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Design of Unmanned Landmine Detection Vehicle Using Arduino

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Abstract:** The concept presented in this article revolves around the idea of an economically designed UGV (Unmanned Ground Vehicle) for the demining process. Landmine discovery is a critical area of exploration due to the high number of losses and injuries caused by landmines each time. The developed technology generally requires human assistance nearby for landmine detection. Every so often the military bear loss of their equipment specialists. Also, false detection leads to the wastage of resources invested in the technology. Our prime aim is to develop a sturdy design for UGV which require minimum assembly time i.e., "Ready-to-Assemble" concept. This paper outlines the design of a UGV equipped with IR sensor, and metal detector and controlled using Arduino microcontroller. The Arduino microcontrollers are programmed to control the UGV's movements and the sensor data processing. The UGV is built on a six-wheel drive controlled by two motor drivers, which is equipped with IR sensor to detect the heat signature of buried landmines and a metal detector to detect metallic landmines. The GPS location of the landmine is sent directly to a mobile device using a GSM Module. The UGV is controlled using Bluetooth remotely. The design of the vehicle was performed on Solidworks, CAD software. The software was used to design the chassis, suspension system, and other components such as the metal detector and IR sensor mounts. Proteus software was used to stimulate the electronic circuitry. The UGV has potential applications in detecting and removing landmines safely, minimizing the risk of human casualties. Future work could involve improving the system's accuracy and efficiency to make it a more effective tool for landmine detection and removal.

***Keywords:** Arduino, GPS, GSM, IR Sensor, Landmine, Ready-to-Assemble, UGV.*

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1. INTRODUCTION

The Ottawa treaty also known as the Anti-Personnel mine ban convention, was signed on December 3,1997 in Ottawa, Canada. The treaty seeks to prohibit the use, production, stockpiling and transfer of anti-personnel landmines and to ensure their destruction. The treaty came into force on March 1, 1999, and has been ratified by 164 countries as of 2021.The cause of the Ottawa Treaty was the growing concern about the humanitarian impact of anti-personnel landmines. According to the international campaign to ban landmines, the use of anti-personnel landmines has declined significantly since the treaty was adopted, and the number of countries that produce and stockpile these weapons has also decreased.[1]
A landmine is an explosive device that is designed to be hidden in the ground and detonate when a person or vehicle passes over or near it. Landmines are often used in armed conflicts to create barriers or to inflict casualties on enemy forces, but they can remain active long after the conflict has ended, posing a threat to civilians. Landmines can cause injury or death by fragmentation or blast effects.
Presently, the number of landmines planted around the world totalizes further than 110 million, and, far from breaking down, the landmine product planting rate is, at least, one order of magnitude advanced than the rate at which they are removed. An essential step, before landmine removal, is landmine detection. There are several types of mines, each with its characteristics and intended use. Anti-personnel mines are small devices designed to injure or kill people, while anti-tank mines are larger explosive devices designed to damage or destroy armoured vehicles. [2]
Landmines are designed to cause injury or death, and they often have a lasting impact on the lives of those affected. They can cause physical injuries, emotional trauma, and long-term disabilities, and they can prevent access to essential services such as healthcare and education. landmines can cause damage to the environment by contaminating land and water sources, killing wildlife, and polluting the air. They also limit access to natural resources such as forests and agricultural land. Landmines are placed to create barriers along borders, roads, or other strategic locations, preventing people from moving freely and limiting access to essential services such as healthcare, education, and food. The impact of access denial can be severe, particularly in conflict-affected areas where people may already be struggling to meet their basic needs. Landmines can prevent farmers from accessing their fields, making it difficult to cultivate crops and leading to food shortages.

Fig.1 PROM_1 Anti-personnel Mine

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Fig.2 TM_46 Anti-tank blast mine

Research Elaboration

Several technologies have been developed over the years to address this problem, including unmanned ground vehicles (UGVs), rovers, and robots. [3] In this research, we focused on analysing the various technologies developed for landmine detection, with an emphasis on UGVs, rovers, and robots, dating back to 1998. None of the technologies presented seems, in fact, able of reaching, in a veritably large number of situations, good enough discovery while maintaining a low false alarm rate.[4] Various techniques were developed for this purpose, including metal detection, ground-penetrating radar, chemical detection, and therefore the use of trained dogs. These methods use different sensors and detectors to locate landmines, and advancements in technology have made them more efficient and effective. By using these techniques, we will make sure that landmines are detected and removed safely, minimizing the danger of casualties. Although these research and findings address a particular number of problems faced in demining of landmines.

Hence, so as to supply a remedy to affect these barriers, we've done radical research and designed a model of UGV based detection, given dual-detection technology alongside real-time location generator, keeping in mind the target of our research. Our keen inspiration were the land rovers used in different fields for their respective tasks.

Fig.3 Land Rover

Design Specifications

Designing an effective UGV involves considering several critical factors. One of the crucial factors is component measurements. Design specifications are another critical factor, as these determine the UGV's functionality and capabilities.[5] These specifications should be clearly defined to ensure that the UGV meets the desired requirements which are as follows:

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Table 1. Component Measurements

Sr no.	Components used	Dimensions (mm)
1	GPS module GPS neo- 6m Module	Antenna: 25x25x27 GPS board: 25 x 30 x 4
2	SIM 800L GSM Module	24x24x3
3	IR SENSOR:	50x40x10
4	Arduino uno R3	68.6 x 53.4
5	Motor driver	49 x 55 x 33
6	Bluetooth module	26.9 x 13 x 2.2
7	Buck Converter or Step-Down regulator LM25965	50 x 40 x 20
8	Metal detector coil	50
9	Breadboard, PCB zero	80 x 50 x 10
10	9 V Battery	17.5 x 26.5 x 48.5
11	Arduino Mega REV3	101.52 x 53.3

In addition to component dimensions and design specifications, the selection of appropriate materials is also vital. The grade is A356. The properties [6] are:

Table 2 Physical Properties

Sr. no.	Property	Value
1	Density	2.67 g/cc
2	Tensile strength (Ultimate)	>= 234MPa
3	Tensile strength (Yield)	>= 165MPa
4	Poisson Ratio	0.33
5	Youngs Modulus	72.4GPa

The chassis and the plates for suspension mounting will be casted in Aluminium. There are various reasons that justify the selection of the grade are:

- Stresses are found to deliver minimum impact on aluminium alloys.
- We get a tremendous weight reduction overall.
- Least deformation as compared to cast iron and other Grades such as A354.
- Minimum strain value.

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Circuit Diagrams

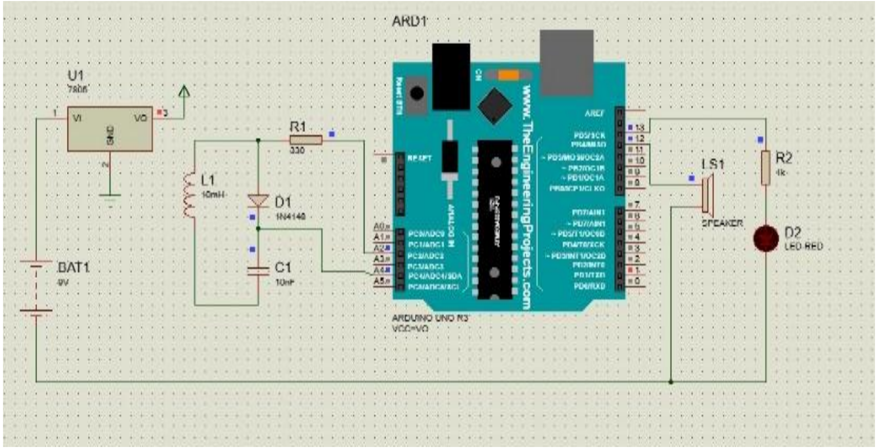

Fig. 4 Metal Detector Circuit

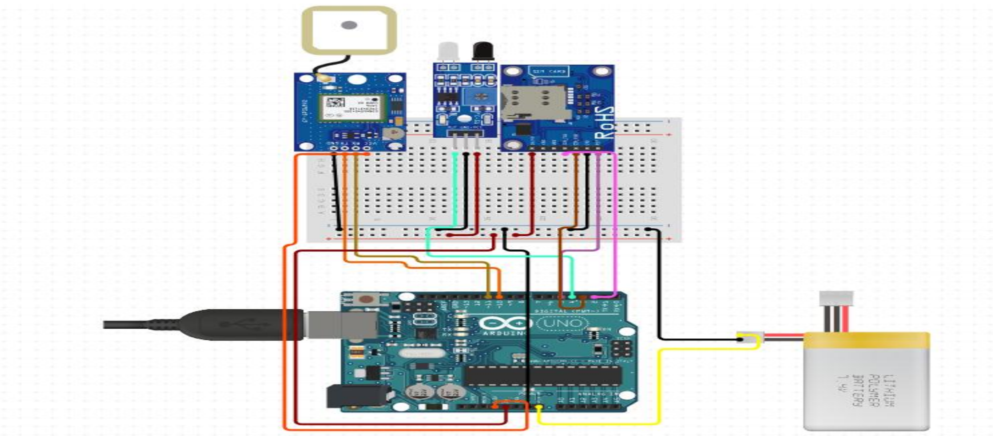

Fig.5 Component Connection Circuit

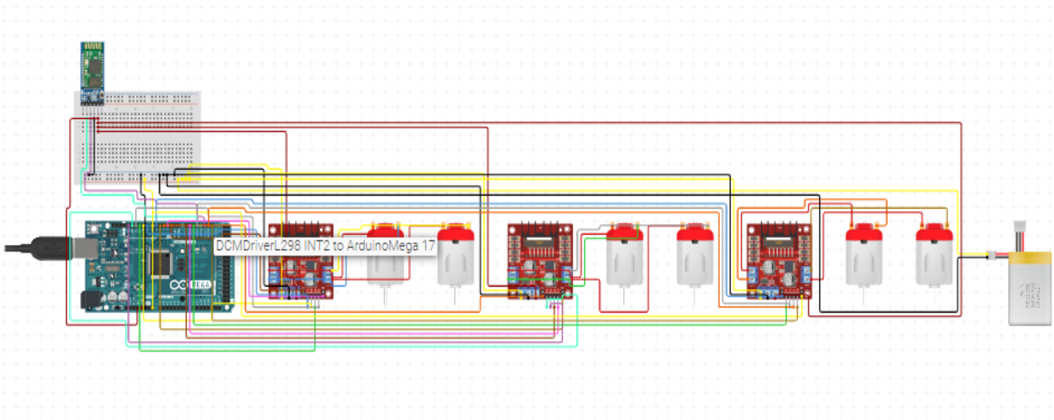

Fig 6 Motor controller circuit

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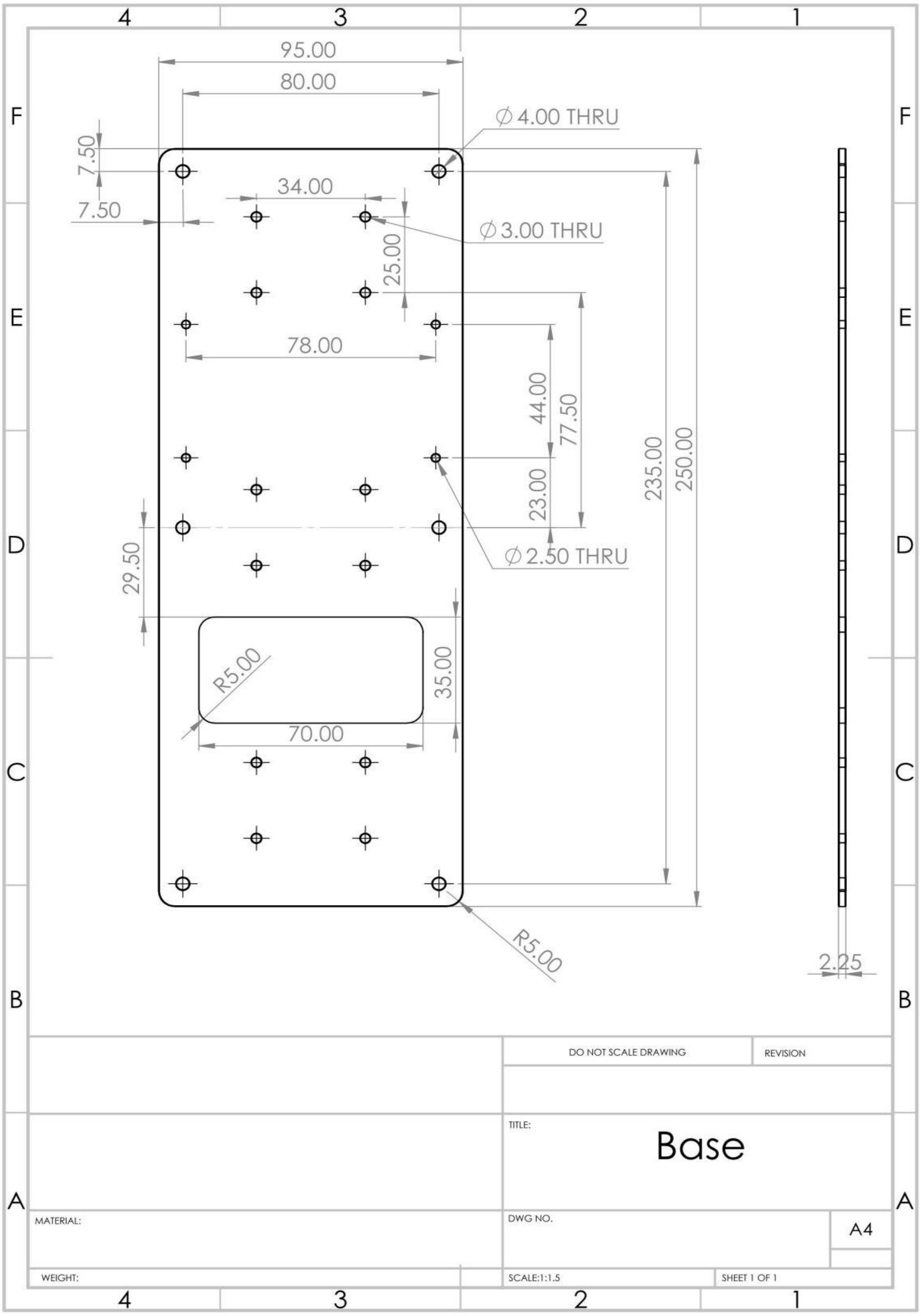
Drawings

1. First Base Plate



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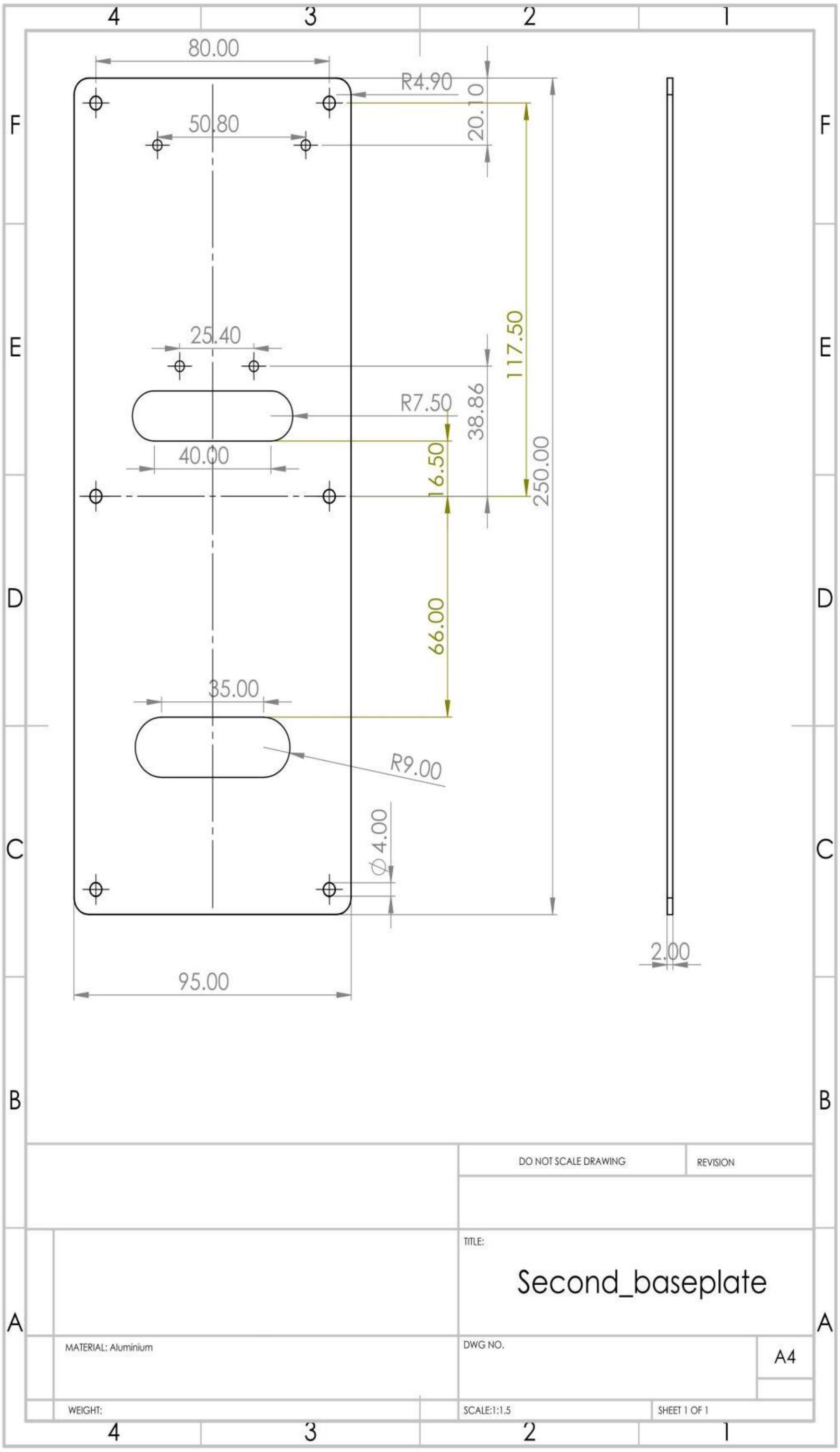
2. Second Base Plate



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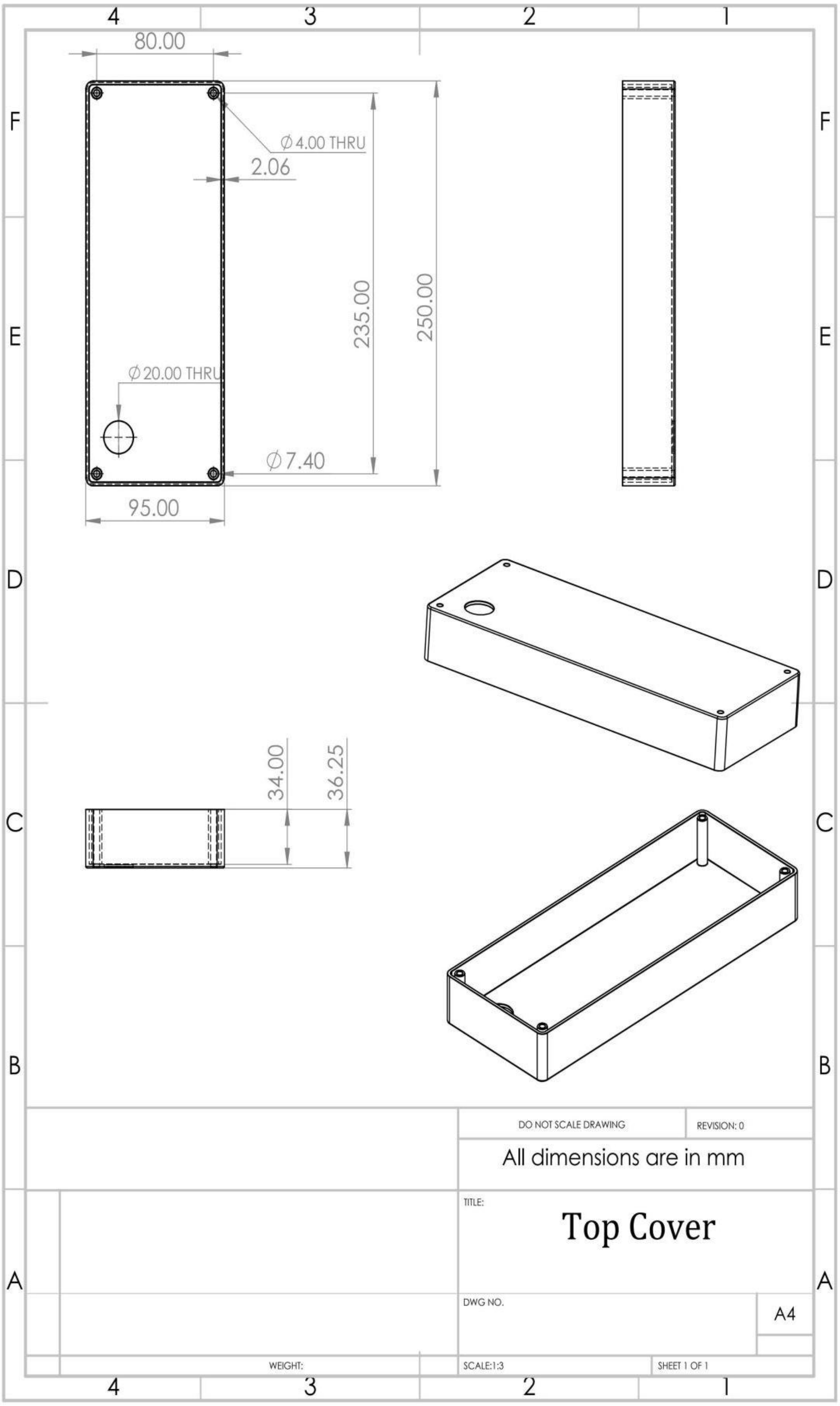
3. Top Cover



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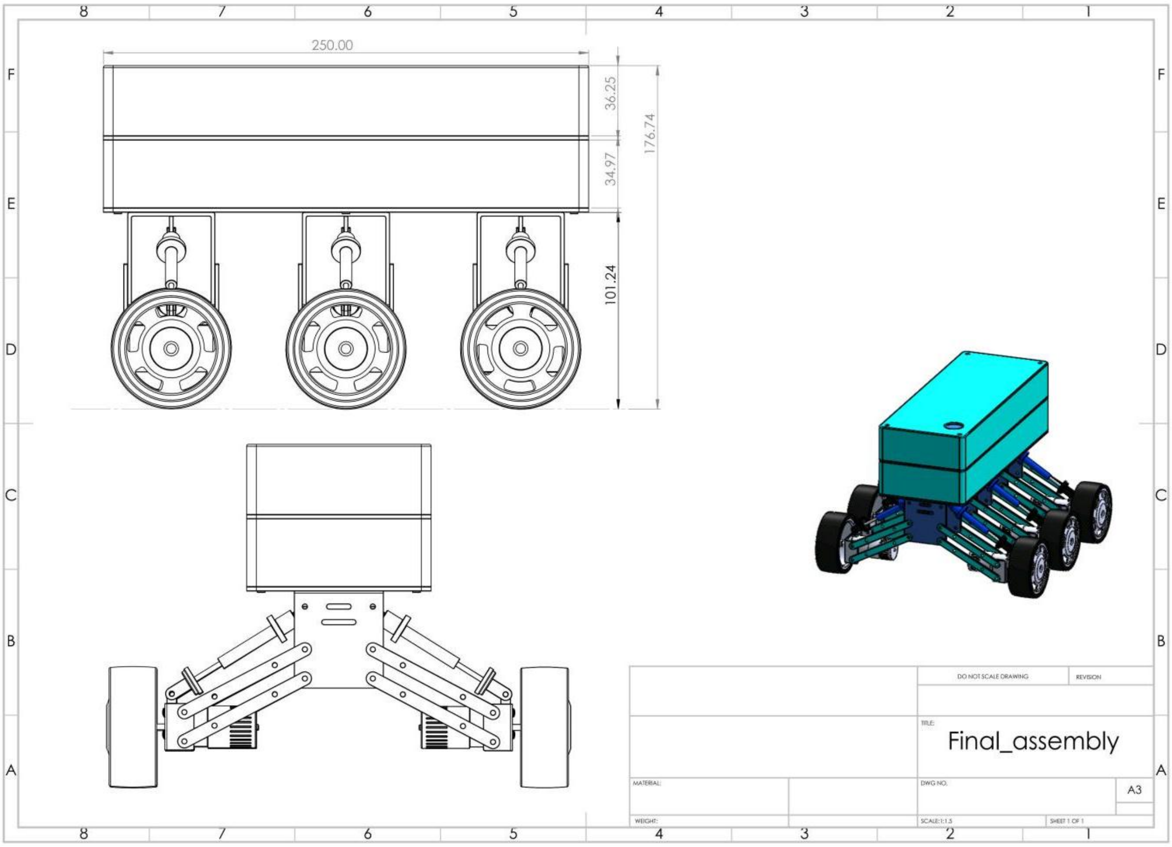
4. Final Assembly



2. RESULT

Designing an effective UGV requires careful consideration of several critical factors, including component measurements, design specifications, material selection, manufacturability, and environmental resilience By carefully considering these factors, the designed UGV that performs optimally in challenging situations is:

A. Frame

Fig. 7 Isometric View

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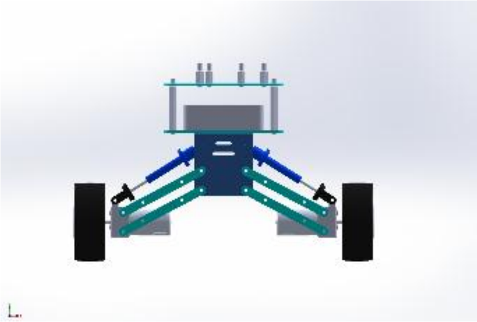
Fig. 8 Front View

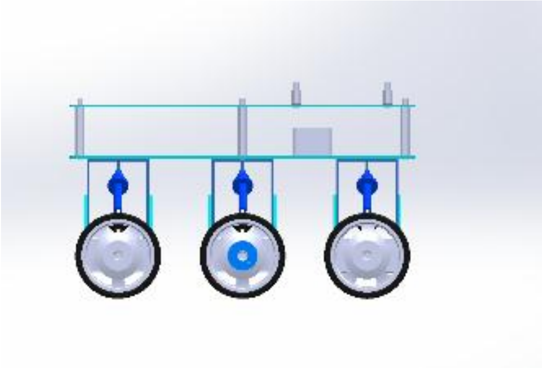
Fig. 9 Side View

B. Wheel & suspension assembly and Accumulator container


Fig 10 Wheel Assembly & Suspension mounting

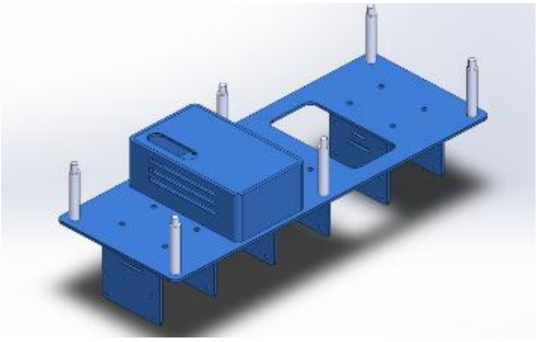
Fig.11 Battery container mount

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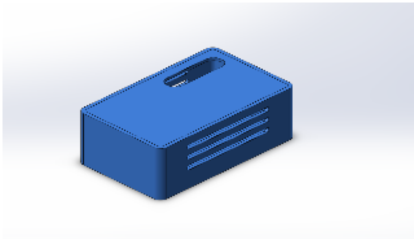

Fig. 12 Accumulator container

Softwares used:

i. Solidworks 2021

SolidWorks is a 3D CAD software used for creating 3D-models and designs for various engineering applications. It offers features such as simulation, visualization, and data management.

ii.Proteus 8

Proteus 8 is a software used for designing and simulating electronic circuits. It allows users to design, test and debug embedded systems and provides a comprehensive suite of tools for PCB design and layout.

3. CONCLUSION

In conclusion, the project has successfully designed a UGV accordingly as Ready-to-assemble concept which provides a sturdy design for landmine detection UGV. The project combines modern technology with practical applications to make a tool which will navigate through difficult terrains and detect potential hazards. With regular maintenance and updates, the car can still function effectively and potentially save lives.
Overall, the project demonstrates the potential of technology to enhance the security and well-being of communities in areas suffering from landmines. the appliance of Bluetooth and GPS technologies, especially, could lead on to further advancements within the field of landmine detection and removal.

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