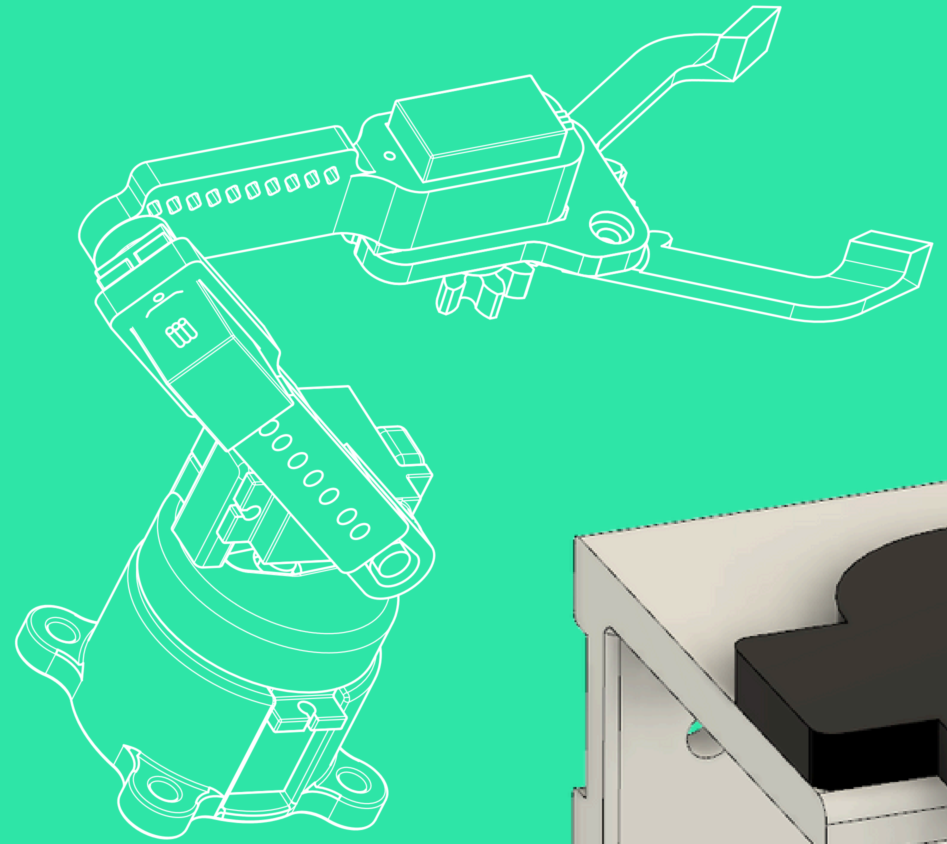
PLASTAL-BOT BUILDERS



CONCEPT NOTE:

DEVELOPMENT OF A CUSTOM SELF-BALANCING ROBOTICS PLATFORM FOR EDUCATION, RESEARCH, AND PROTOTYPING IN AFRICA

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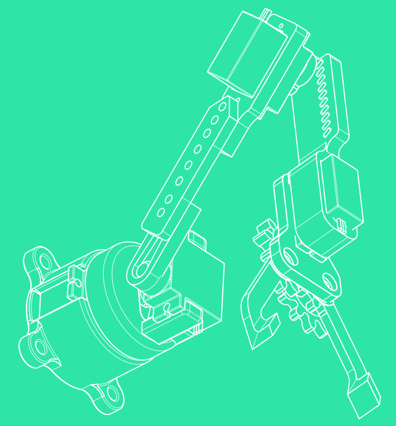
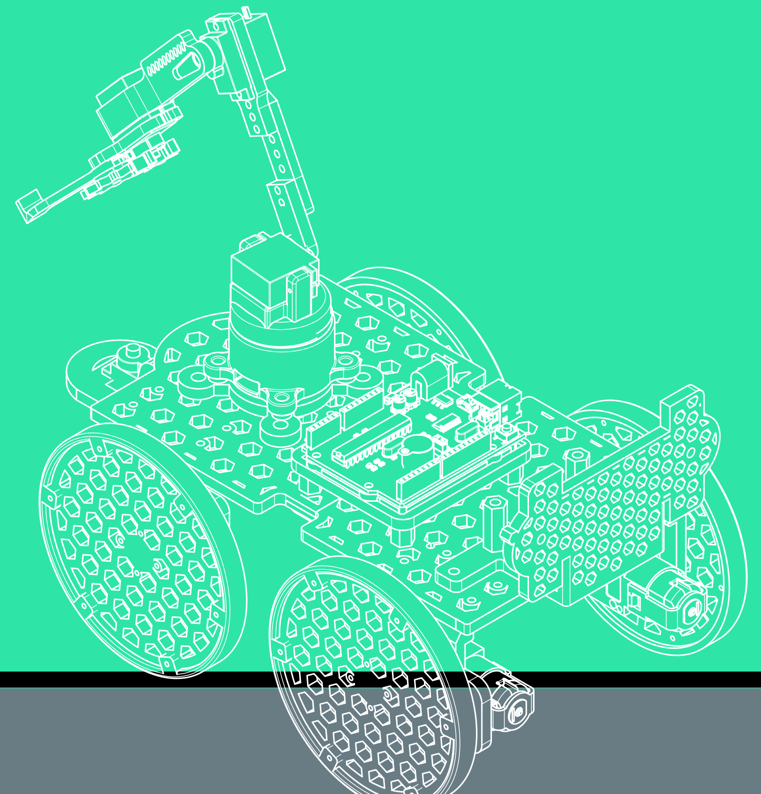
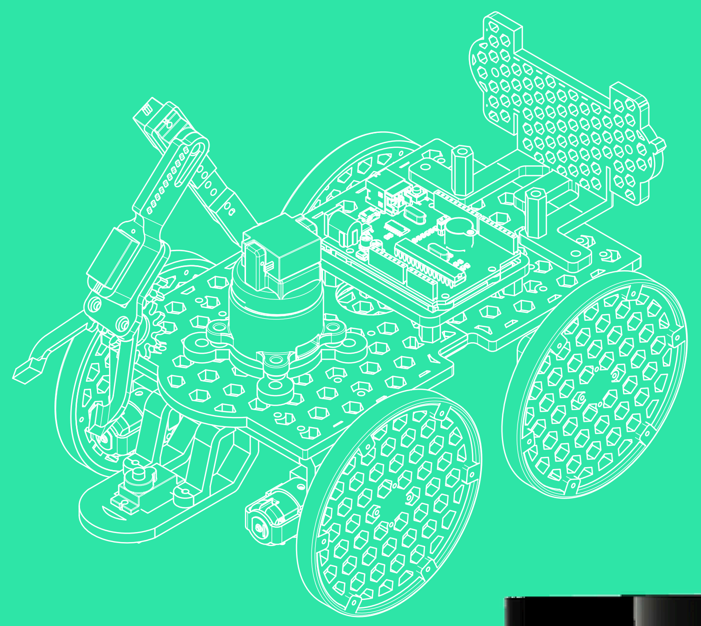
INTRODUCTION



Plastal-Bot Builders is a Zambian-based technology startup committed to creating affordable, practical, and locally manufactured robotics solutions. This proposal outlines our plan to design, develop, and manufacture a custom PCB-based self-balancing robotics platform targeted at learners, researchers, and makers in Zambia and the wider African market.



PROBLEM STATEMENT



MACHINE LEARNING & AUTOMATION

Access to robotics tools remains a significant challenge in Africa. Current solutions are often prohibitively expensive, overly complicated for beginners, or fail to offer flexibility for research and innovation. Robotics kits on the market typically cost between $50 to $600, excluding shipping and taxes, placing them beyond the reach of most individuals, schools, and institutions in the region.

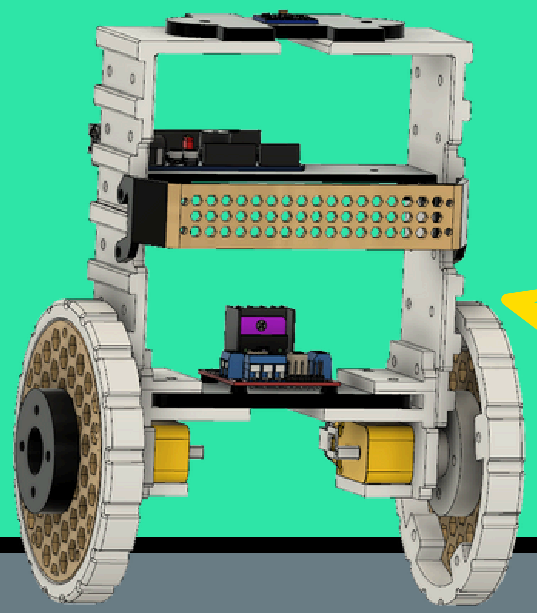
PROPOSED SOLUTIONS

We propose a locally designed, affordable, and modular self-balancing robotics platform built around a custom PCB. This platform will integrate:

- ESP32 microcontroller (wireless communication)
- Dual motor driver (motion control)
- IMU sensor (balancing and navigation)
- Battery management and power regulation

The robot is designed to support:

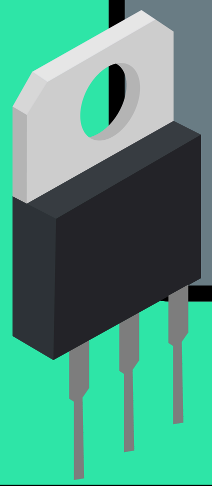
- Educational use (STEM learning)
- Maker experimentation and prototyping
- Research applications, including AI and robotics simulation

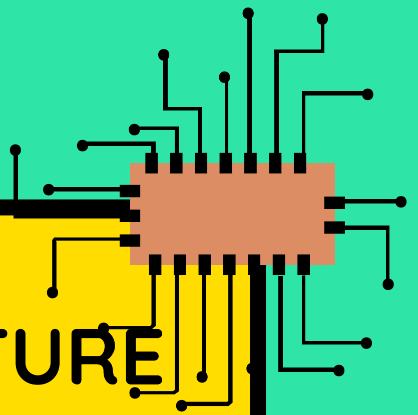


WHAT ARE OUT OBJECTIVES (1)

1. DEVELOP A FULLY FUNCTIONAL PROTOTYPE

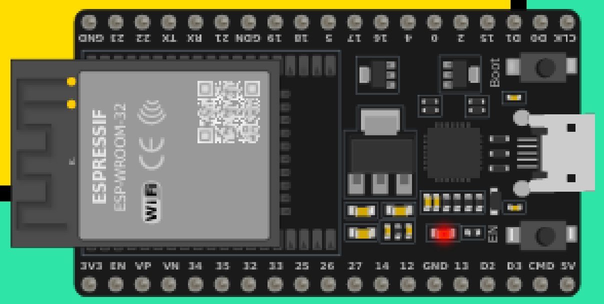
To develop a fully functional prototype of the self-balancing robot, demonstrating reliable balance control, wireless connectivity, and modular design that can serve both educational and research purposes.





2. DESIGN AND MANUFACTURE A CUSTOM PCB

To design and manufacture a custom PCB optimized for this platform, integrating essential components such as the ESP32 microcontroller, motor driver, IMU sensor, and power management circuitry for efficient and compact performance.



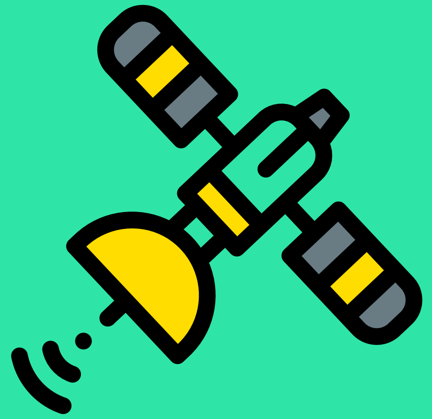
WHAT ARE OUT OBJECTIVES (2)

REDUCE PRODUCTION COSTS THROUGH LOCAL MANUFACTURING

To reduce production costs through local manufacturing (PCB fabrication, 3D printed structural components, CNC machined parts), ensuring affordability and accessibility for our target markets.

POSITION THE PLATFORM AS A SCALABLE PRODUCT

To position the platform as a scalable product for education and innovation in Africa, with clear pathways for future upgrades, curriculum integration, and collaboration with educational and research institutions.



TARGET MARKERT

- Students and Educators: For use in STEM curriculums.
- Makers and Hobbyists: As a foundation for building custom projects.
- Researchers: For control systems, AI, and robotics simulations.
- Startups: As a development platform for autonomous and mobility robotics.

OUR TARGET MARKET

STUDENTS AND EDUCATORS

For use in STEM curriculums, this platform provides hands-on experience with core robotics principles, electronics, and control systems. It allows students to engage with real-world technology, enhancing classroom learning through experimentation and project-based activities.

MAKERS AND HOBBYISTS

As a foundation for building custom projects, this robot offers a modular and programmable platform. Makers can extend its functionality by integrating additional sensors, actuators, and control algorithms, allowing for creativity in both hobby and competitive robotics settings.

For control systems, AI, and robotics simulations, this platform serves as an adaptable testbed. Researchers can implement advanced algorithms, test new hardware configurations, and conduct experimental work in fields such as autonomous navigation, machine learning, and sensor fusion.

RESEARCHERS

As a development platform for autonomous and mobility robotics, this solution offers a reliable prototype framework. Startups can leverage its compact design and expandability to accelerate proof-of-concept development for robotics products or services aimed at various industries, including delivery systems, healthcare, and agriculture.

STARTUPS

KEY INNOVATIONS

Locally designed and manufactured PCB, integrating essential robotics components, including microcontroller, motor drivers, and sensors, to provide a compact, efficient, and tailored solution for our application.

Cost-effective alternative to expensive foreign kits, providing a locally produced, affordable solution that reduces reliance on costly imports and makes robotics education and development more accessible.

Expandable through standard communication protocols (I2C, UART), ensuring compatibility with a wide range of peripheral devices and simplifying integration with existing tools and platforms.

Open, modular, and adaptable for various applications, allowing users to expand functionality through additional modules, sensors, and custom software, fostering innovation and experimentation.

Locally designed and manufactured mechanical components (3D printed and CNC fabricated), enabling rapid prototyping, customization, and cost savings while promoting local manufacturing capabilities.

PROJECT DELIVERABLES

- Working prototype of the self-balancing robot.
- Production-ready custom PCB design and documentation (Gerber files, BOM).
- 3D CAD designs for chassis and parts, suitable for 3D printing and CNC.
- Educational resources and user manuals for target audiences.

These deliverables reflect both the hardware (mechanical and electronic) and supporting documentation necessary to ensure the successful implementation and potential commercialization of the self-balancing robotics platform.

WHY WE CHOSE A CUSTOM PCB (1)

Allows for future scalability and feature expansion by reserving interface headers, communication buses, and modular design elements that make it easy to integrate additional sensors, communication modules, or other extensions in future iterations.

Simplifies assembly and wiring by combining multiple components onto a single board, reducing the need for extensive wiring, connectors, and external modules, which in turn lowers assembly time and potential points of failure.

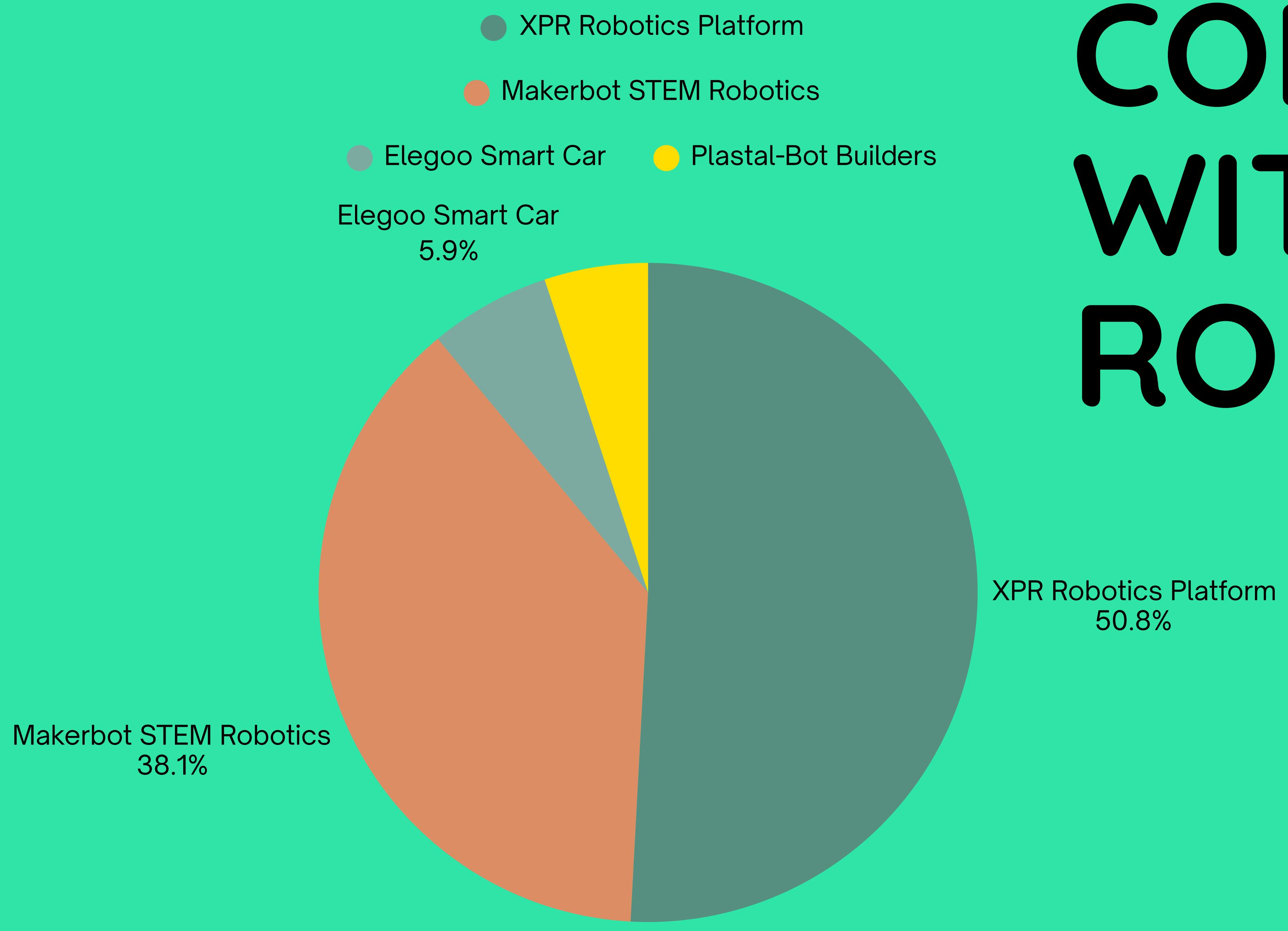
Reduces per-unit costs at scale by streamlining the design and manufacturing process into a compact, integrated solution that minimizes material and assembly expenses.

WHY WE CHOSE A CUSTOM PCB (2)

Provides better control over supply chains and component sourcing by allowing us to specify and standardize components that align with local availability and pricing, mitigating risks associated with import delays or shortages.

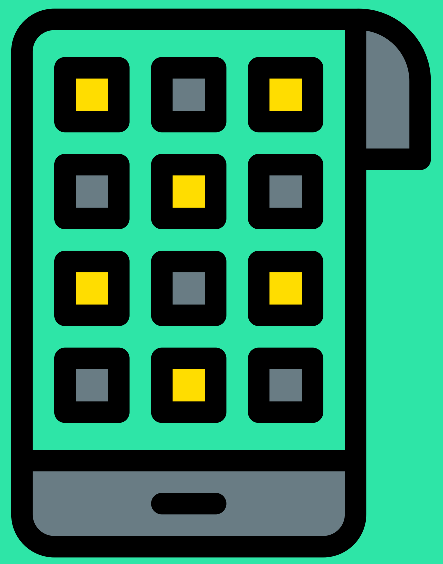
Optimizes for power efficiency and integration through precise power distribution, on-board voltage regulation, and efficient component placement, which enhances overall system reliability and battery performance.

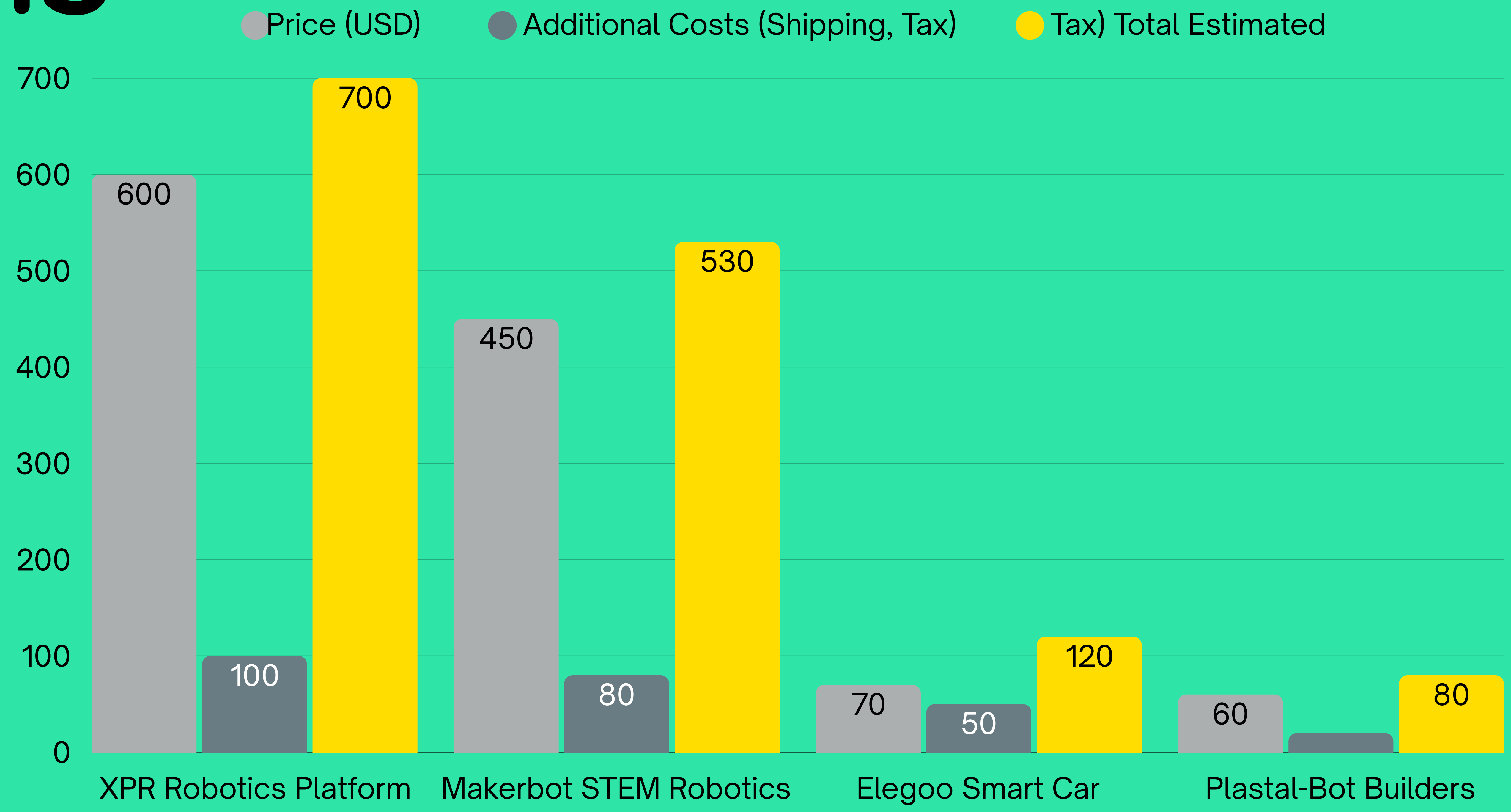
COMPARISON WITH EXISTING ROBOTICS KITS:

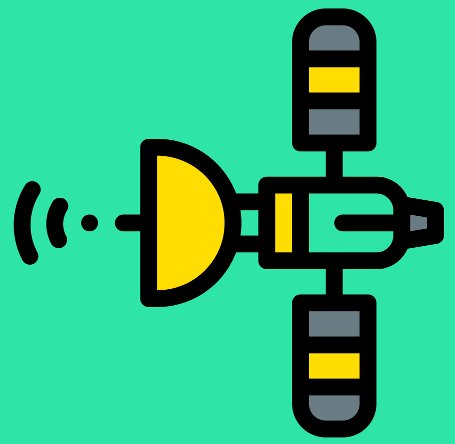


This comparison serves to highlight the significant price gap between established imported robotics kits and our locally manufactured alternative. These figures illustrate how our solution not only reduces costs through local sourcing and production but also addresses the broader issue of accessibility to robotics tools in the African market, where high importation costs often create a barrier to entry for educational institutions, makers, and innovators.

COMPETITIVE PRICING ANALYSIS







RESOURCES REQUIRED

- Funding for prototype development and small-scale manufacturing, including resources for acquiring materials, components, and specialized tools necessary to build and test initial versions of the product. This funding will also cover expenses for iterative improvements during the prototyping phase.

- Establishing strong manufacturing partnerships for PCB fabrication and chassis production, leveraging local and regional manufacturers to ensure cost efficiency, timely delivery, and high-quality production standards. These partnerships are crucial for transitioning from prototype to scalable manufacturing.

- Building effective distribution channels to reach educational institutions, makerspaces, and innovation hubs. This involves developing a network of local distributors, partnerships with educational supply companies, and targeted outreach through STEM and innovation programs to ensure our product is accessible to its intended audience.

EXPECTED OUTCOMES

- Accessible, affordable robotics platform tailored to Africa's needs, addressing the financial and logistical barriers that currently limit access to robotics tools in educational and maker communities. Our platform will be positioned as a practical and scalable solution for hands-on learning, prototyping, and research.

- Increased engagement in STEM education through hands-on learning tools that encourage curiosity, experimentation, and practical understanding of complex engineering concepts. This will empower students to actively participate in the creation and advancement of technology, fostering innovation from a young age.

- Strengthened local capacity for robotics innovation by nurturing a vibrant ecosystem of learners, makers, and researchers who can develop, customize, and improve upon open-source robotics solutions. This initiative supports the growth of a self-reliant technological community capable of solving local problems through innovation.

OUR BUSINESS MODEL CANVAS

Key Partners

- PCB Manufacturers
- 3D Printing Services
- Local Distributors
- STEM Network and institutions
- Educational Supply Companies

Key Activities

- PCB Design and Manufacturing
- Mechanical Design and production
- Software Development
- Assembly and Testing
- Customer Support

Key Resources

- Custom PCB design
- 3D CAD, Protypes
- Software librarues
- Testing Facilieties
- Technical Expertise

Value Prepositions

- Affordable, local robotics platform
- Scalable education and research tool
- Accessible, adaptable, and modular
- Reduced import dependancy
- Hands-on learning for STEM and Robotics

Customer Relationship

- Support, training, community
- Feedback - driven development
- Partnerships with institutions
- Direct outreach programs
- Workshops, Tutorials

Channels

- Direct sales, partnerships
- Maker fair, STEM expo's
- Distributors, Online stores
- Education programs, innovation hubs
- Education distributors

Customer Segment

- Educators, Student
- Makers, Hobbyists
- Researchers, startups
- African STEM programs
- Innovatin Hubs, University

Cost

- PCB production, component sourcing
- 3D printing material, Assembly
- Software development, Marketing
- Education material, training workshops
- Customer support. logistics

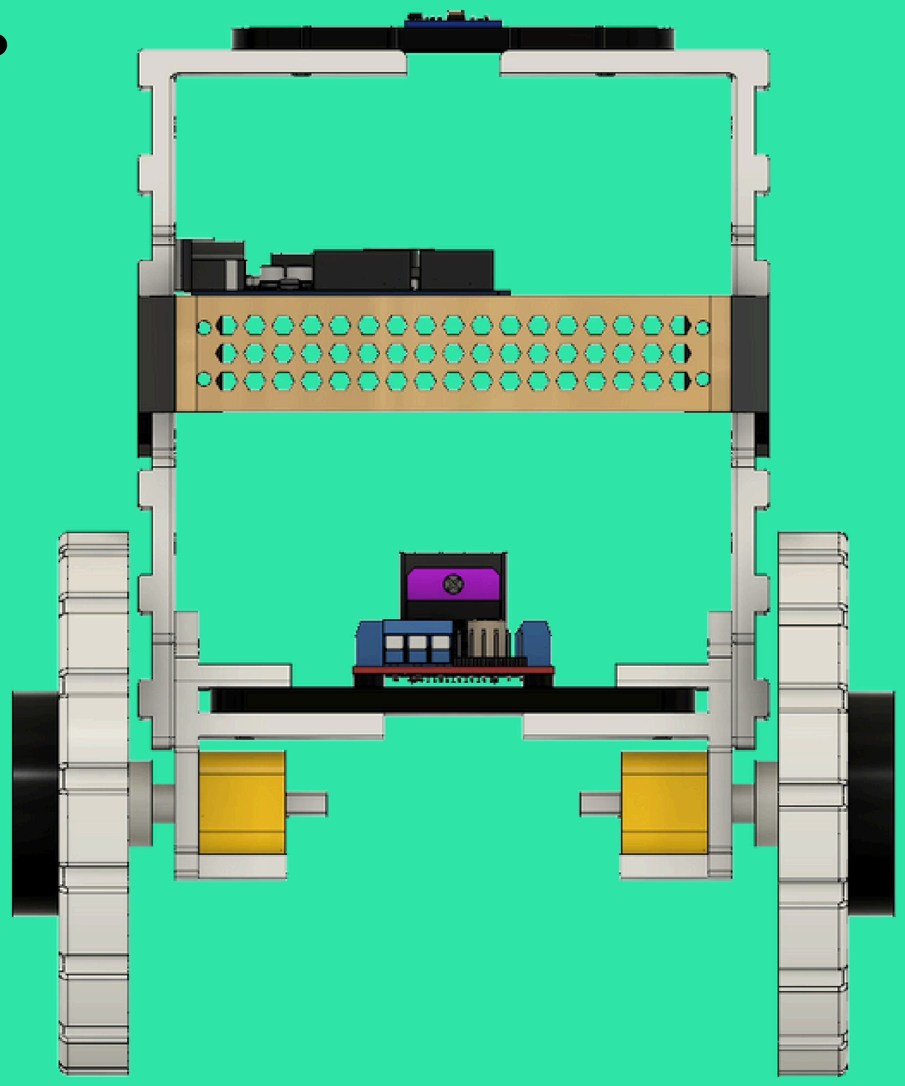
Resources Streams

- Product Sales (Units, kits)
- Licensing, Education contacts
- Subscription for add-ons/support
- Grants, sponsorships
- Bulk orders from institutions

This outlined here reflects our strategic approach in building a robust ecosystem around the self-balancing robot platform. This model emphasizes collaboration with local manufacturing partners, educational institutions, and distribution networks to reduce costs, improve accessibility, and ensure sustainability. Through partnerships and direct engagement with target users, we aim to create value not only through the product itself but also through supplementary resources such as workshops, training materials, and technical support. These efforts contribute to fostering a self-sustaining robotics community, promoting innovation, and positioning Plastal-Bot Builders as a key player in Africa’s growing tech landscape.

TECHNICAL DESCRIPTION OF THE ROBOT

The self-balancing robot integrates various mechanical and electronic components to achieve its intended functionality. Below is a detailed breakdown of the system



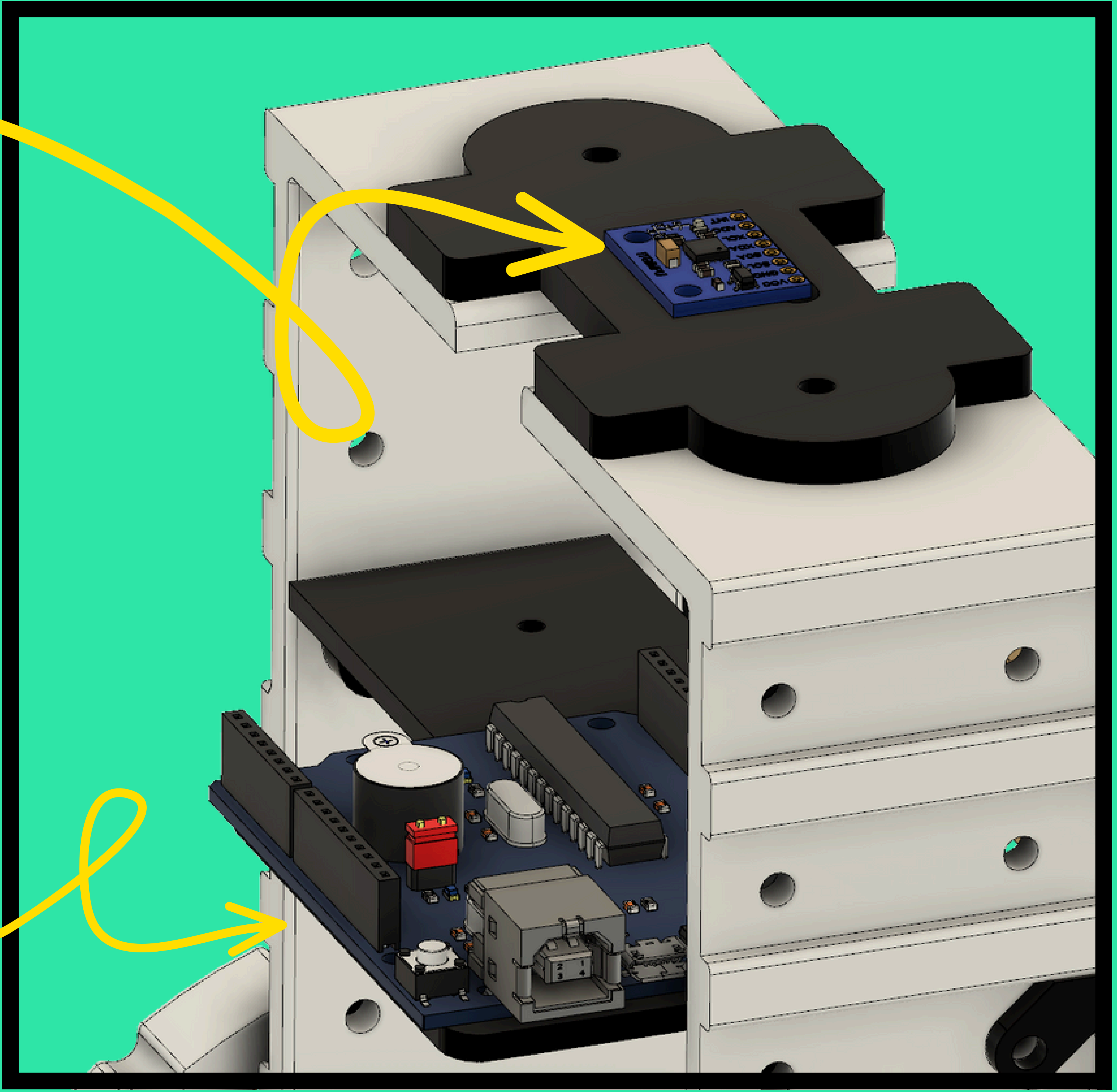
IMU SENSOR (GYROSCOPE & ACCELEROMETER)

Continuously monitors the robot's orientation, angular velocity, and acceleration across multiple axes. This data is critical for detecting any deviations from the upright position, enabling the control system to make immediate adjustments to maintain balance and stability.

MAJOR COMPONENTS & FUNCTIONS (1)

CUSTOM PCB WITH ESP32

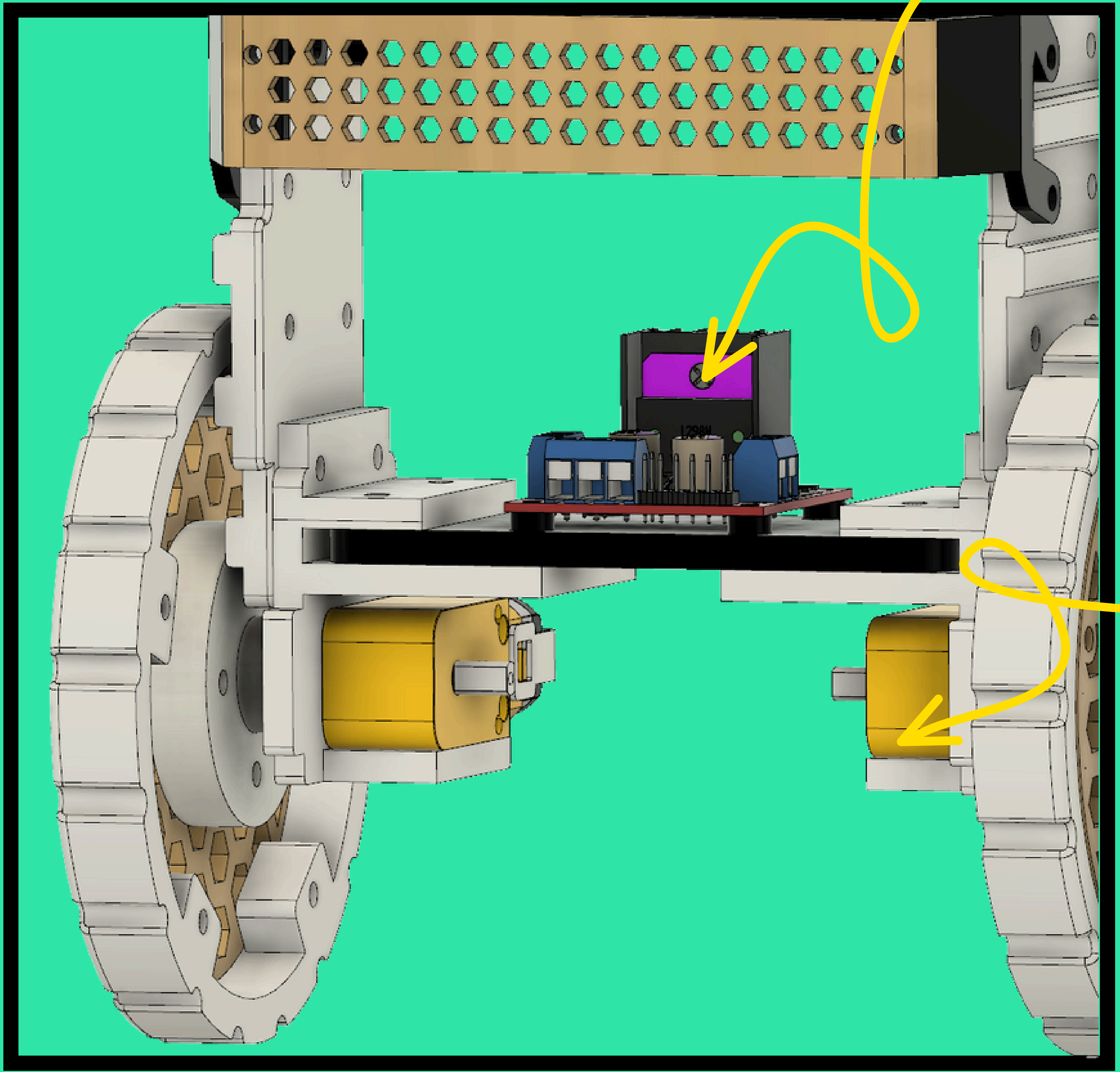
Serves as the central processing unit and communication hub of the robot. It processes data from all sensors, executes balancing algorithms (such as PID control), and manages wireless communication protocols like Wi-Fi and Bluetooth. The ESP32 enables real-time decision-making and provides the flexibility for future software updates and expansions.



MAJOR COMPONENTS & FUNCTIONS (2)

DUAL MOTOR DRIVER IC

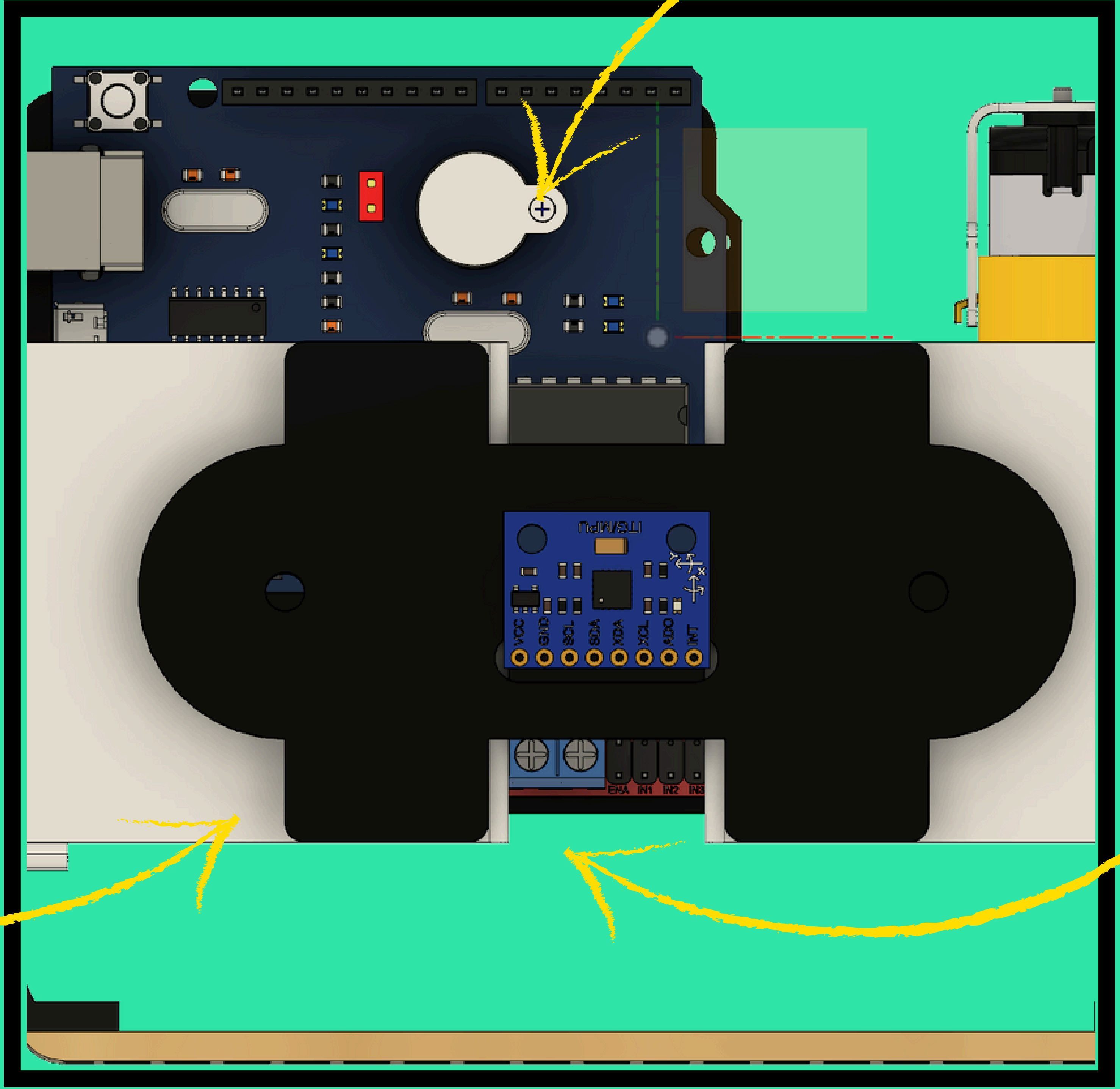
Manages the power and direction of the two DC motors based on commands from the ESP32. It provides the necessary current amplification and ensures smooth transitions between speed changes, forward/reverse motion, and braking.



DC MOTORS WITH ENCODERS

Provide the mechanical drive needed for movement and stabilization. The encoders offer precise feedback on wheel rotation, allowing closed-loop control for accurate speed regulation and position tracking, which enhances the robot’s responsiveness and balance control.

MAJOR COMPONENTS & FUNCTIONS



PIEZO BUZZER

Provides auditory feedback for states like start-up, errors, or balance loss.

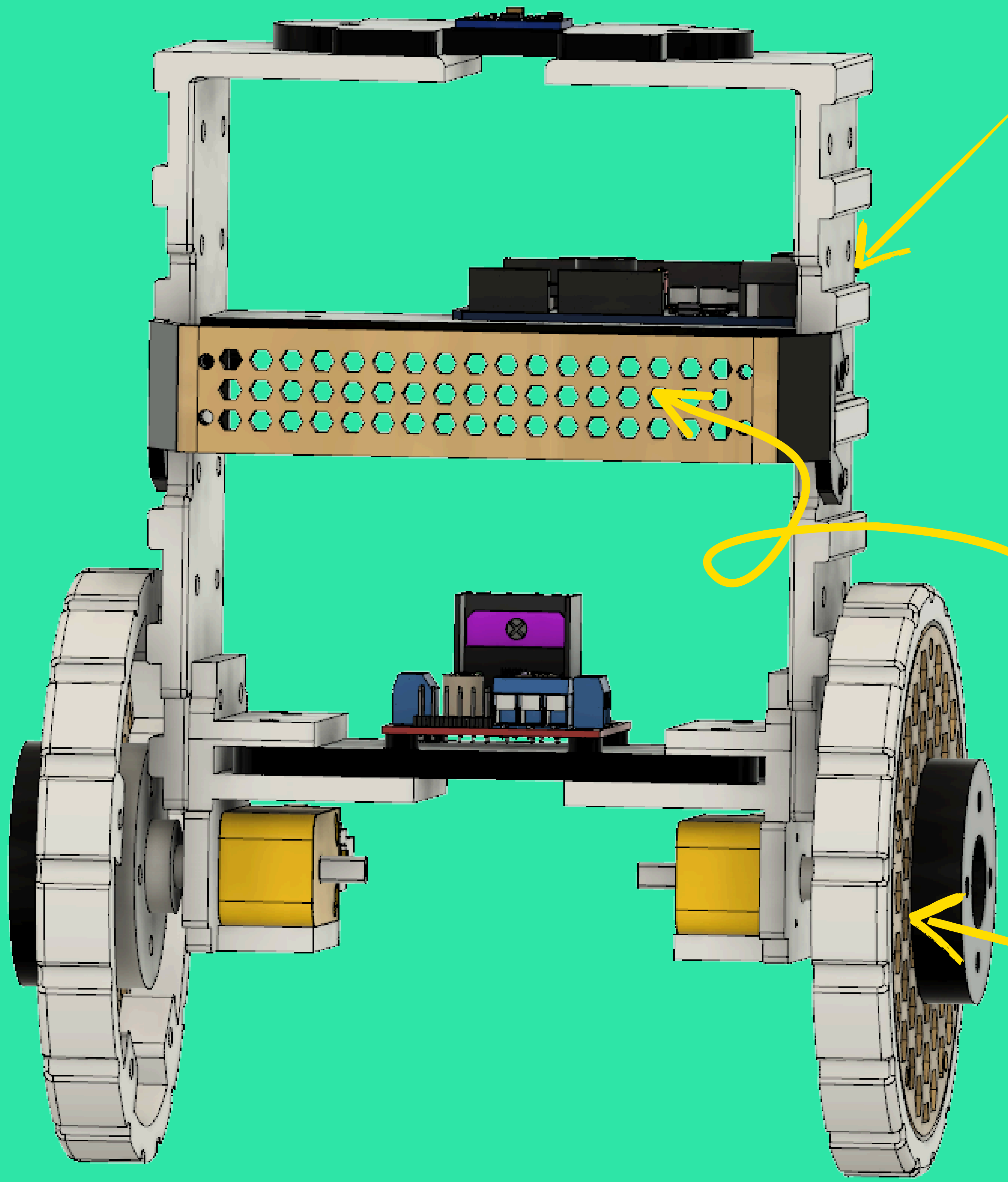
BATTERY PACK (2S2P 18650 LI-ION)

Supplies power to both the electronics and the motors.

VOLTAGE REGULATOR CIRCUIT

Ensures stable voltage supply to sensitive components.

MECHANICAL STRUCTURE



3D PRINTED CHASSIS

Lightweight yet robust structure to house all components.

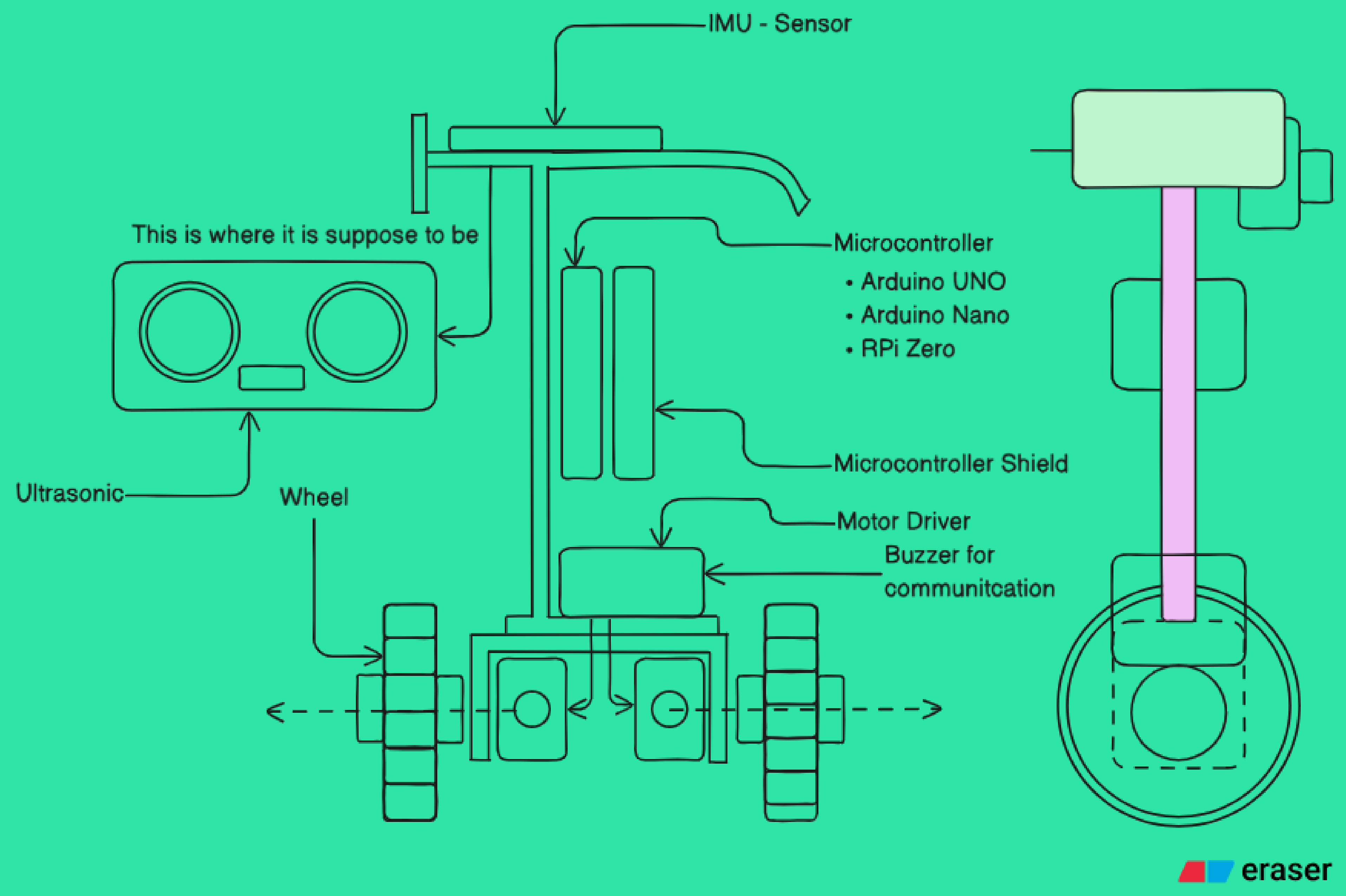
CNC MACHINED WOOD PARTS

Provide durability where necessary (motor mounts, structural supports).

WHEELS

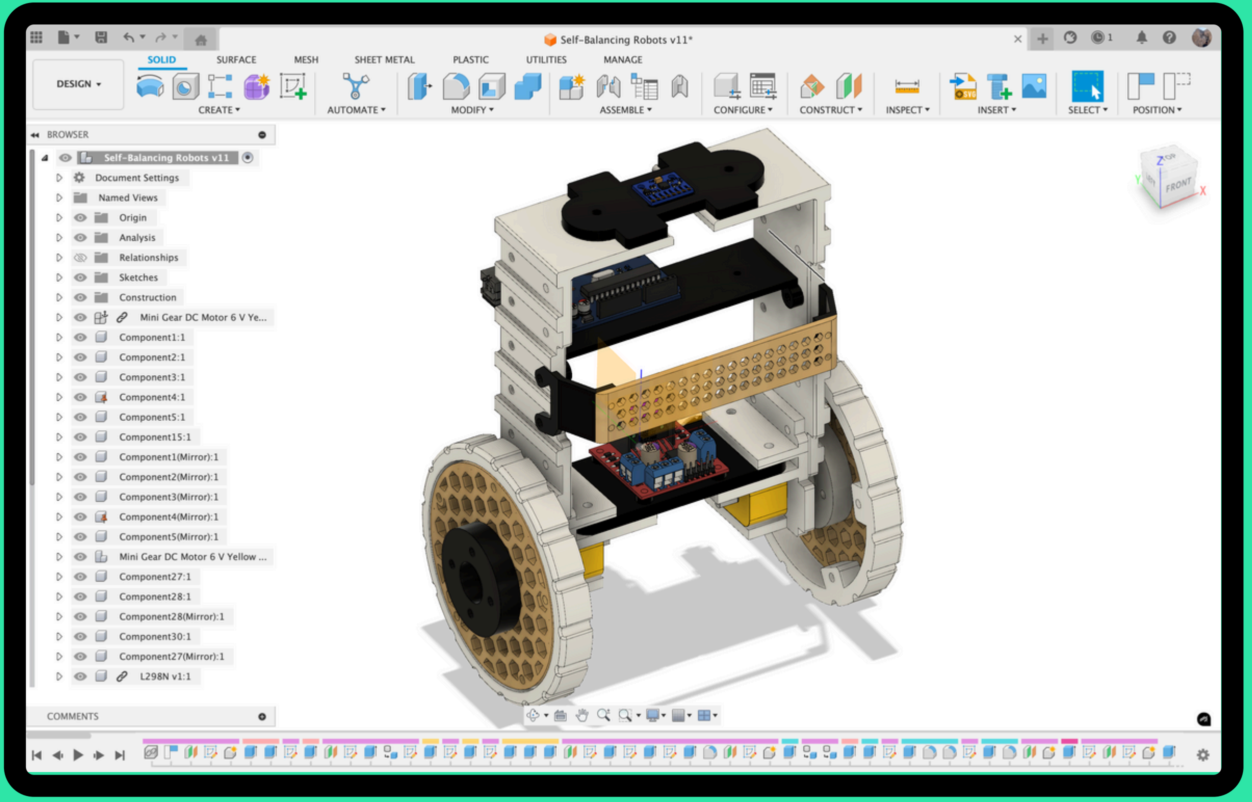
Precision balanced wheels for smooth, stable movement.

MANUFACTURING PROCESS

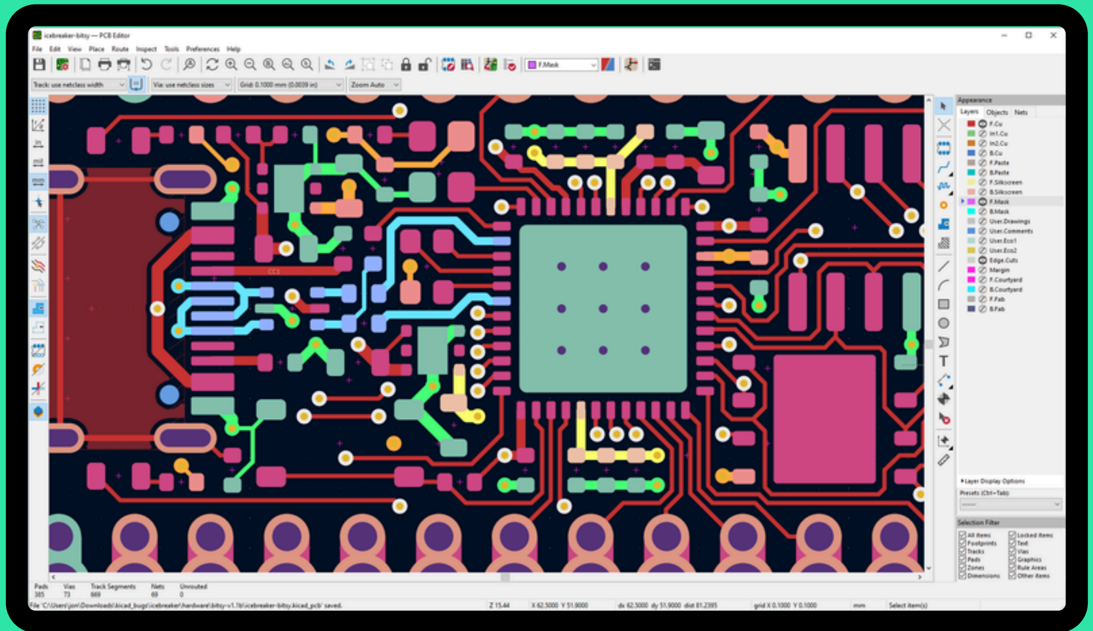


FUSION 360

Modeled in Fusion 360 with a focus on structural integrity, weight optimization, and ease of assembly. The chassis is 3D printed using PLA for prototyping due to its affordability and ease of use, while ABS may be considered for production units where greater strength and heat resistance are needed. The design ensures precise alignment for critical components such as the motors and sensors to maintain performance consistency.

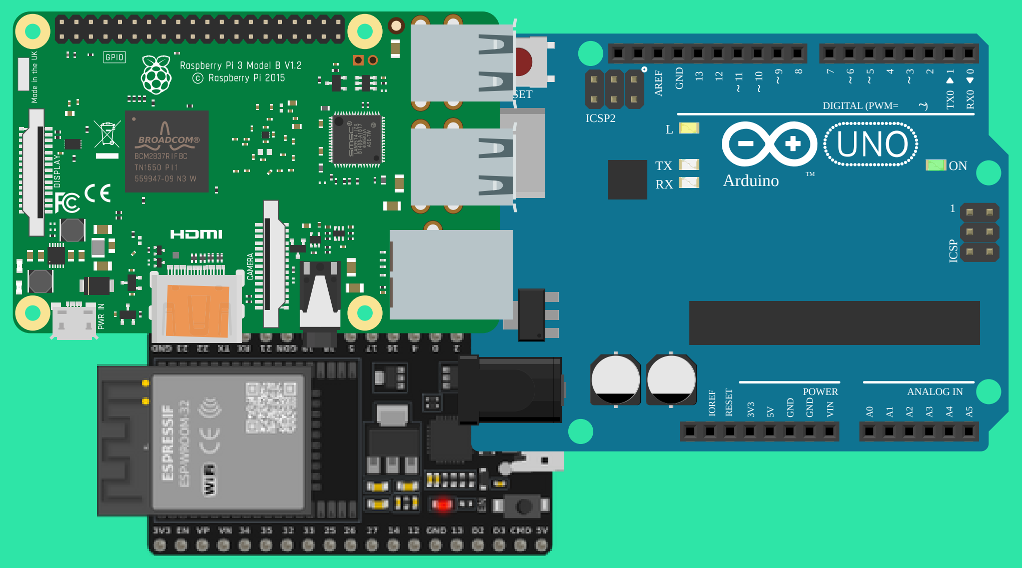


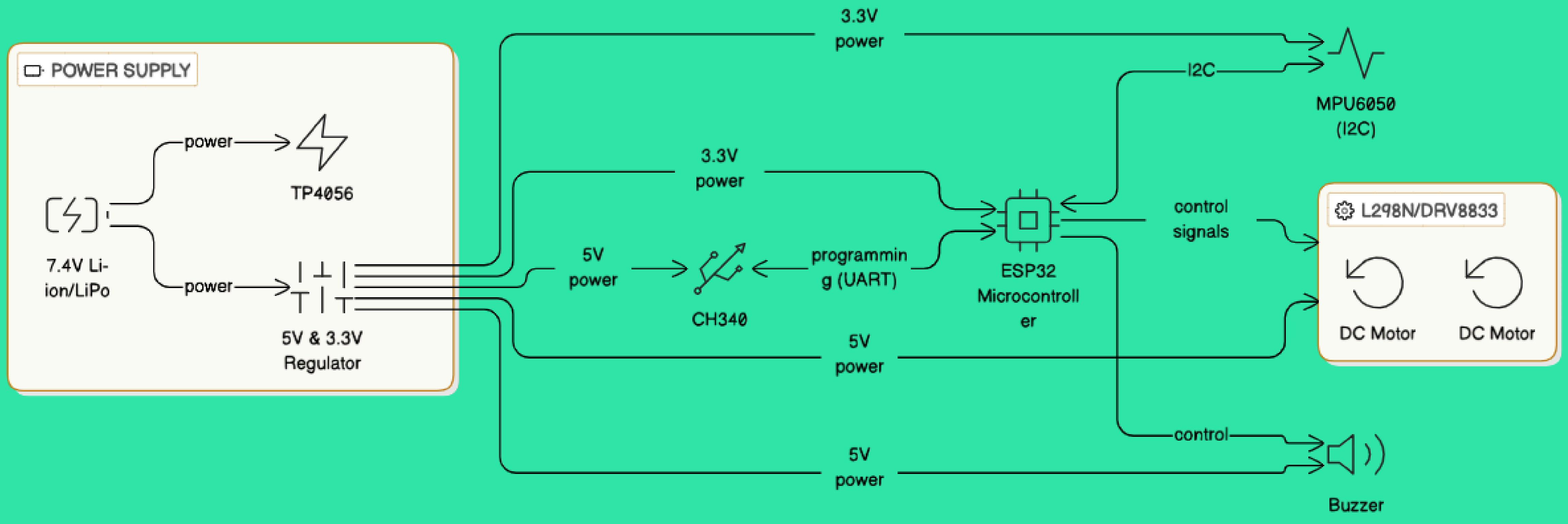
MANUFACTURING PROCESS



PRINTED CIRCUIT BOARD

Designed in KiCad, incorporating careful considerations for efficient component placement, optimal trace routing for signal integrity, and dedicated power planes to minimize noise. Fabrication is carried out by trusted local PCB services to ensure quality and reduce costs, and lead times. The design allows for future scalability and integrates all essential subsystems required for self-balancing control.





MANUFACTURING PROCESS

3D PRINTED PARTS

These include key structural elements such as the main chassis, brackets, sensor housings, and battery compartments. Using FDM 3D printing technology, components are fabricated in PLA for early-stage prototypes due to its cost-effectiveness and ease of manufacturing. For final iterations or where higher durability is required, materials such as PETG or ABS can be employed. The use of 3D printing enables rapid prototyping, customization, and local production, reducing both development time and costs.

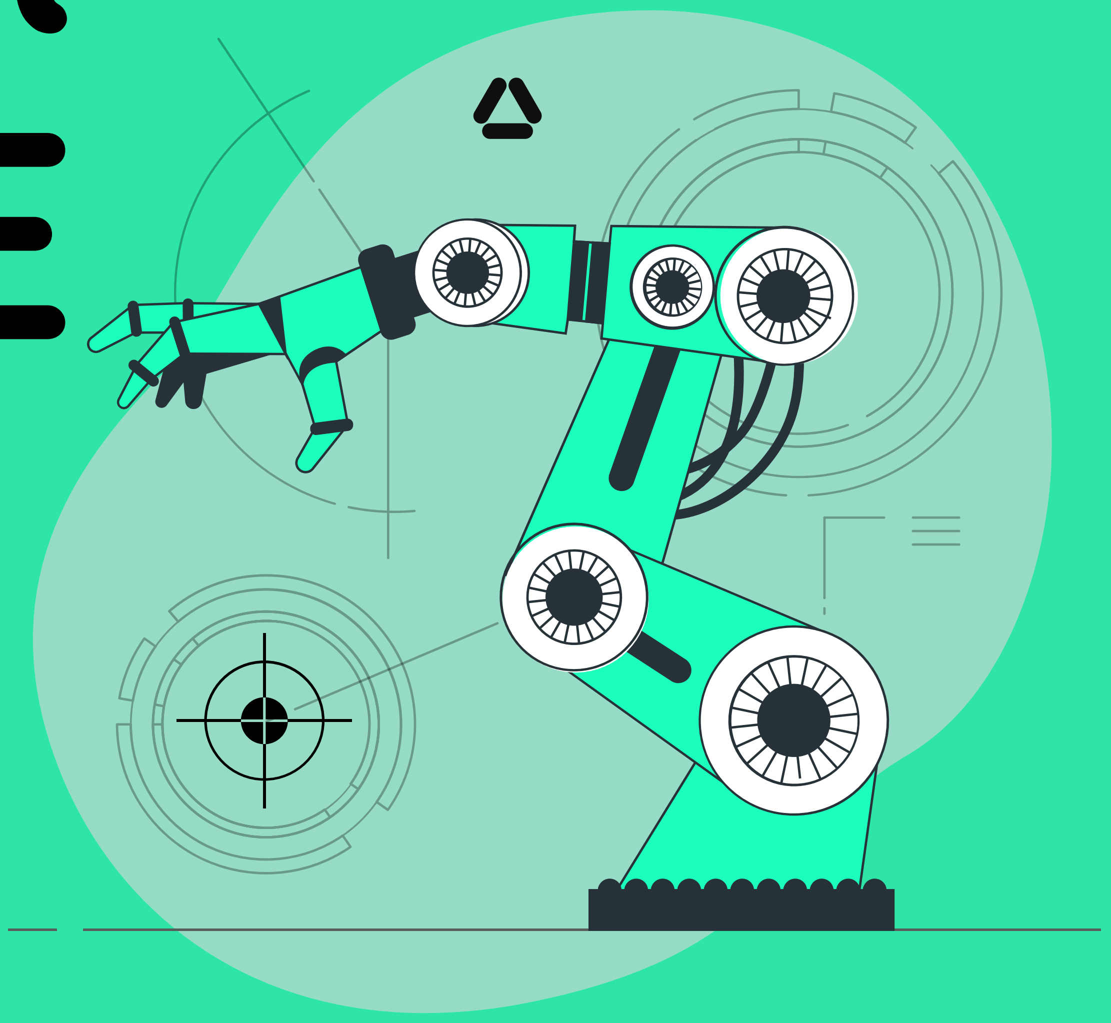
MANUFACTURING PROCESS

ASSEMBLY

Components integrated and tested in-house for quality assurance. This process involves meticulous inspection of each assembled unit to verify the integrity of solder joints, the accuracy of component placement, and the performance of all electrical connections. Functional testing ensures that the control algorithms, communication interfaces, and power regulation systems operate as intended. In-house assembly not only guarantees adherence to our quality standards but also allows us to iterate quickly on design improvements based on testing outcomes and user feedback.

PLASTAL-BOT BUILDERS

SCAN FOR MORE



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