Higher National Diploma in Engineering (HNDE)

Department of Electrical and Electronics Engineering

Labuduwa-Galle

EE 3206 - Robotics & Automation

Project Proposal

Group No:05

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1 Introduction

As part of our Robotics and Automation studies, our team is undertaking the design and development of a battle robot to participate in the upcoming Inter ATI Robot Battle Competition, organized by the Department of Electrical and Electronics Engineering, Advanced Technological Institute, Labuduwa, Galle. This event is designed to encourage innovation, teamwork, and technical excellence by providing students with an opportunity to apply theoretical knowledge in a practical and competitive setting. For us, it represents not only a challenge but also a chance to gain valuable experience in engineering design, problem-solving, and real-world application of robotics.

Our group consists of six dedicated members, each contributing unique skills and expertise to different aspects of the project. Together, we aim to design and construct a lightweight, cost-effective, and highly functional robot that complies with the rules and regulations of the competition while delivering strong combat performance. The robot has been carefully designed to maintain a total weight of 2 kg, ensuring agility, speed, and maneuverability. Special emphasis has been placed on cost-effectiveness by selecting materials and components that remain within budget without compromising efficiency, durability, or functionality.

The robot will be remotely controlled, allowing for precise movements and effective strategic control during matches. Its drive mechanism is powered by TT DC gear motors, which provide the necessary torque and speed balance essential for rapid responses and competitive performance in the arena. At the core of the control system is an Arduino-based platform, chosen for its versatility, reliability, and compatibility with a wide range of sensors and actuators. This system not only enables effective programming of movements and actions but also allows for real-time responses to environmental changes, thereby enhancing the robot's overall combat capability.

Throughout this project, we are engaging with a variety of technical disciplines, including electrical circuit design, embedded programming, and mechanical construction. We are also addressing practical engineering challenges such as optimizing power consumption, ensuring structural robustness to withstand collisions, and fine-tuning mobility for smooth and responsive control. By integrating these aspects, we are ensuring that each component of the robot contributes effectively to its overall performance in the competition.

Robots, in general, are machines designed to perform tasks autonomously or semi-autonomously by combining sensors, actuators, and control systems. In the context of our project, these technologies come together to enable our robot to operate reliably in a high-pressure, competitive environment. The Inter ATI Robot Battle Competition will serve as a platform to test not only the mechanical strength and mobility of our robot but also its durability, adaptability, and strategic effectiveness in combat scenarios.

Beyond the technical challenges, we have placed strong emphasis on safety and compliance with all competition rules and regulations. Given that battle robots engage in controlled combat, ensuring safety is vital to protect both participants and equipment. Our design incorporates appropriate safeguards while maintaining focus on efficiency and performance.

Ultimately, this project is more than just the construction of a battle robot it is an opportunity to apply classroom knowledge in a hands-on context, strengthen teamwork and problem-solving abilities, and gain valuable experience in robotic system design. By participating in the Inter ATI Robot Battle Competition, we aim not only to compete successfully but also to showcase the innovation, technical capability, and collaborative spirit of our team as aspiring engineers.

2 Literature Review

The design and development of battle robots is a multidisciplinary field, integrating concepts from robotics, mechanical engineering, electronics, control systems, and embedded software. Academic and industrial literature emphasizes the importance of balancing performance, durability, weight, and cost, particularly for lightweight robots participating in competitive events. For the 2 kg Arduino-controlled robot designed for the Inter ATI Robot Battle Competition, these principles guide decisions regarding chassis materials, drive and weapon systems, control architecture, and energy management.

2.1. Historical Context of Battle Robots

Battle robots have evolved from early experimental machines and military robotics into competitive platforms for education, research, and entertainment. Competitions such as Robot Wars, BattleBots, and other academic events have shaped modern design practices, fostering innovation in lightweight mobility, efficient weapon systems, and autonomous or semi-autonomous control. Historical studies highlight the importance of structural durability and energy management, as these factors have consistently determined competitive success in small-scale robotic combat. Moreover, literature emphasizes that student competitions provide an ideal context for hands-on learning, applying theoretical knowledge in electrical, electronic, and mechanical engineering to practical robot design [1].

2.1. Chassis and Materials

The chassis is fundamental to a robot's performance and survivability. Lightweight materials such as aluminum alloys, acrylic sheets, and composite polymers are widely recommended in the literature for robots under strict weight limits .These materials offer high strength-to-weight ratios, allowing robots to maintain durability while achieving agility in the combat arena. Modern additive manufacturing techniques, such as 3D printing with reinforced polymers, enable custom chassis designs with integrated mounts for motors, batteries, and sensors, while reducing overall weight .Shock absorption features and strategic placement of critical electronics, such as the Arduino microcontroller and battery pack, have been shown to improve resilience during collisions and combat impacts [2].

2.2. Mobility and Drive Systems

Mobility is a key determinant of combat effectiveness. Literature indicates that TT DC gear motors are widely used in small-scale combat robots due to their compact size, cost-effectiveness, and reliable torque-speed characteristics .By selecting appropriate gear ratios and wheel diameters, these motors can provide sufficient acceleration, maneuverability, and control. Integrating sensors such as gyroscopes and accelerometers allows for real-time feedback, improving stability and responsiveness during rapid movements or collision events .Research also emphasizes the importance of energy efficiency in drive systems, as motor selection directly affects battery life and overall robot endurance in competitive scenarios [3].

2.3. Weapon Systems

Offensive capabilities define the strategic performance of battle robots. Studies on kinetic energy transfer and weapon impact dynamics highlight that spinning blades, flippers, and wedge-based systems are most effective when optimized for weight and power constraints. For lightweight robots, pneumatic-assisted flippers and spring-loaded mechanisms provide sufficient force to flip or destabilize opponents without excessive mass addition. Rotating blades or drum mechanisms, powered by dedicated motors, require careful structural mounting and balance to prevent damage to the chassis or drivetrain. Literature emphasizes that proper energy allocation between mobility and weapon systems is crucial for sustained combat effectiveness [4].

2.4. Control Systems and Arduino Integration

Modern small-scale combat robots frequently employ embedded microcontrollers, with Arduino being a popular platform for its versatility and ease of programming . Literature highlights that Arduino-based systems allow precise motor control, integration of sensors (such as limit switches, infrared, and ultrasonic sensors), and wireless remote operation. Best practices include using separate circuits for high-current motor control and low-current sensor or logic signals, ensuring operational reliability and safety. Additionally, sensor integration enhances situational awareness, allowing operators to make strategic decisions based on proximity sensing, collision detection, or environmental feedback [5]. Studies indicate that even basic sensor-assisted navigation can significantly improve combat performance in competitive events.

2.5. Energy Management

Efficient power management is critical for sustaining mobility, weapon systems, and control electronics. Lithium Polymer (Li-Po) batteries are commonly recommended due to their high energy density and low weight. Literature emphasizes the importance of monitoring current and voltage levels to prevent over-discharge, over-current events, or thermal issues, particularly during high-demand combat actions such as sudden acceleration or weapon activation. Lightweight robots benefit from modular battery placement to optimize center of gravity, thereby enhancing stability and maneuverability during battle [6]. Energy-efficient motor control and weapon actuation strategies also extend operational time, ensuring peak performance throughout the match.

2.6. Future Trends and Sustainability

Emerging research trends focus on energy-efficient robotics, autonomous decision-making, and sustainable material usage. Lightweight robots increasingly incorporate advanced sensors, microcontrollers, and AI-assisted strategies to improve autonomy and combat efficiency [5]. Sustainable chassis materials, recyclable polymers, and energy-efficient motors are being explored to reduce environmental impact while maintaining performance [2]. Academic competitions provide an ideal environment for students to experiment with these trends, applying innovative materials, embedded control techniques, and energy management strategies in a practical setting.

3 Design

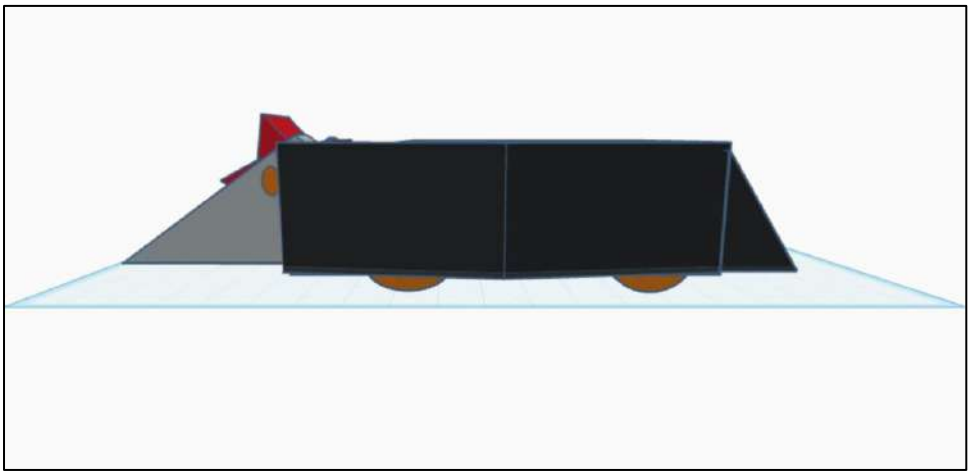

Figure 1 Side View

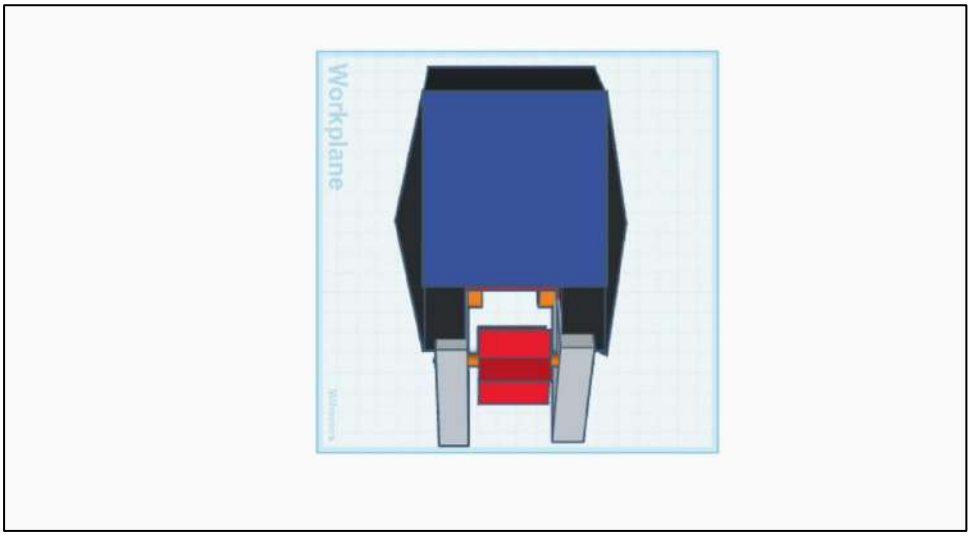

Figure 2 Top View

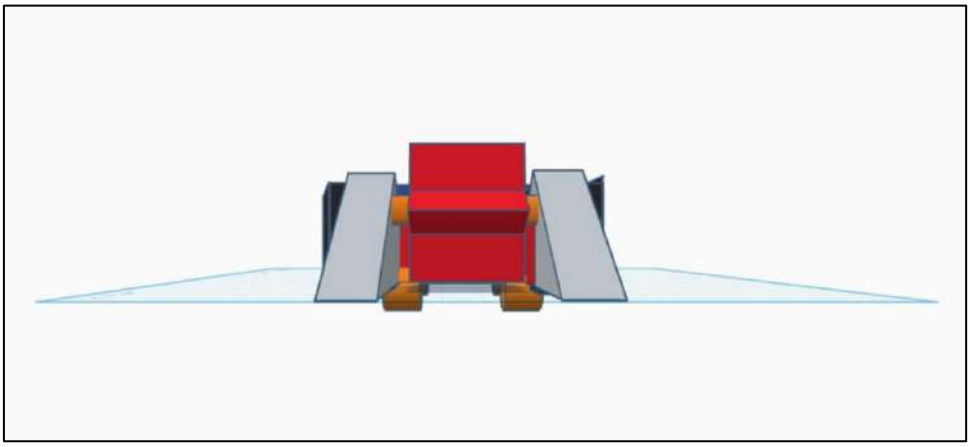

Figure 3 Front View

4 Budget

Table 1 Proposed Budget

Part	Quantity	Price (Rupees)
Li-po Battery	1	4050
Gear wheels	1	600
Arduino uno	1	1000
Breadboard	1	300
Rubber Wheels	4	400
Motors	5	2000
Bluetooth Module (HC-06)	1	860
Box bar 1/4	1	1400
Bearings	4	500
Screws and nuts	-	100
Moving Wheel Arrangement	-	1000
Wires	-	200
Others	-	3000
Total Cost		15,410

5 Project Timeline

Table 2 Project Timeline

Task	September				October				November			
Weeks	1	2	3	4	1	2	3	4	1	2	3	4
Creating battle groups & Initial Research												
Proposal Submission and Approval												
Robot Design and Build Phase												
Testing and Optimization												
Implementation												
Technical Inspections												
Final Presentation & Submission												
Conduct the Robot Battle & Award Ceremony												

6 Conclusion

In conclusion, our group project for the Inter ATI Robot Battle Competition represents a focused effort to apply theoretical knowledge and practical skills in robotics, mechanical design, and control systems. By designing a lightweight, durable robot powered by DC gear motors and controlled via Arduino technology, we aim to achieve optimal maneuverability, efficiency, and combat readiness. The use of cost-effective and robust materials ensures that the robot remains agile while withstanding the physical demands of the battle arena.

Throughout this project, our team will leverage skills in electrical circuit design, programming, and mechanical construction, with each member contributing to key areas such as motor integration, control system programming, chassis design, and testing. The robot's remote-control functionality will allow precise strategic movements during combat, while careful component selection ensures reliability under intense operating conditions.

Furthermore, our design adheres strictly to the competition's rules and safety guidelines, including considerations for mobility, weapon systems, and overall structural integrity. This project not only showcases our technical abilities but also fosters teamwork, problem-solving, and innovation, providing valuable hands-on experience in engineering design and robotics. We are confident that our robot will perform effectively in the competition, demonstrating creativity, precision, and resilience.

7 References

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