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EE 59869 – Senior Design II for Computer Engineering
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# SubSurface Scout

GPR Path Finder

SUBMITTED TECHNICAL REPORT FOR THE AWARD OF THE DEGREE OF
***Bachelor of Engineering***
***in***
***Computer Engineering***


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# Table of Contents

# Abstract

This project presents the design and construction of a mobile robot platform specifically for ground-penetrating radar (GPR) applications. The robot features a custom-built frame constructed from acrylic and aluminum, optimizing the balance between structural integrity and weight reduction to enhance mobility. Omnidirectional wheels allow customizable scanning patterns, enabling GPR data collection within the designated survey area. This mobile GPR platform offers a versatile solution for efficient data collection across various fields, including archaeology, geotechnical engineering, and utility mapping.

# Introduction

This report details the design and construction of a mobile robot platform specifically designed for ground-penetrating radar (GPR) applications. The platform is configured to operate efficiently within a designated survey area.

# Project Scope

The project encompassed the following key stages:

- **Design:** SolidWorks software was utilized to design the robot's frame, considering factors like material selection, weight distribution, and ease of assembly. The design incorporated features to accommodate operation within a predefined area.
- **Fabrication:** The designed frame components were fabricated using laser cutting technology for precise cuts in acrylic sheets. Aluminum components were incorporated for additional strength where needed.
- **Assembly:** Following fabrication, the laser-cut pieces were assembled to form the robot's frame, ensuring proper fit and functionality.
- **Control System Integration:** An Arduino Uno microcontroller was chosen as the control unit, and code was written to enable the robot to execute predefined movement routines within the designated area, facilitating efficient GPR data collection.
- Testing and Evaluation: The completed robot platform underwent testing to evaluate its movement capabilities and functionality within the predefined operating area.

# Design Considerations

- Material Selection: Acrylic was chosen for its lightweight properties and ease of fabrication with laser cutting. Aluminum was used for specific components requiring greater strength.
- Manufacturing Process: Laser cutting was the primary manufacturing method due to its accuracy and suitability for acrylic.
- Assembly Considerations: The design prioritized ease of assembly with components featuring proper fit and minimal complexity.

- Cost Constraints: Material selection, fabrication techniques, and overall design aimed for cost-effectiveness within the project budget.

# Software and Hardware Integration

- SolidWorks: This 3D modeling software facilitated the design of the robot frame, ensuring precise dimensions and component compatibility for operating within a predefined area.
- Laser Cutter: Laser cutting technology is provided in Makerspace for accurate cuts in the acrylic frame components.
- Arduino Uno: This microcontroller serves as the brain of the robot, governing its movements based on pre-programmed routines for efficient data collection within the designated area.
- Omnidirectional Wheels: These wheels enable the robot to move in any direction, offering superior maneuverability for executing pre-defined scanning patterns within the operating area.

# Design

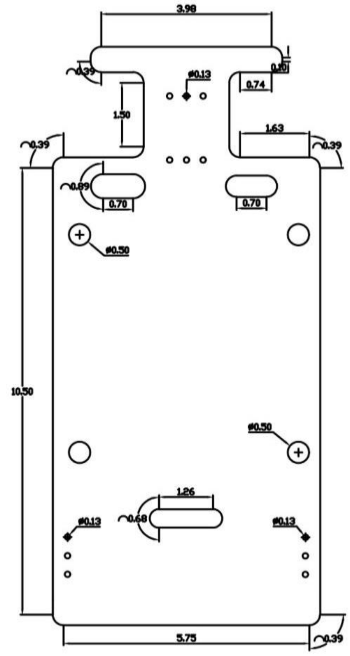
SolidWorks software was utilized to design the robot's frame. The software's sketching and assembling features facilitated the creation of an accurate 3D model with precise dimensions and specifications. Upon completion of the 3D model, the design was exported as a DXF file for compatibility with the laser cutting software.

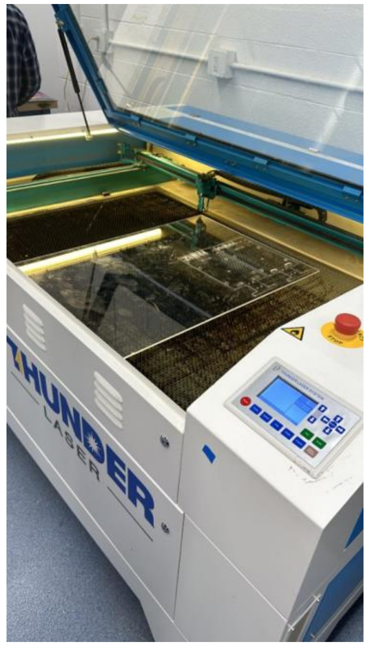
# Manufacturing

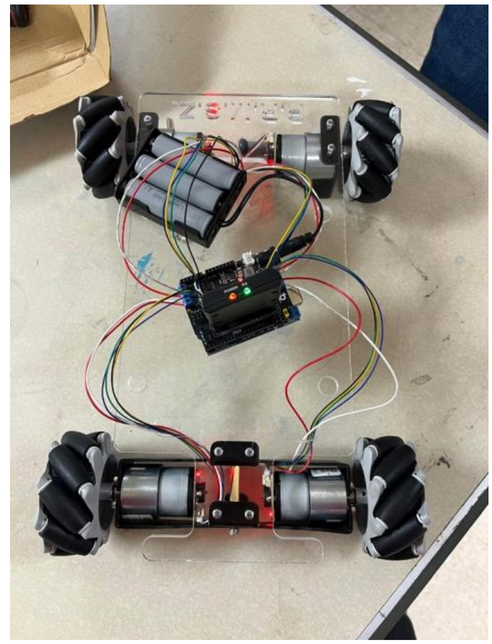
The exported design file was loaded into the laser cutting software. Specific cutting parameters were established based on the material type and thickness (acrylic in this case). Power, speed, and frequency settings were optimized through experimentation to ensure clean and accurate cuts. Following the cutting process, the individual pieces were meticulously removed from the laser cutter bed.

Next, we carefully mounted the GPR scanner onto the frame, ensuring proper alignment and stability. This required precision and attention to detail to guarantee optimal performance during scanning operations. We utilized specialized tools and mounting hardware to securely fit the GPR scanner onto the frame, minimizing vibrations and ensuring accurate data acquisition.

Once the GPR scanner was securely attached, we conducted thorough testing to ensure functionality and performance. This involved verifying communication between the scanner and the control systems, as well as testing the mobility and maneuverability of the robot with the integrated wheels. All necessary finishing touches or assembly processes were completed to ensure the fabricated frame met the desired quality and accuracy standards.







# Component Selection

The robot platform combines commercial and custom components that were available:

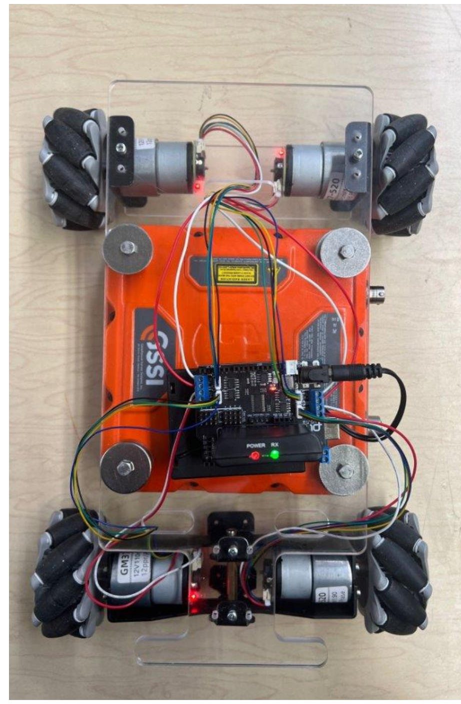
- **Control Unit:** An Arduino Uno microcontroller that serves as the core processing unit, governing the robot's movements and sensor data acquisition.
- **Motors and Wheels:** Encoder motors paired with omnidirectional Mecanum wheels provide precise movement control and enable customizable scanning patterns.




# Functionality and Control

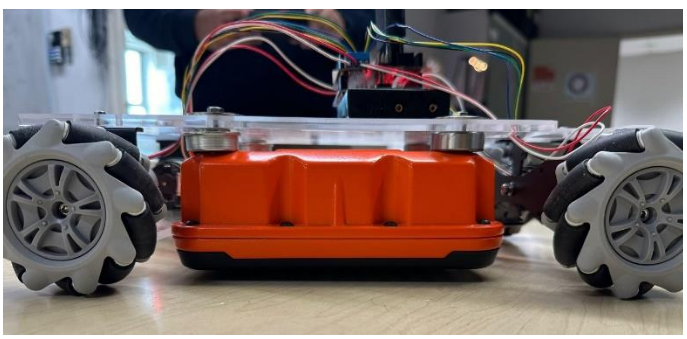
The robot platform features a modular design that allows for user-defined control and payload integration. The control system, built around the Arduino Uno, enables manual operation through a user interface (e.g., game controller) or pre-programmed routines for automated movement within a predefined area. The omnidirectional wheels offer superior maneuverability, facilitating precise navigation and customizable path execution.

# Conclusion / Executive Summary



This project successfully designed and constructed a mobile robot platform specifically for ground-penetrating radar (GPR) applications. The custom-built frame, constructed from a blend of acrylic and aluminum, optimizes structural integrity while minimizing weight, and enhancing mobility. Equipped with omnidirectional wheels, the robot executes precise and customizable scanning patterns within designated areas, ensuring comprehensive GPR data collection.

The platform's focus on pre-defined operation areas and user-programmed routines allows for efficient data collection in controlled environments for various fields like archaeology, geotechnical engineering, and utility mapping.



Looking ahead, future iterations could incorporate advanced control systems with obstacle avoidance capabilities, expanding operational range and adaptability. Additionally, integrating additional sensors could further enhance data collection capabilities for specific applications. Exploring new applications and functionalities will solidify the platform's position as a valuable tool for researchers and professionals.

By combining a robust design with advanced mobility features, this mobile GPR platform lays the foundation for efficient subsurface data collection within designated areas.

# References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