# Autonomous Piloted Tethered Submersible Vehicle Used For Marine Intervention Incorporated With Instantaneous Retrieval System

Submitted in partial fulfilment of the requirements

for the degree of

**Mechanical Engineering**

by

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Under the guidance of

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**Mechanical Department**

School of Engineering

**Anjuman-I-Islam's Kalsekar Technical Campus**

Sector- 16, Khandagaon, New Panvel- 410206

Maharashtra State Board of Technical Education

**2021**

# CERTIFICATE

This is to certify that the project entitled "**Autonomous Piloted Tethered Submersible Vehicle Used For Marine Intervention Incorporated With Instantaneous Retrieval System**" being submitted by **Prof. Arshad Qureshi**

is worthy of consideration for the award of the degree of "**Mechanical Engineering**. and is a record of original bonafide carried out under our guidance and supervision. The results contained in this respect have not been submitted in part or full to any other university or institute for the award of any degree, certificate.

**Mr. Mohd Ismail Shaikh(16ME78)**

**Mr. Shaikh Basit Hussain(17ME89)**

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**Mr. Prof. Arshad Qureshi**
**(Project Guide)**

**(External Examiner)**

**Mr.PROF.ZAKIR HUSAIN**
**(HOD,Mechanical EngineeringDept.)**

Dr.**Abdul Razak Honnutagi**
**(Principal, AIKTC)**

# Declaration

I declare that this project report entitled **"Autonomous Piloted Tethered Submersible Vehicle Used For Marine Intervention Incorporated With Instantaneous Retrieval System"** represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any data/fact in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

**Mr. Mohd Ismail Shaikh (16ME78)**

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Date: 29/05/2021

Place: New Panvel

# Acknowledgement

I consider myself lucky to work under guidance of such talented and experienced people who guided me all through the completion of my dissertation.
I express my deep sense of gratitude to my guide **Mr.Prof. Arshad Qureshi**

Lecturer of Mechanical Engineering Department, and **Mr.Prof. Arshad Qureshi** for his generous assistance, vast knowledge, experience, views & suggestions and for giving me their gracious support. I owe a lot to them for this invaluable guidance in spite of their busy schedule.
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I also take this opportunity to thank my Friends for their support and encouragement at every stage of my life.

Date:29/05/2021

# ABSTRACT

The 500-word abstract shall highlight the important features of the thesis/dissertation/ project report and shall correspond to the electronic version to be submitted to the Library for inclusion in the website. The Abstract in the thesis, however, shall have two more parts, namely, the layout of the thesis giving a brief chapterwise description of the work and the.

# APPROVAL SHEET

This dissertation report entitled **"Autonomous Piloted Tethered Submersible Vehicle Used For Marine Intervention Incorporated With Instantaneous Retrieval System"** by

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is approved for the degree of "Meachanical Engineering"

Examiners

1. ……

2. ……

Supervisors:

1. ……

2. ……

Date:29/05/2021

Place: Panvel

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# Chapter1: Introduction

**Ocean** Engineering & Research is a broad network which starts from getting into water and exploring the natural habitat along with maintainence of man made systems like electricity cables, optical fibre cables & pipes.

The history of marine biology may have begun as early as 1200 BC when the Phoenicians began Ocean Voyages using celestial navigation. Even the greatest & the most ancient philosopher, Aristotle had writings on references to marine life around 384-322 BC. He is also reffered as father of marine biology because he was the first to record observations in marine life.

After that, modern explorations were begun by Captain James Cook from 1728-1779 in 18$^{th}$ Century in Britian. After circumnavigating the earth twice, he had logged descriptions of numerous plants & animals which were unknown to most of the mankind. Following Cook's exploration, scientists like Charles Darwin conyributed significantly to early study of marine biology.hid expedition aboard HMS beagle from 1831-1836were spent studying & collecting specimens. The marine laboratories around the world started following these expeditions & began showing interests in study of Marine biology.

Exploration of deep sea technology brought the study of marine biology to new heights during the years of expedition on HMS Challenger. Also, in 1934, William Beebe & Ortis Barton descended 923 m/3,028 ft below the surface in a bathysphere designed & funded by Barton. This depth record was not broken until 1948 with the same bathysphere with some modifications which dived upto 1372 m/4500 ft.

This record for observations & depth was further broken down by Challenger Deep, in the Marianna Trench uptill a depth of 10,916 m/35,813 ft.

Advancements happened over a long period of time & there came a year where instead of humans, a robot was sent to the depths i.e. AUV (Autonomous Underwater Vehicles). It was a part of a long chain of such similar vehicles which were named as Remote Controlled Vehicles or Unmanned Underwater Vehicles. The best advantage of

having such marine technology was that it can be applied to diverse fields ranging from commercial cleaning purposes to defence along with advance intelligent purposes.

AUV's were first created in the year 1957 and from that point on, they came into lime light of marine explorers enthusiasts and marine researchers. Massachusetts Institute of Technology further developed the AUV technology in the year 1970 after which the standard of AUV's was raised to an altogether new level.

An AUV uses a computer system that can be manned from a ship or a naval vessel from which it is being launched or deployed. It has mountings like compasses, thermal resistors, sensors which are useful for navigation & data collection. It has to be noted that AUV as a marine technology operates and navigates on the basis of Underwater Acoustic Positioning System which uses the aid of GPS which helps to propel it further. With so many technological aids to help the marine technology of an AUV is a very successful apparatus when it comes to underwater recon & scouting.

In the modern era, there are variety of vehicles like SUV's and ATV's which are used for variety of purposes based on different applications. But amongst all these, AUV provides with facilities like no other. Autonomous Underwater Vehicle is a very important development that has taken place in contemporary times and will continue to grow & bloom.

## A: Problem definition

The AUV's currently present and used are of Torpedo shape and bulky in nature. We aim to make it more compact and light weight. We focus on collecting more data, more safety into the light weighted compact AUV.

## B: Aim/Objective/Purpose of the Study

Our aim is to make it more compact and light weight with higher power and more efficiency so that it can be used for exploration at greater depth. We focus giving more data more power and more safety into a light weighted compact AUV which will help in research.

## C:THE FUTURE

AUV advancements have been mainly in the technology and techniques in areas like systems, sensors, batteries etc etc. This has presented opportunities for manufacturers to be able to compete with traditional techniques both in terms of quality and cost for a range of applications. As per the blogs on 4coffshore, many entrepreneurs alongside with private companies are in collaboration and are working on ways to increase the use of it for coastal surveys. The study also focuses on a series of recommendations for future use of AUV technology for mapping across areas of data quality, positioning, vertical reduction and data output formats.

Also, SUT (Society for Underwater Technology) has confirmed with their blog that in industries such as Oil & Gas and also Militaries would be using it for going into inhospitable places.

Important Enabling technologies include:

Navigation (especially inertial navigation systems) and collision avoidance (both the sensors and logic), long range acoustics : low BW for supervisory control of the missions & high BW for data transmission to the surface.

## D: Materials

High strength/Low density materials together with novel structural design techniques, to provide great depth facility with minimum weight penalty.

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# REVIEW OF LITERATURE

Ocean Engineering and Research has been a predominant field of interest for explorers & has grown exponentially in the last few years.

However, with the current technology we have,we still face some challenges in terms of intervention on the areas like Design, Navigation and Communication. But, by incorporating the design techniques given in [3] & [4], which explains the importance of Hull Design. Whereas, in terms of navigation, we intend to use various control systems strategy as mentioned in [1].

| Sr No | Author | Title |
|---|---|---|
| 1 | Riya Rout | Control of Autonomous Underwater Vehicle |
| 2 | Uzair Ansari & Abdul Rahaman. H. Bajoda | Autonomous Underwater Vehicle Control using Neuro-Adaptive Generalized Dynamic version |
| 3 | Allessia Mesdiui<br>Allen Saudro Ridolfi<br>Andre Rindi | Pressure Hull Designs for Unmanned Underwater Vehicles |
| 4 | Steve Thone | Basic ROV Control System Wiring |
| 5 | Michael Drtil | Electronics & Sensor Design of Autonomous Underwater Vehicle |

| | | |
|---|---|---|
| 6 | Jing Ting Li<br><br>Yiwen Wang | Simple Underwater Wireless Communication System |
| 7 | Vikrant . P . Shah | Design Consideration for Engineering Autonomous Underwater Vehicle. |

The motion can either be tethered or non-tethered by making a control box as mentioned in [4] and waterproofing it. We selected the hull design to be of Torpedo shaped.

In [1], the importance of Torpedo shaped has been briefly explained saying that it reduces drag greatly allowing the AUV to travel more distance. After adopting all the techniques given & incorporating some modifications, our end result would be a mid-ranged AUV which can be used for Marine intervention.

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# Method and Methodology

Materials: The water pressure on the AUVs is enormous where ocean depth can range up to 11000m. We can get an idea of how high these pressures are from the fact that at just 10m, the pressure is 406 kPa, which is twice the atmospheric pressure Also the chemical environment of the open ocean is highly corrosive, making the selections of materials used in the ocean a critical issue. The materials that can be used need extremely high strength, rigidity and resistance to corrosion. The materials used for underwater vehicles can be classified into the following categories:

a) Housing Material b) Structural Material

Housing Materials

Most electronic components need to be placed in housings at one atmosphere, such as batteries, computer electronics, sensors etc.The pressure housings need to be of extremely high strength since they bear a differential pressure between one atmosphere in the housing and the water pressure outside. The selection of the pressure housing materials becomes a critical issue for AUVs since the materials determine the weight of the AUV which in turn affects the size of the resulting vehicle.

Structural Material:

This refers to the materials used to make the structural members that hold the vehicle together like the struts, back plates etc. These components do not experience a differential pressure and have to be able to hold the weight of the vehicle in air and in water, so they are much thinner than those used on the housings. Usually a convenient choice for these is Aluminum alloys since they are light, cheap and easy to fabricate. Sensor: Once an AUV is deployed it drives around

gathering different kinds of sensor measurements. In order to make any sense of these measurements, the AUV has to be able to keep a track of where the measurements were made. Also to make a successful survey it is necessary to be able to direct the vehicle to a particular location and keep track of where it has been with respect to the earth's axis so that we can associate the data gathered by the AUV to a particular X-Y location. In almost any typical application of the AUV we do not have the convenience of such a map, and even if the area is familiar, the quality of the a priori survey done from a surface vessel would be limited. Betteries: Batteries are by far the most commonly used power sources for AUVs. The advantages include the simplicity of the resulting system and commercial availability. Battery technology is also very mature because of its innumerable applications in automobiles, portable electronics, etc . The AUV development has taken advantage of this development and adapted available batteries to the AUV use. Most of these AUVs have now adopted the newer technologies like Lithium ion or Lithium polymer. The rest of this section is devoted to the characteristics of the various battery chemistries. The typical setup on an AUV involves packing the batteries into 1 atmosphere pressure housing .

Software:

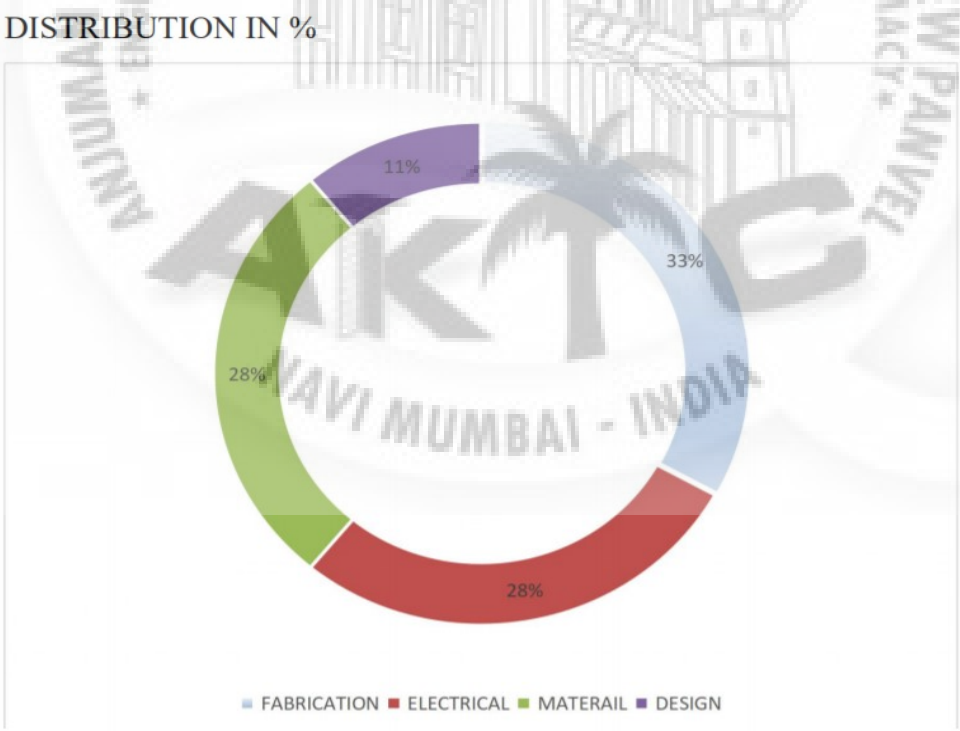
Standardization of hardware has brought along some standardization in the software platforms used on the AUVs Commercial off the Shelf (COTS) software is the more common choice for most AUV designers for the operating systems of the AUV as predicted by Whitcomb [73]. Even with the standardized operating systems, there are some differences in the control software architecture of the different AUVs. Even though in many cases these differences in the architecture result in the same behavior of the AUV in similar scenarios There is a philosophical difference in the way the different architectures approach the problem of AUV control.

# Total Costing Analysis

| Expenditure |
|---|

| Requirments | cost |
|---|---|
| Electrical Components | 9800 |
| Materails,<br>Housing,structural,waterproofing | 9800 |
| Design | 3900 |
| Fabrication | 11500 |
| Total Eatimated cost | 35000 |

## ALLOCATION OF FUNDS



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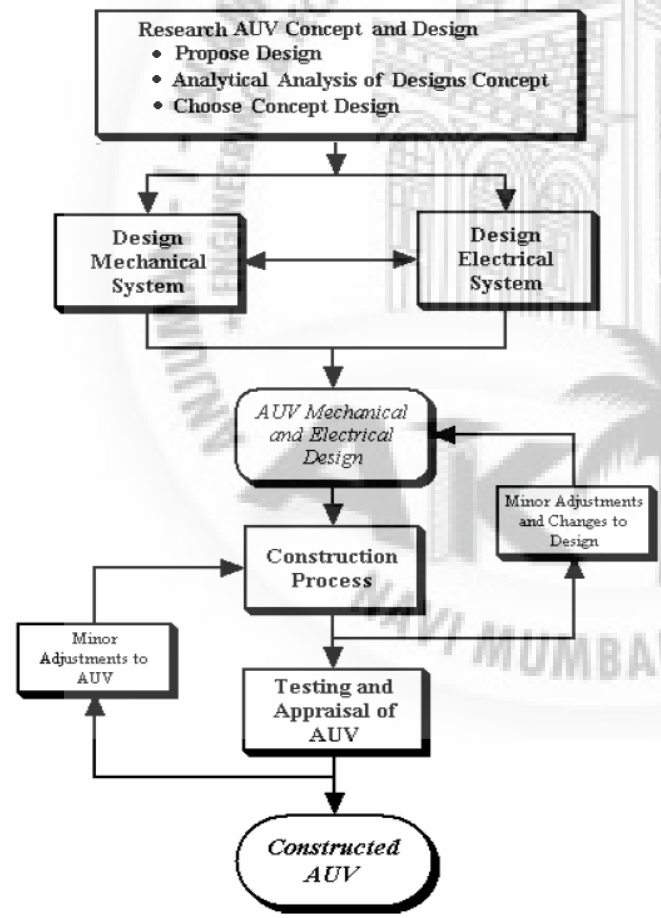
# DESIGN

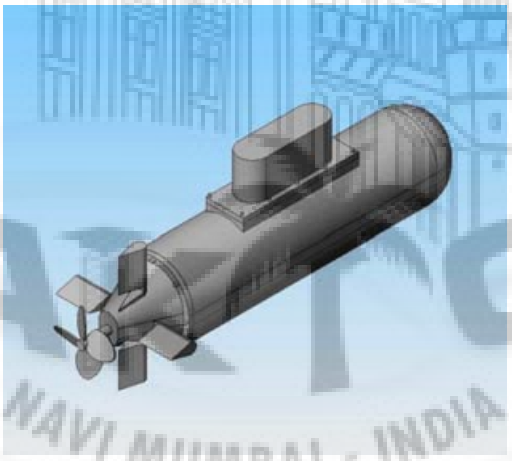
The Design Or The Auv Is Inspired By The Design Of Torpedo Due To The Various Factor That Come Under Considerations While Maneuvering A Device Under Water (For Example: Thrust Drag Unstable Water Currents) . The Auv Is Designed On Fusion 360 And There Are Many Ways To Fabricate The Hull Of The Auv Which Is The Main Component Of The Design As It Holds All The On Board Electronic Components Responsible For The Maneuverability Of AUV . Once The Design Is Completed The Auv Can Be Tested And The Required Adjustments Can Be Done To Get The Desired Results.

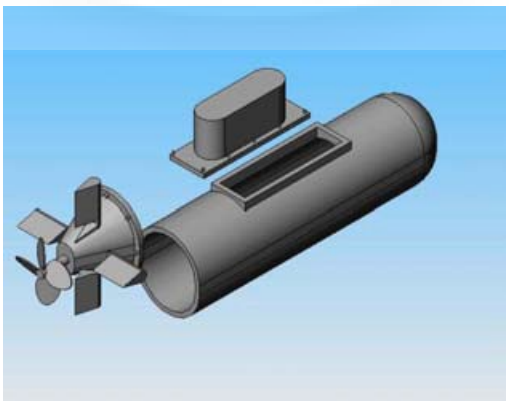
The Stages Of Developing A AUV Is Explained Below In Flow Chart For Better Understanding

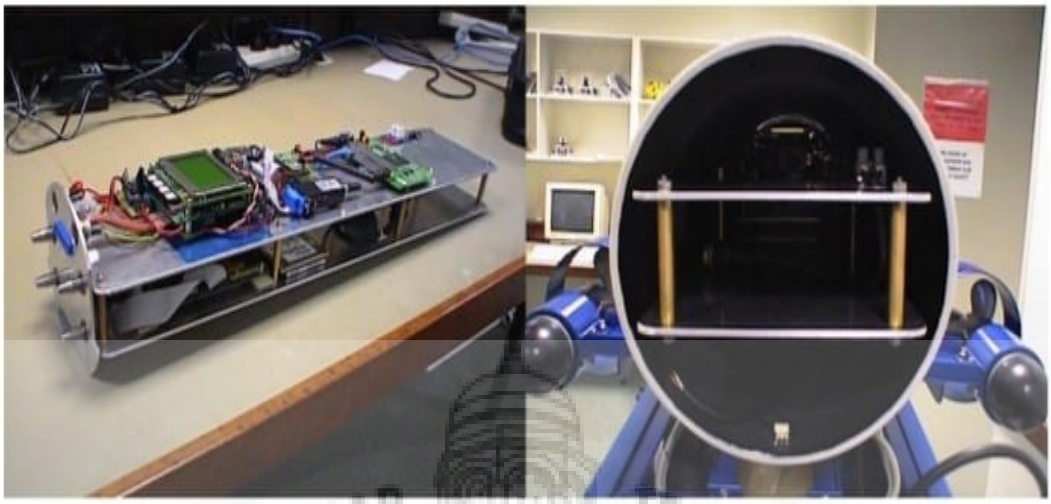


**HULL DESIGN :**

The hull is the important component as it will house all the components . since the hull is spherical in shape it provide high structural integrity and can be easily made airtight. the hull is designed in such a way that it provides easy maintenance .the material of the hull should be highly resistant to corrosion as it would be exposed to a salt water environment submerging to dive in to greater depths the downward force acting upon vehicle must be increased to counter act the buoyant force as the vehicle mass remains constant . this can be achieved by two ways .[1] incorporating ballast tanks . it involves the use of pumps compressed air to regulated the movement of water inside the ballast tank .[2]the second applicable method is incorporating high power thrusters facing downwards but this method is ineffective due to its high power consumption and ineffective at greater depths . Auv are designed to have residual buoyancy to reduce the size of the ballast tanks or the force required by the thrusters to achieve the task of submerging







**ALL TYPE OF SENSOR ,SENSOR CONNECTION AND SPECIFICATIONS:**

**HC 05:**


**Specification and Features:**

- Voltage supply: 3.5v to 5v
- Working current: matching for 30 mA, matching the communication for 8 mA.
- Speed: Asynchronous: 2.1Mbps(Max) / 160 kbps, Synchronous: 1Mbps/1Mbps
- With the integrated antenna and edge connector
- Sensitively: -80dBm

- RF Transmit Power: up to +4dBm
- Supported baud rate: 9600, 19200, 38400, 57600, 115200, 230400 and 460800
- Slave default baud rate: 9600
- Data bits: 8
- Stop bit: 1
- Parity: no parity
- A programmable input-output control
- Range: 100m
- Supported device: laptop, desktop, mobile, tablet
- Protocol: IEEE802.15.1
- Dormancy current: no dormancy.
- Bluetooth module HC-05 Master and slave Two in one module.
- Use the CSR mainstream Bluetooth chip, Bluetooth V2.0 protocol standards.
- Bluetooth protocol: Bluetooth Specification v2.0+EDR
- Security: Authentication and encryption

**Applications:**

- Embedded Projects.
- Industrial Applications.
- Computer and Portable Devices.
- GPS receiver.

## L293d driver shield:


L293D use 16 pin DIP package, its internal integration is bipolar H - bridge circuit. This kind of bipolar pulse width method has many advantages, such as the current continuous, or microcurrent vibration when the motor stops, which as a lubrication effect. It can eliminate the dead zone of static friction when positive and negative

## Arduino UNO:


The Arduino Uno R3 Compatible Board is a microcontroller board which is based on the ATmega328. Arduino Uno has 14 digital input or output pins(where 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It has everything needed to support the microcontroller, you need to simply connect it to a computer with a

USB cable or power it with an AC-to-DC adapter or battery to get started

## Features:

- Easy application programming using open source IDE
- Easy to learn Microcontroller using Arduino boards.
- 256k Flash
- Easy application programming using open source IDE
- Ready Library for most of the sensors and application modules.

## Specifications:

- ATmega328 Controller
- Digital IO 13
- PWM Channel 6
- Working Freq. 16MHz
- DC current / IO 40mA
- DC current / IO 50mA (3.3V)
- Input Voltage 6V to 20V DC
- Flash 32Kb
- SRAM 2Kb
- EEPROM 1Kb

# Li-Ion 18650 Rechargeable Battery 1200MAH:


## LI-ION RECHARGEABLE BATTERY NOMINAL SPECIFICATIONS :

- Standard discharge capacity : Min. 1200mAh
- Nominal voltage : 3.63 V
- Maximum charge voltage : 4.20 V
- Standard charge current : CCCV, 1.3A, 4.20V, 20mA or 3hr cut-off
- Rapid charge : CCCV, 2.6A, 4.20V, 2.5hr cut-off
- Charging time Standard charge : 180min (@ RT) Rapid charge : 150min (@ RT)
- Max. continuous discharge : 5.2A (@ RT)
- Discharge cut-off voltage : 2.75V (End of discharge)
- Cell weight : 38.0g max (Approx)
- Cell dimension
- Height : Max. 65.00 mm
- Diameter : Max. 18.4 mm
- Operating temperature (Cell Surface temperature)
- Charge : 0 to 45℃
- Discharge: -10 to 60℃

# L293d driver module:


The Device is a monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads (such as relays solenoids, DC and stepping motors) and switching power transistors.
To simplify use as two bridges each pair of channels is equipped with an enable input. A separate supply input is provided for the logic, allowing operation at a lower
voltage, and internal clamp diodes are included. This device is suitable for use in switching applications at frequencies up to 5 kHz.

**Features:**

- Input voltage DC4.5-25V,
- 600mA output current capability per channel

- 1.2A PEAK output current(non-repetitive) per channel
- Enable facility
- Overtemperature protection
- Logical "0" input voltage up to 1.5 V(HIGH NOISE IMMUNITY)
- Internal clamp diodes

## L298N MOTOR DRIVER MODULE:

L298N 2A Based Motor Driver is a high power motor driver perfect for driving DC Motors and Stepper Motors.
It uses the popular L298 motor driver IC and has an onboard 5V regulator which it can supply to an external circuit. It can control up to 4 DC motors, or 2 DC motors with directional and speed control.
This motor driver is perfect for robotics and mechatronics projects and perfect for controlling motors from microcontrollers, switches, relays, etc. Perfect for driving DC and Stepper motors for micro mouse, line-following robots, robot arms, etc.

**Features:**

- Maximum motor supply current: 2A per motor.
- Current Sense for each motor.
- Heatsink for better performance.
- Power-On LED indicator.
- Double H bridge Drive Chip: L298N.

**NOTE**: This module has a built-in 5v power supply when the driving voltage is 7v-35v, this supply is suitable for power supply, DO NOT input voltage to +5v supply interface, however, leading out 5v for external use is available.

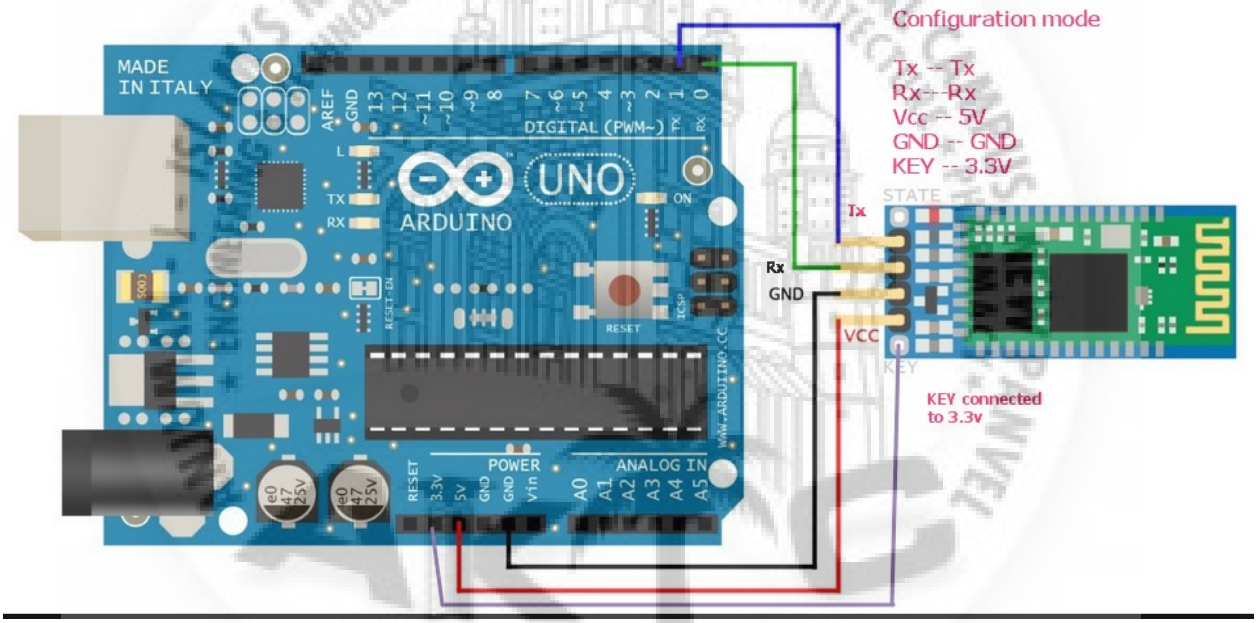
**ESP32 CAM Development Board WiFi+Bluetooth with OV2640 Camera Module:**

**Features:**

- Ultra-small 802.11b/g/n Wi-Fi + BT/BLE SoC module
- Low-power dual-core 32-bit CPU for application processors
- Up to 240MHz, up to 600 DMIPS
- Built-in 520 KB SRAM, external 4M PSRAM

- Supports interfaces such as UART/SPI/I2C/PWM/ADC/DAC
- Support OV2640 and OV7670 cameras with built-in flash
- Support for images WiFI upload
- Support TF card
- Support multiple sleep modes
- Embedded Lwip and FreeRTOS
- Support STA/AP/STA+AP working mode
- Support Smart Config/AirKiss One-click distribution network

## ARDUINO WITH HC05:



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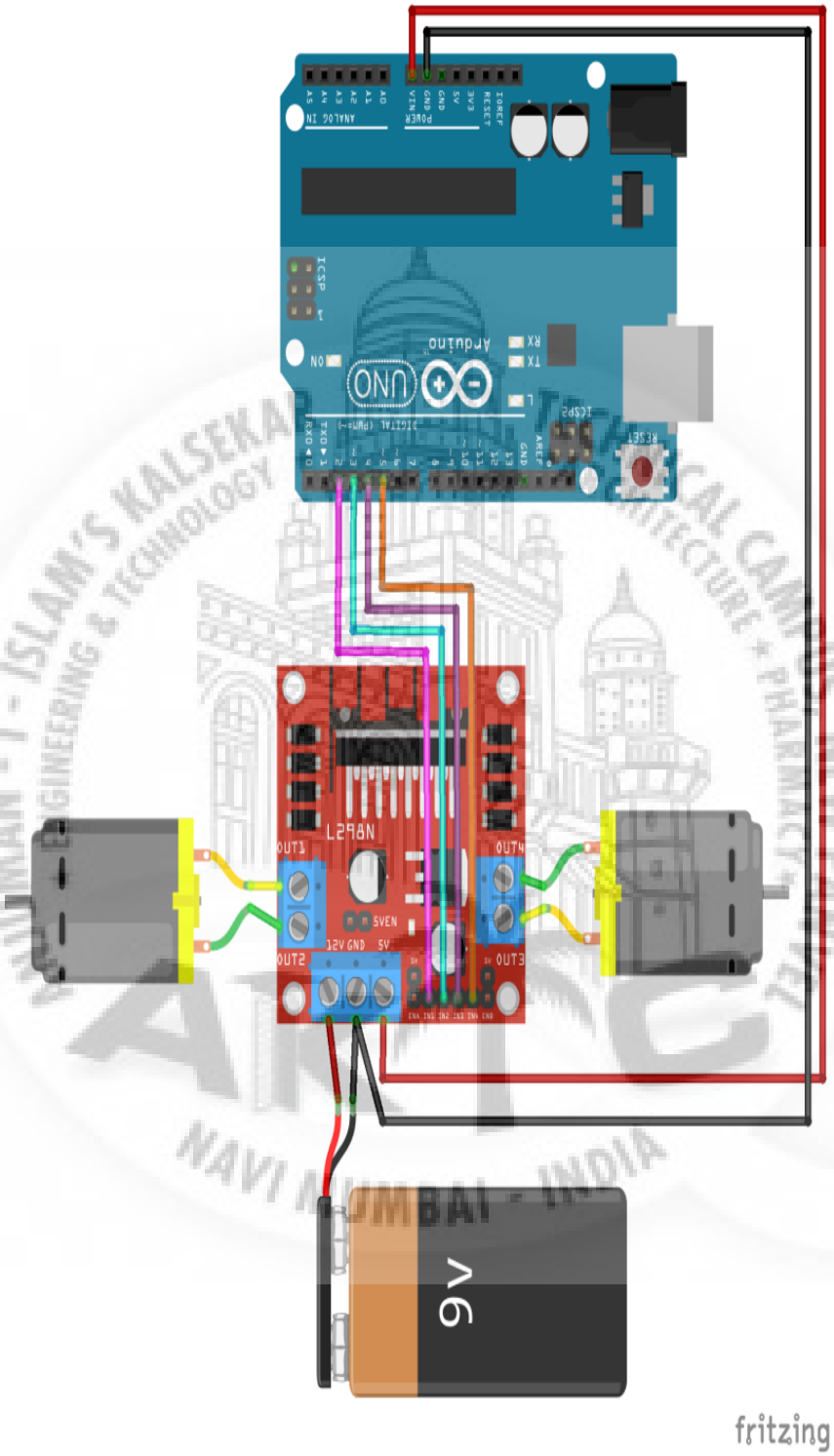
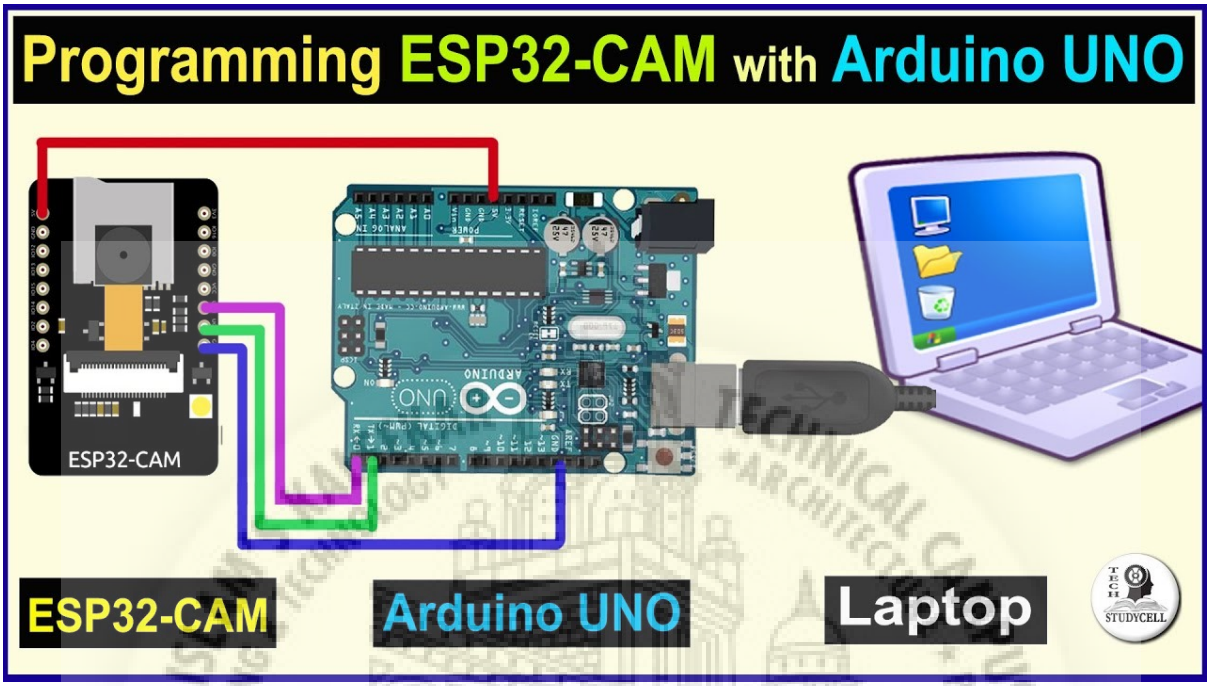
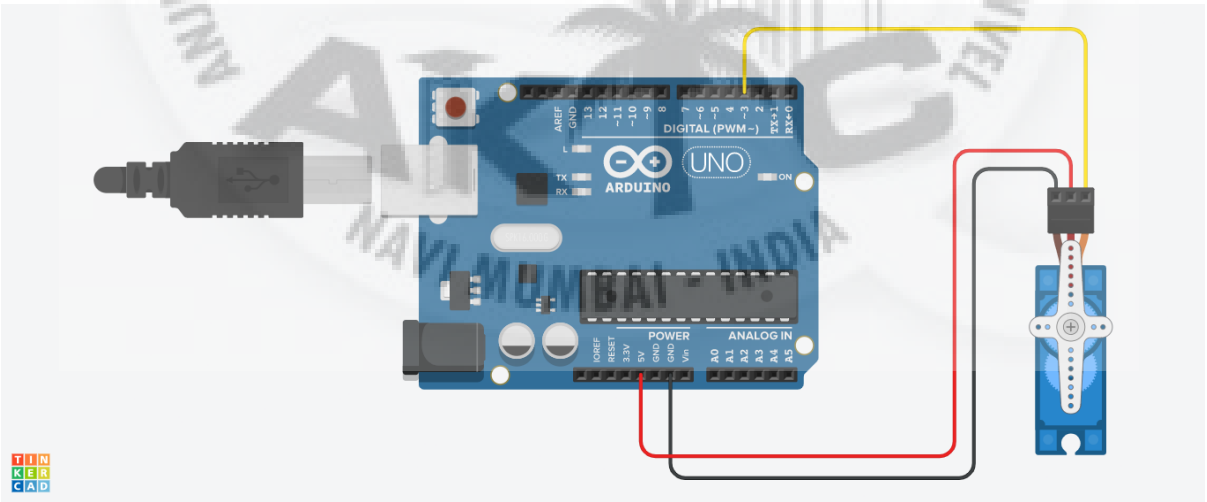
# ARD WITH MOTOR AND L298N:



# ARDUINO WITH CAM:




# ARDUINO WITH SERVO MOTOR:



**PROPULSIONS:**

This is one of the most important factor while designing a AUV as it's the main source of power consumption and it positioning determines the degree of freedom which can be controlled. since the auv travels at a constant speed thrust generated by the motors is equal to the friction or drag of the vehicle

$$Thrust = Drag = 0.5\rho s^2 A_{CD}$$

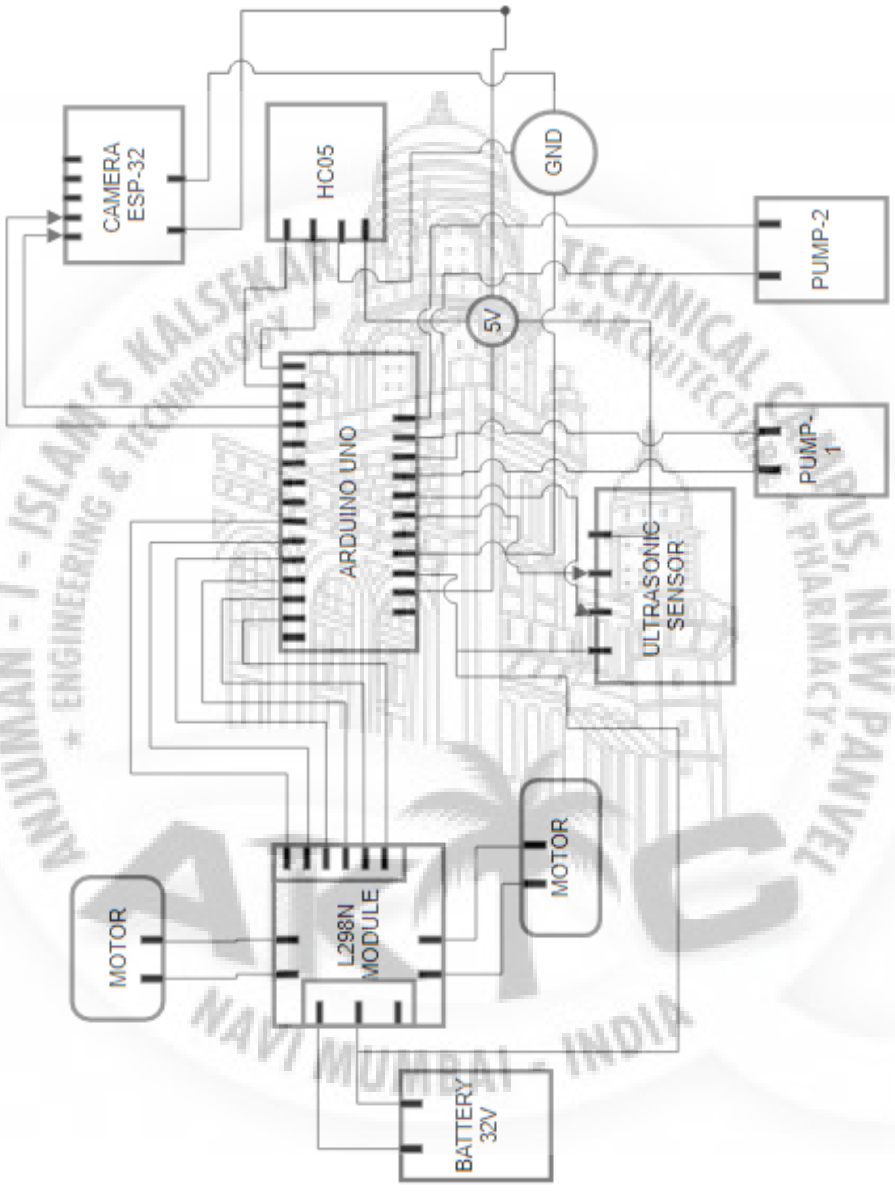
WHERE $\rho$:*Density of water*
*s: Speed*
*cd :Drag Coefficient*

We know that as speed of the vehicle increases the power consumption too increases. Now thrust power in terms of thrust and speedcan be expressed as

$$Thrust\ Power = Thrust\ x\ s = 0.5\rho s^3 A_{CD}$$

Therefore AUV are operated at constant speed due to scarcity of power supply. power: electrical power is provided by li-ion batteries which are connected in a parallel arrangement and a safety fuse to eliminate any short circuit if any electrical or electronic device malfunctions. due to limited power supply the types of components that can be used are limited and components are selected with minimum power requirement connections below is the connection of arduino with all the electrical and electronic component

## Circuit Diagram:



# 5.1 CONCLUSION

Autonomous robots not only present the next great milestone for science, but their practical uses span a wide range. In particular, AUVs are being used to explore underwater environment, mines clearing operation. Another area where these vehicles are in monitoring and maintenance tasks in environment where hazardous for humans or impractical for humans.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.

With the current design & material specifications, we can hereby come to a conclusion that the AUV will work efficiently & serve the purpose of monitoring, inspection & data transmission efficiently. Not only, the AUV is packed with enough power to sustain longer, but also, improvements in areas like design and data transmission will certainly prove to be beneficial

## 5.2 Future Scope

1. After successfully completion, the AUV would be used for intervention purposes and can travel to difficult places where humans cant reach.

2. Using AUV, we would be able to get more output and more data as compare to sending Human being.

3. Also, as it is light and compact it can also be of use in defense sector by modifying the current AUV.

4. After successfully completion of the project, we will be ready with an AUV( Autonomous Underwater Vehicle) which can be used for Marine intervention.

5. It can transmit data and images with good clearity making it more easier to intervene.

6. It would have sufficient amount of power to navigate through a certain distance and return back.

# PUBLICATION

**With help of our guide Prof Arshad Qureshi), we were able to publish our research paper on the topic of " Autonomous Piloted Tethered Submersible Vehicle Used For Marine Intervention Incorporated With Instantaneous Retrieval System " on EQUINOX 2021,**

**6th International Conference on Engineering Research & Innovation organized by Terna College of Engineering, Navi Mumbai.**

**Also, our paper has been accepted & it will be published in UGC Approved Journal of Engineering Technology & Research. We also hope that we get into extended version which will get us an International Publication.**

**We will also try going for free publications and free journals, as the time permits.**

# References

[1] Control of Autonomous Underwater Vehicle by Raja Rout.

[2] Autonomous Underwater Vehicle Control using Neuro Adaptive Generalized Dynamic Inversion by Uzair Ansari & AbdulRahman.

[3] Pressure Hull design methods for Unmanned Undewater Vehicles by Allessia Meschini, Jonathan Gelli, Andrea Rindi.

[4] Basic ROV control system wiring manual by Steve Thone.

[5] Electronics & Sensor design of an Autonomous Underwater Vehicle by Michael Drtil.

[6] Simple Underwater wireless communication system by Yiwen Wang.

[7] Design Consideration for Engineering Underwater AUV by Vikrant P Shah.

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