. 13. Skysport 6 Channel Controller by Futaba

It is expected for any engines that ought not to be set off during the AUD while pivoting their hub, pushing ahead or in reverse with no sideways deviation, and expanding or diminishing with few issues. The Futaba Skysport's distinct nobbs will allow you to determine the amount of grip each robotic arm will use while attempting to hold objects.

IV. POWER SUPPLY

The battery inside the ROV will be replaced with the ROV Power Supply Enclosure, which contains a power supply capable of converting 400-volt power to the 15 volts required by the ROV. It starts with a pre-installed power link and a tie signal link with penetrators, making it a drop-in replacement for a real battery tube. Two wet-mateable electrical connectors are installed inside, allowing the ROV to be linked and removed from the tether cable (figure 14).



Fig. 14. ROV-Power Supply

V. ZIGBEE NETWORK OF WIRELESS SENSORS

ZigBee is a correspondence convention for uninformed rate short-range far off systems administration characterized by many guidelines. Remote devices in light of ZigBee work in reiteration gatherings of 868 MHz, 915 MHz, and 2.4 GHz. The most elevated speed of data is 250 K pieces each second. ZigBee is planned fundamentally for battery-fueled applications that require a low information rate, simplicity of use, and long battery duration. The ZigBee Alliance, which incorporates an assortment of partners from semiconductor organizations and programming specialists to unique gear producers (OEMs) and installers, fostered the ZigBee standard. The ZigBee Alliance was established in 2002 as a non-benefit association accessible to anybody who wishes to join. The IEEE 802.15.4 Physical Layer (PHY) and Medium Access Control (MAC) shows have been taken on by the ZigBee standard. Like this, a ZigBee-empowered contraption additionally conforms to the IEEE 802.15.4 norm. Figure 1 portrays the ZigBee far off frameworks the executives show layers. The ZigBee show layers utilize the crucial reference model of the Open System Interconnect (OSI).

For ZigBee remote association, the XBee ZigBee/Mesh RF module was utilized. XBee ZigBee/network modules empower designers both ZigBee network and the bound to-be- conveyed exclusive DigiMesh™ for applications where solid lattice organizing geographies are wanted. These associations empower contraptions to address the whole association of RF modules to effectively broaden range past that of a solitary module and make a more steady and solid association. XBee ZigBee/network RF modules simplify network design and are clear to convey by using dynamic self-repairing, self-disclosure handiness for solid correspondences. The XBee module is incredibly simple to utilize. The point of interaction depends on a basic trade with a consecutive port, which can be effectively taken care of by a microcontroller or a PC, as displayed in Figures 15 to 16.

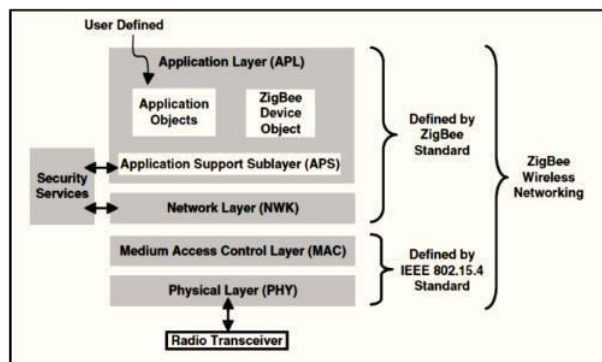


Fig. 15. Layers of the ZigBee Wireless Networking Protocol

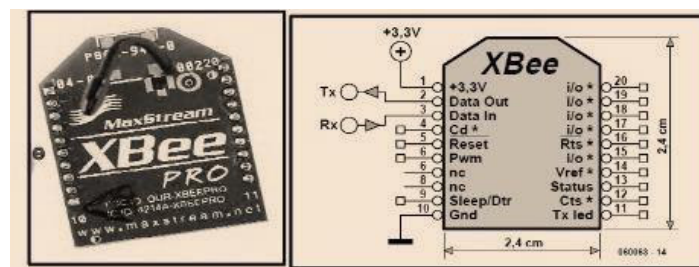


Fig. 16. RF module for ZigBee/Mesh from XBee

VI. CONCLUSION

AUD is the most effective equipment for inspecting and surveying natural and man-made water bodies. Its main purpose is to assist the Indian Navy in locating the unusual activity discovered beneath the surface. It can also gather the expertise that local fishermen demand and collect data for research objectives. The equipment will also determine and distinguish anything found in the lower section of the lake that must be removed to maintain the lake's or specific water body's ecology.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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