Review Paper on Design and Fabrication of Remotely Operated Underwater Electric Welding Vehicle

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Abstract **- underwater welding in a seaward, marine, and its modern application is a piece of research and comprehension with numerous undetermined issues. The innovation gives a local dry strategy of an underwater welding robot. The local dry-strategy underwater welding robot contains the ROV and a welding mechanical arm introduced on the ROV. The ROV contains an edge, a vertical assistant thruster, a vertical fundamental thruster, and a flat thruster. Wherein the vertical helper thruster, vertical primary thruster, and level thruster are introduced on the casing. The upper segment of the casing is furnished with light materials, the center segment of the frame is equipped with an electronic gadget fixed lodge, a welding gadget fixed lodge. The front of the casing is given imaging sonar and an underwater lighting gadget. The ROV is associated with a water surface control framework on a mother transport through a funicle link. The front segment of the welding mechanical arm is given a neighborhood of dry-strategy bend welding gun and a weld tracker. In the current situation, underwater welding is done manually by the divers. With the assistance of ROV, the subsea activity of welding is performed and limiting the obstruction of divers. This paper focuses on the methodology of the arrangement of underwater welding and remotely operated vehicles and optimizing ROV design.**

Index Terms **- Remotely Operated Vehicle (ROV); Underwater Wet Arc Welding; Welding Techniques; Marine Application.**

I.INTRODUCTION

Underwater electric welding is a significant device for submerged manufacturing works. With the advancements in present-day innovations and economy, the quantities of coastal structures, for example, oil boring apparatus, pipelines, hydropower plants, and stages are being introduced significantly. A portion of these structures will encounter disappointments of their elements during typical use and unpredicted circumstances like tempests, impacts, rust, etc. Any sort of fixing technique will be required for underwater welding.

Underwater welding is categorized into dry welding and wet welding. Dry welding performs in the load fixed around the structure to be welded. The characteristic environmental factors are fixed into the pipeline and stacked up with a breathable mixture of helium and oxygen or hardly over the set pressure at which the welding is to be performed. In wet welding, the welding is performed underwater, clearly introduced to the wet condition, by the welder. The probe terminal is used and welding is performed efficiently as similar to surface welding. Underwater wet curve welding is difficult and at some point includes danger to welder jumpers. To help welder, jumper's benefit from their underwater wet circular segment welding aptitudes, another preparation strategy is proposed on the haptic gadget which was inspected by the maker "Yizhong Wang".

The wet welding power supply is situated on a superficial level with association with the welder using links and hoses. In place of manual welding, which is performed in the presence of human interference with the remotely operated vehicle (ROV). The remotely operated vehicle will have mechanical arms. One arm is used for the positive inventory voltage which is utilized for the welding assignments. The remotely operated vehicle (ROV) contains a temperature sensor, camera module, overlay framework, depth and pressure sensor, accelerometer, spinner, and has a route framework. All the sensors are interfaced with the raspberry pi module. According to the capacity of the sensors, the sensors accomplish the task and are

operated by the administrator according to the operation.

II.METHODOLOGY

ROV addresses the 'Remotely Operated Vehicle'. ROVs are given significantly adaptable underwater robots that can be used to investigate the ocean and water proficient life. "Yu- Hsien Lin", the producer examines appraisal and the movement of visual attestation and stereoscopic imaging progression, applying them to the improvement of dealing with the structure for self-directing lowered vehicles (AUVs). He proposed a stereoscopic imaging framework to assess the division. A remotely controlled vehicle can work without external control by recommending that it doesn't confine its headway with start beyond the contraption. It is consistently a radio repeat regulator contraption, with wires to control the vehicle or a cardinal controller.

ROVs are the media of marine building. In the business of oil and gas, where the dominant part of ROV is utilized. This class can be part of the light work class models. Generally, work-class ROVs can weigh between 100 kg and 1500 kg. They are commonly all-electric-powered vehicles. Assessment of perception class ROVs regularly has a lighter impression than the intercession class ROVs. Besides, assessment class ROVs can be partitioned into medium-sized and handheld or miniature estimated ROVs. Medium estimated investigation ROVs by and large weigh between 30 kg and 120 kg are frequently deployed and recovered using manpower. The ROVs are used for different activities according to the need. "Romano Capocci" the maker talks about the connection of wired data transmission development, assessment of typical ROV correspondence shows, and relationships of various inertial course frameworks ROV telemetry is part of a conversation on the different transmission equipment frameworks and the correspondence conventions that are utilized in industry. The utilization of ROV is to perform an underwater task. As wet welding is the essential support and fixes hotspot for seaward, oil, and marine enterprises in which the ROV is outfitted with various kinds of electronics and mechanical gear. For example, sensors, mechanical arm, and its controlled accomplices to perform underwater welding, utilizing ROV highlights.

III.WET WELDING PROCESS

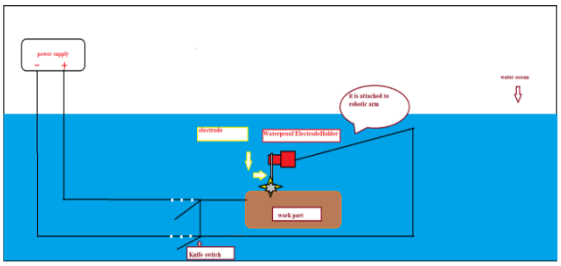

Fig. (a)I: Under Water Welding.

Underwater welding is a significant apparatus for submerged manufacturing works. In the ongoing year number of seaward construction including oil boring apparatuses, pipelines, and stage are being introduced essentially. Welding is one of the unavoidable cycles of the current design. Submerged welding gives a way to amass or fix submerged.

Electric Welding – The process of welding together through the use of the heat that is produced by an electric current, in wet welding positive polarity is given to a work piece of metal and negative polarity is given to electrode as shown in fig. (a)I.

There are two type of electric welding.

1) Dry welding
2) Wet welding

- Dry welding- In dry welding, a dry chamber is created near the area to be welded and the welder does the job by staying inside the chamber.
- Wet welding- In wet welding, the welding is performed underwater directly exposed to the wet environment.

In wet welding, as the name implies, underwater welding takes place in the wet workspace of an environment where the base metal and the arc are surrounded by water. In wet welding, MMA (Manual metal bend welding) is employed. An increase in the degree of freedom makes wet welding the most effective, efficient, and economical. The welding power supply is located on the surface with a connection to the diver/ welder via cable and hoses.

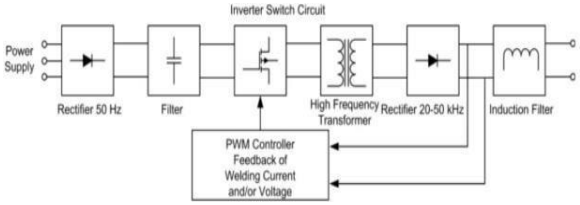

Fig. (b)I: Structure Diagram of Arc Welding Power Source Control System.

At present, in the modern industrial production, inverter arc welding power source has been used widely. In the power switch devices, MOSFET has a high frequency, but the capacity is not high. IGBT has good control performance, the advantages of large capacity, and is particularly suitable for the development of high-power arc welding inverter the arc welding power source control system structure diagram of this design as shown in the fig. (b) I.

Process-

- Works to be welded are connected to one side of an electric circuit and metal electrodes to the other side.
- These parts of the circuit are brought together and then separated slightly.
- The electric current jumps the gap and causes a sustained spark, which melts the bare metal, forming a weld pool.
- At the same time, the tip of the electrode melts and the metal droplets are projected into the weld pool.
- During this activity, the transition covering the terminal melts to give a protecting gas, which is utilized to settle the circular segment section and shield the exchange metal.
- The work is to connect to the positive side of the D.C. Source and electrodes to the negative.

IV.DESIGN AND FABRICATION

A. 3D Design

The remotely operated vehicle is a much-modernized concept in the Engineering world that is applicable in marine. The initial step is surrounding the structure of the body ought to be solid to support in brutal circumstances. The body structure is designed in CATIA V5 software and makes a 3D plan which is shown in the figures below (a) II, (b) II and (c) II respectively.

For making the design, contemplating, there are certain parameters -

1. Buoyancy system.
2. Material, shape.
3. Size is classified and distinct parts to apply in framing.

A nonlinear unique model of an ROV with bother because of hydrodynamic powers is talked about. As a rule, there are two strategies to determine the unique model: The Lagrange detailing utilizing the energy technique and Newtonian's definition utilizing Newton's Second Law of Motion. The last technique gives a condition utilizing the rakish speeds about the body-fixed tomahawks; dissimilar to the summed up factors utilized in the Lagrange condition, the precise speeds cannot be incorporated to get rakish relocations about these tomahawks and are hence inadmissible to depict completely the direction of an unbending body in three-dimensional (3D) space. Be that as it may, the body-fixed precise speeds can be addressed and changed to give the direction of the vehicle in 3D space utilizing Euler's points. Euler's change (or regularly known as kinematics condition) gives the connection between the elements inferred in the earth-fixed and the body-fixed arrange for the accompanying reasons.

To start with, most sensors and actuators mounted on the ROV measure the body boundaries, for example, the ROV speeds, and give moving powers. Also, the powerful condition is naturally defined and consequently less muddled because this defined structure isn't Euler's point subordinate. Unfortunately, because of displaying vulnerabilities, the model inferred by either strategy can be insufficient for a control framework plan. These vulnerabilities are principal because of the hydrodynamic powers which are tentatively and hypothetically hard to acquire. In any case, for control configuration purposes, there is a need to consider a rearranged notable model with added substance irritation limits that are sufficiently exact to address the ROV dynamic conduct.

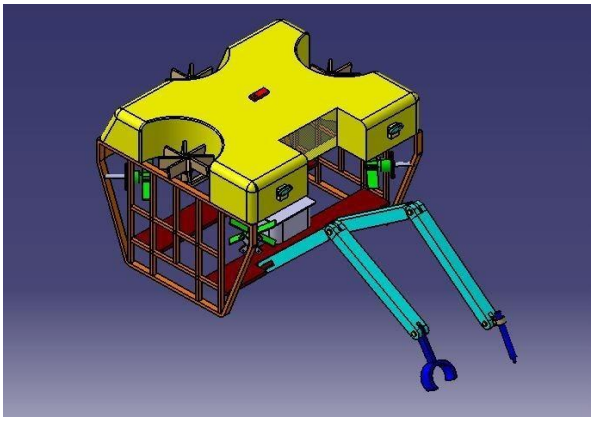

Fig. (a)II: Structure Of ROV.

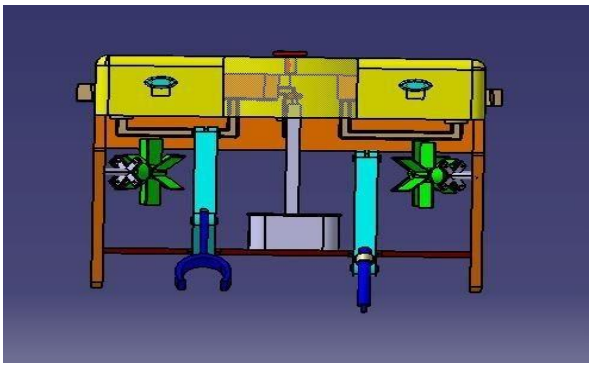

Fig. (b)II: Front View.

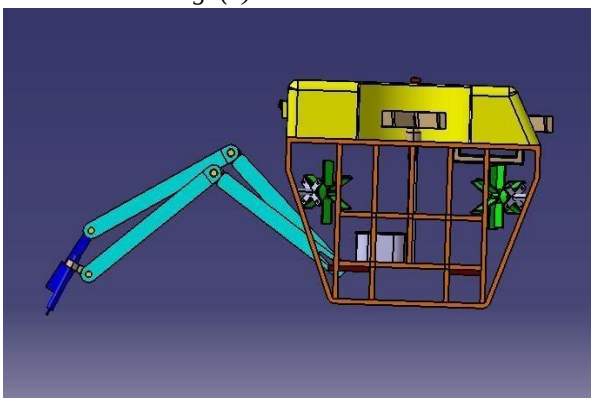

Fig. (c)II: Side View.

V.BUOYANCY SYSTEM

The buoyancy system is structured and received basic to the prosperous activity of remotely operated vehicles. Low-thickness syntactic materials make ROV impartially light-weighted, insusceptible to hydrostatic weight, and prepared to investigate further pits for wide periods. Furthermore, these superior materials help also satisfy the rapidly growing demand to support heavier and more complex payloads while maintaining the vehicle's compact dimensions. Syntactic froths are created to supply the very best probable lightness and steadiest long-term operational performance from the outermost at the bottom of the shore. Quick-turn buoyancy assemblies are often fully machined to exact customer specifications and include protective skins and coatings additionally as supplements for affection. Toward prevailing terms, this buoyancy force is often calculated with the

Equation: -Fb = Vs × D× g,

Where 'Fb' is the buoyancy force that is acting on the object, 'Vs' is the underwater volume of the object, 'D' is the density of the fluid the object is underwater in, and 'g' is the force of gravity.

VI.MATERIAL

The material is the essential segment for the fabrication. The material properties must be:

- The materials should be thick for the casting such that the desired framework is obtained.
- The material should withstand high temperature and pressure.
- Material should be waterproof.
- Effectively accessible materials are used in this ROV.
- Substances should be moldable to achieve the desired requirement.

Underwater sound transmission structure (USTS) for a light-work class ROV, was revealed by the maker "Benjamin Greenspon". Which measures lowered sound using two hydrophones and replay it for ROV executives on a shallow level vessel yet furthermore to perceive source course and repeat differentiate beam forming technique to improve the source heading finding direction.

Table no I.

Sr. no	Material	Density(g/cm3)	Thermal conductivity in (w/mk)
1	ABS	1.53e	1.73
2	PVC	1.38e	0.19
3	Bronze	8.73e	70
4	SS 316	7.750e	16.000

As per the investigations, the ABS material is more suitable for the ROV because of the property. The base stand is framed with the help of Aluminum.

A. SHAPE AND SIZE

Shape and size are the significant factors in the ROV. Firstly the outline diagram is made with the help of creo parametric 5.0 software show in Figures (a) III and (b) III respectively. The ROV must be shaped by the delicacy system which has to go underwater. It must be the robustness of the ROV which lowers it and keep that going in. A streamlined shape is given leads to the appropriate speed of ROV for the tough operations. It is designed to avoid any leakages in the body. The specific parts applied in the framing of ROV are:

1. Thrusters
2. Robotic arm

i. Thrusters

The thrusters are the legs of ROV. It provides motion to the robot. The thruster is fabricated and planned as per the internal space structural design of underwater ROV. Each ROV is compelled by a couple of vertical and level thruster modules. The vertical thrusters are mounted at such an extent edge to allow for sidelong development of ROV. It consists of a total of seven thrusters. Three thrusters are set in a vertical direction and four thrusters are set in horizontal to a specific degree.

ii. Robotic Arm:

It is a device that operates in a similar way to a human arm, with several joints and links that either move along an axis or can rotate in certain directions in the workspace. “Ms. Rasika Yenorkar”, the creator examines GUI and simple preparing technique for the working of the multipurpose automated arm when taught to play out a specific assignment. Two robotic arms are used in ROV resulting in one arm is for holding the objects and another arm is attached with welding equipment for underwater welding application as shown in Fig. (a) III & Fig. (b) III.

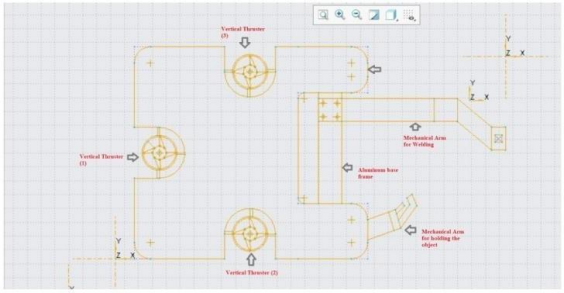

Fig. (a)III: Top View of ROV in 2d Plane.

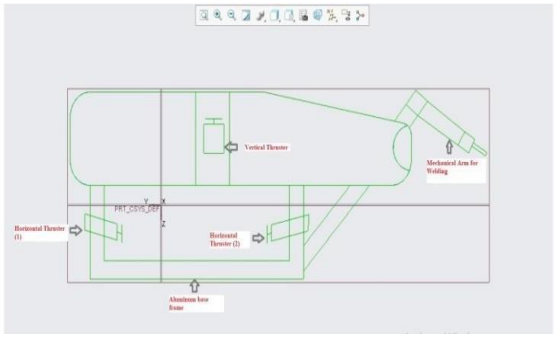

Fig. (b)III: Side View of ROV in 2d Plane.

B. ROV CONTROL SYSTEM

The control of ROV is equipped to work underwater and with any conditions as showing in fig. IV below. The ROV is mainly designed to weld in underwater condition and ancillary inspect and determine the condition in underwater such as pressure & depth, silts, temperature, cracks, repairing and maintenance. ROV is a waterproof set of equipment with a thruster that gives the guidance, direction, and moment for the development. Gyroscope serves the balance to the system while watching the course development; the camera is mounted in a waterproof case for consistency and perception of the system. The system is attached to a cable on a surface in which signal is transmitted and the welding arm is attached with tradable controllers. It is driven by thrusters to carry out the welding to hold the welding holder to weld at the work piece and to play out a few errands underwater. Sensors are merged with the embedded control system such as with significance sensor, temperature sensor, and sonar sensor. The ROV’s material part and motors are interfaced with Arduino controller. The ROV works on AC as well as DC off-board power source and carries welding probes. The casing material of ROV is to such an extent that it can continue the high weight and constrained water stream. Looking at the subsea action as in seafloor drilling/coring which takes a long time and many boring machine gears are required for various concentrations in the brief timeframe for getting a handle on the highlights of the focus on a wide territory to be conveyed and taken care of by a recently grown little boring/coring machine deal with work-class ROV and can bore/center at various places in a single jump of ROV. With the help of all this equipment, the ROV inspects and determines the conditions inside the water such as water pressure &depth, silts, temperature, cracks, repairing & maintenance, etc.

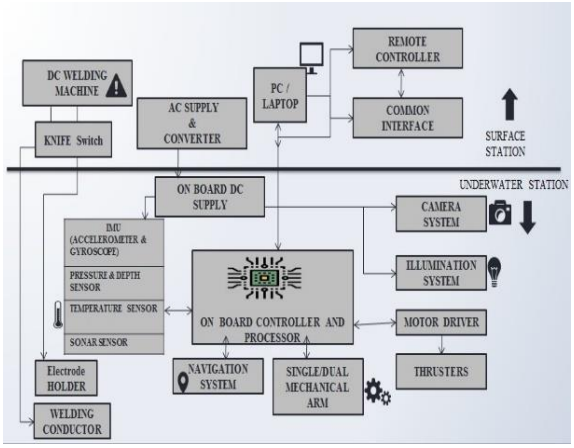

Fig. IV: Communication Block Diagram of Remotely Operated Vehicle for Wet Welding.

C. POWER SOURCE CONTROL SIMULATION

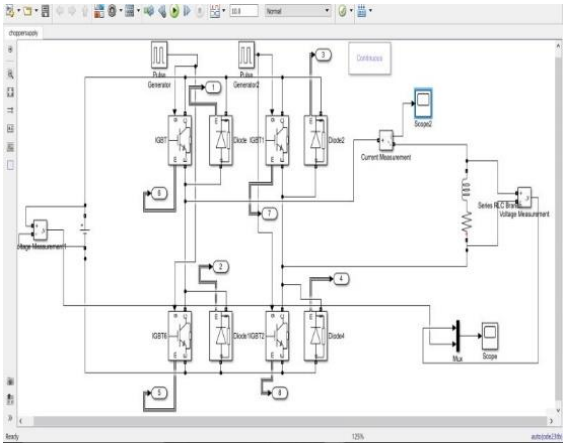

Fig. (a)V: The Full-Bridge D.C. Chopper Circuit.

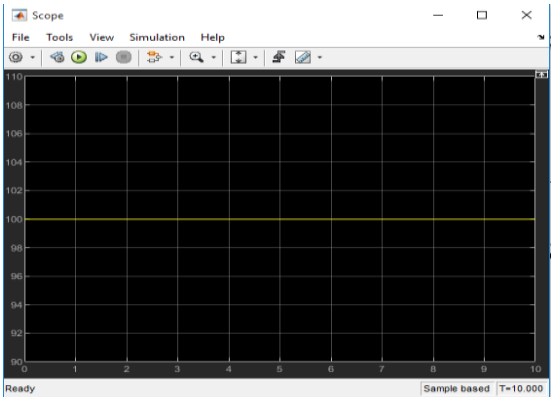

Fig. (b)V: Input Supply Voltage.

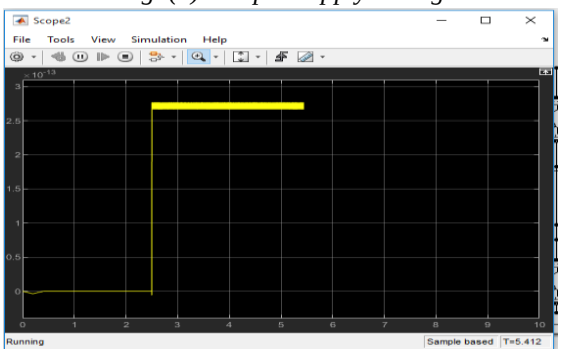

Fig. (C)V: Output Current.

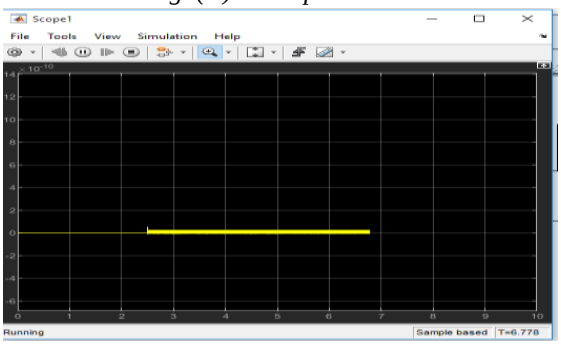

Fig. (d)V: output voltage supply.

The above figure (a) V shows a filter circuit that removes the A.C. component of rectified output and allows only the D.C. component to reach the load. Switch-mode inverters are utilized in A.C. engine drives and uninterruptible ac power supplies where the goal is to create a sinusoidal ac yield whose greatness and recurrence can be controlled. High-frequency transformers operate using the same basic principles as standard transformers. The primary difference is that, as their name implies, they operate at much higher frequencies while most line voltage transformers operate at 50 or 60 Hz, high-frequency transformers use frequencies from 20 kHz to over 1MHz. A rectifier is an electrical gadget that converts exchanging flow, which occasionally inverts bearing, to coordinate flow, which streams just a single way. The opposite movement is performed by the inverter. The cycle is known as revision. The channel circuit can be built by a mix of segments like capacitors, resistors, and inductors. An inductor is utilized for its property that it permits just D.C. parts to pass and squares ac signals. The output signal goes high when the modulating sine wave goes higher than the peak of the carrier signal. PWM signals help to control the voltage of computerized beats. With PWM, an advanced yield comprising of a progression of high or "on" and low or "off" beats controls an thruster or different kinds of simple gadgets. The full-bridge D.C. chopper circuit model is shown in Figure 4.12. From the main circuit, using D.C. power to replace the PWM rectifier; the driving circuit is relative. simple, and showing the specific model of bipolar PWM control circuit, which set the wave cycle as 1e-4 seconds, so each power device operating frequency is 10KHz, In1 is the input of. Duty ratio, Out1 control IGBT T and IGBT T2 to turn on together, Out2 control IGBT T1 and IGBT T6 to turn on together.

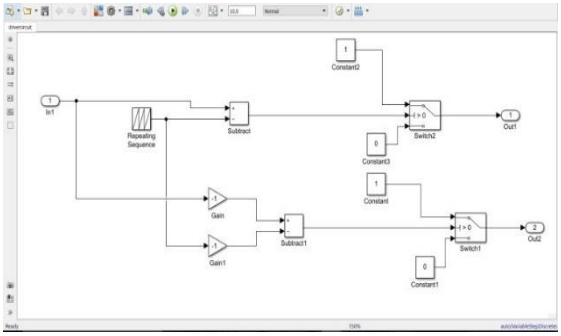

Fig. (a)VI: Control Circuit Diagram of Power Source Control System.

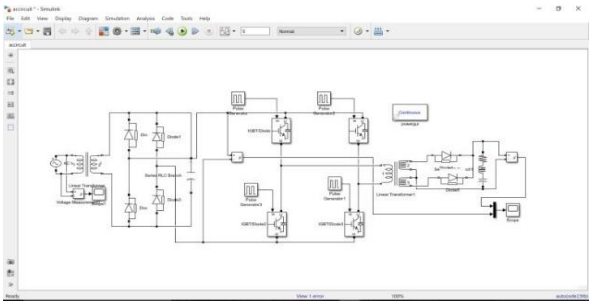

Fig. (b)VI: Combined Control Circuit Diagram of Power Source Control System.

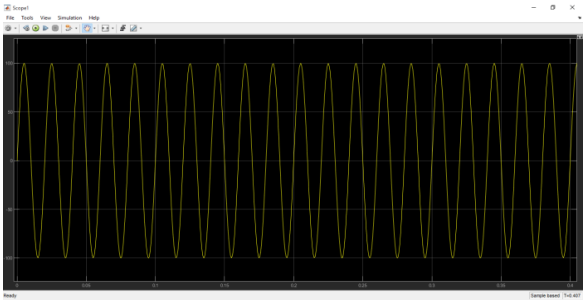

Fig. (c)VI: Input Supply Voltage.

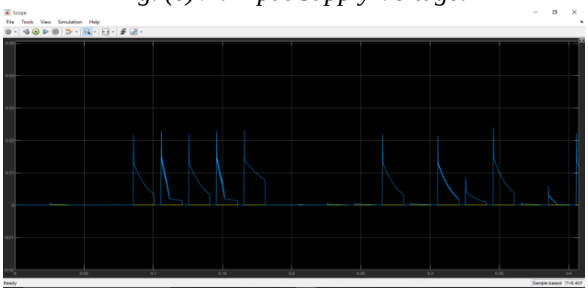

Fig. (d)VI: Output Voltage.

- The PWM technology is introduced into the rectifier control.
- PWM rectifier Circuit Bridge is essentially using PWM technology to convert the low input current harmonic components into a high-order harmonic and then uses a high-frequency filter will be filtered the high-frequency components.
- It has low input harmonic wave current and a high power factor.
- This voltage source PWM rectifier to replace the traditional non-controlled rectifier bridge, which has high.
- Power factor, low current harmonics, and power reversible, quick dynamic response, and so on.
- The main circuit of this design as shown in fig. (b) VI.
- Following design requirements, the role of the A.C. side inductor, PWM rectifier circuit has a certain boost function.
- Then according to design specifications arc welding power input 230V/50Hz the frequency alternating current, and output 200V-600V D.C.
- The PWM rectifier circuit, after the IGBT full-bridge D.C.-D.C. chopper circuit.
- The amplitude of 600V high-frequency square wave, to make the output current continuously to add the reactor, and then get a steady D.C. power.

D. ADVANTAGES

- ROV carries out subsea operations and minimizes/eliminates the use of divers.
- The necessity of modest welding gear, low welding cost simple to work, the adaptability of activity in all positions.
- Minimize electrical hazards, increases welding speed in less time.
- Permit good visibility.
- Produce good quality and reliable work & welds.

E. APPLICATION

- Offshore construction for tapping sea resources.
- Temporary repair work caused by ship collisions or unexpected accidents.
- Salvaging vessels sunk in the sea.
- It is mainly used for recovery purposes.
- In Mining.
- It plays a vital role in aquaculture.
- Search, detection, and reconnaissance.
- Underwater communications & Sub-sea surveillance.
- Self-defense of ships, subs, and harbor's.
- Engineering tasks; mine removal, construction port clearance/survey.
- The oil and gas industry is the biggest users.

VII.CONCLUSION

The main objective of the project is to minimize/eliminate the use of divers in offshore industries, electrical hydropower plant industry to perform the structures works, oil drilling rigs, ship maintenance, pipelines, platforms are being installed inside the water the ROV (remotely operated vehicles) and its applications plays important role in the marine sector and also in underwater wet arc welding it is hard and sometimes involves risks to welder divers. To help

welder divers with their underwater wet arc welding operations.

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