



# PICK & DROP ROBOT

*"Grip. Lift. Deliver."*

TECHNICAL REPORT — PRAVEGA 2025

## PROJECT TEAM

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## 1. Team Details

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Team Name	amiarinjaysarkar
College / Institute	Jadavpur University
Competition	Pick & Drop — Pravega 2025, IISc Bangalore

### Team Members

Name	Role	Contact
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## 2. Abstract

This technical report presents the design and development of an autonomous Pick & Drop Robot engineered to identify, pick up, and accurately place multiple objects into designated target zones. The robot is designed for the Pravega 2025 competition at IISc Bangalore, where precision, speed, and reliability are critical success factors.

The robot features a robust 4-wheeled chassis with a servo-actuated gripper mechanism capable of handling various objects including bottles, cubes, and blocks. The system integrates ultrasonic sensors and infrared sensors for object detection and localization, combined with a precise motor control system for accurate positioning. The modular design allows for rapid adjustments and optimization during competition.

Key objectives include maximizing correct placements, minimizing cycle time, and achieving autonomous operation with minimal human intervention.

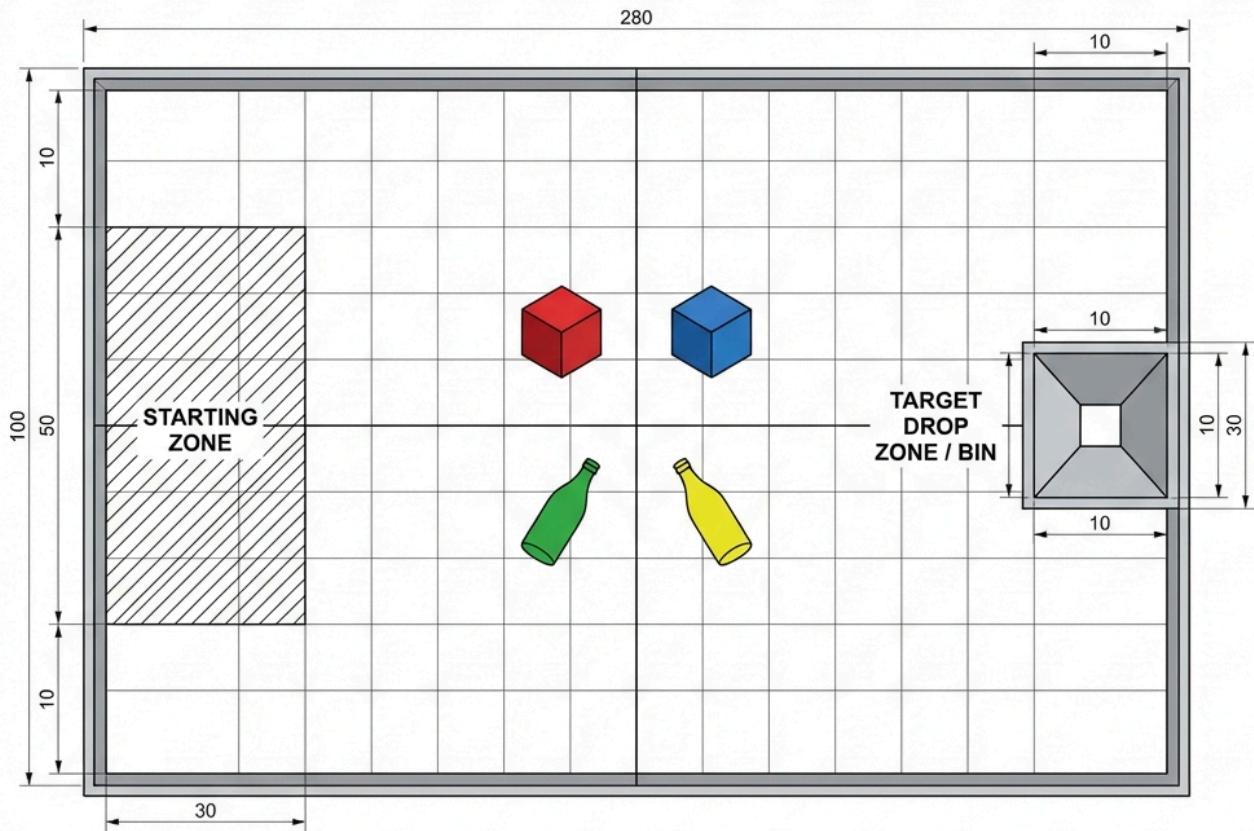


Figure 1: Competition Arena Layout — Objects placed randomly with designated drop zone

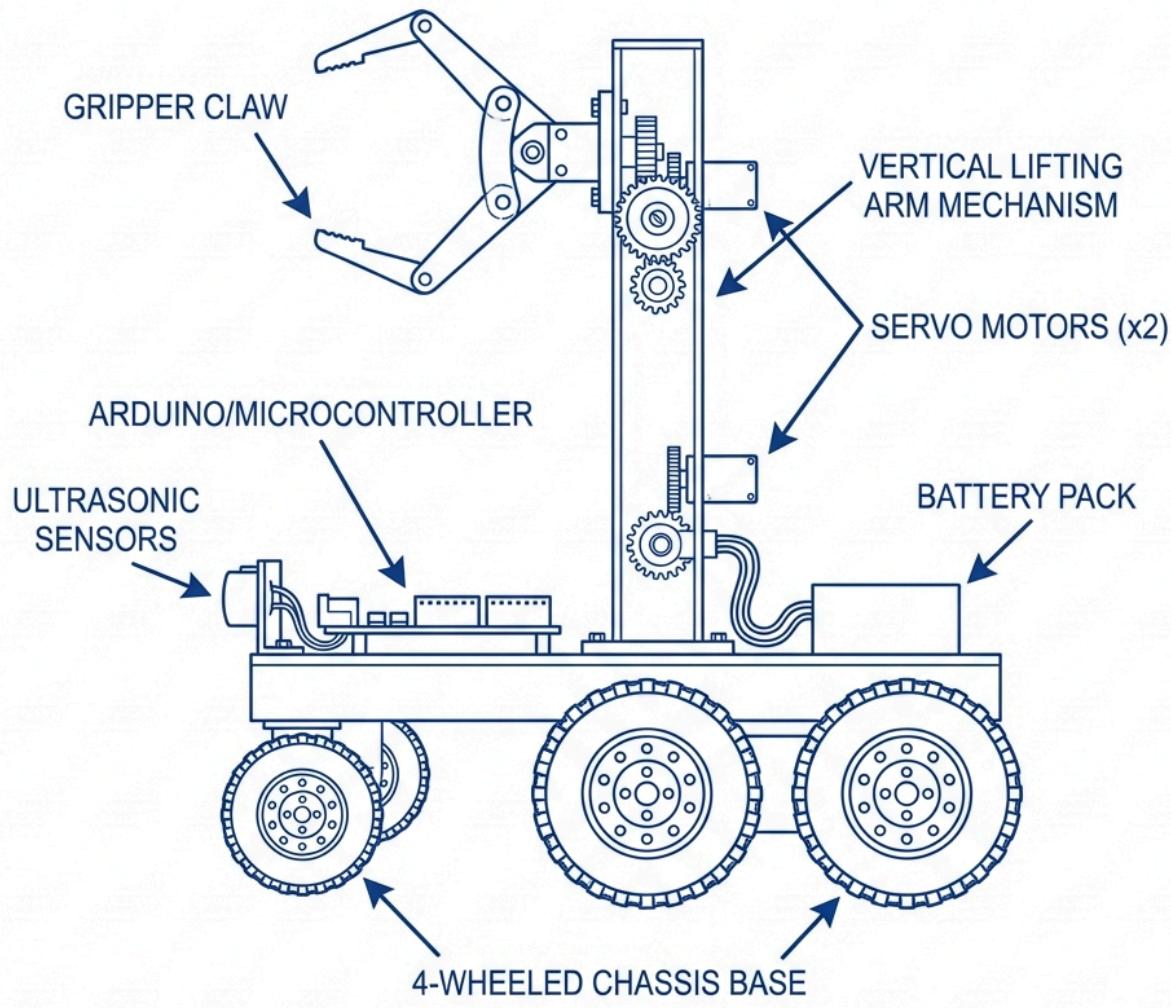
### 3. Design Concept

#### 3.1 Mechanical Design

The robot is built on a sturdy aluminum/acrylic chassis with a rectangular footprint for stability. The mechanical system consists of three main subsystems:

- **Mobility Platform:** 4-wheeled differential drive with DC geared motors for precise navigation and stability during pick-and-place operations.
- **Lifting Mechanism:** Vertical linear actuator or articulated arm with servo motors for height adjustment. Maximum reach designed to access objects at various heights.
- **Gripper System:** Servo-actuated parallel jaw gripper with rubber padding for secure grip on diverse objects (bottles, cubes, blocks). Gripper opening adjustable via servo position.

#### TECHNICAL ENGINEERING DIAGRAM: PICK AND DROP ROBOT (COMPETITION MODEL)



CROSS-SECTION VIEW - SIDE ELEVATION

Figure 2: Robot Structure — Labeled component diagram showing chassis, arm, and gripper assembly

### 3.2 Electronics & Components

- **Arduino Mega 2560:** Main microcontroller for sensor processing and motor control.
- **L298N Motor Driver (x2):** Controls DC motors for wheels and lifting mechanism.
- **Servo Motors (x3):** For gripper actuation and arm positioning.
- **Ultrasonic Sensors (HC-SR04 ×3):** For obstacle detection and object distance measurement.
- **IR Sensors (x4):** For edge detection and arena boundary recognition.
- **Color Sensor (TCS3200):** Optional — for object identification by color.
- **Power Source:** 12V LiPo Battery (2200mAh) for motors, 5V regulator for logic circuits.

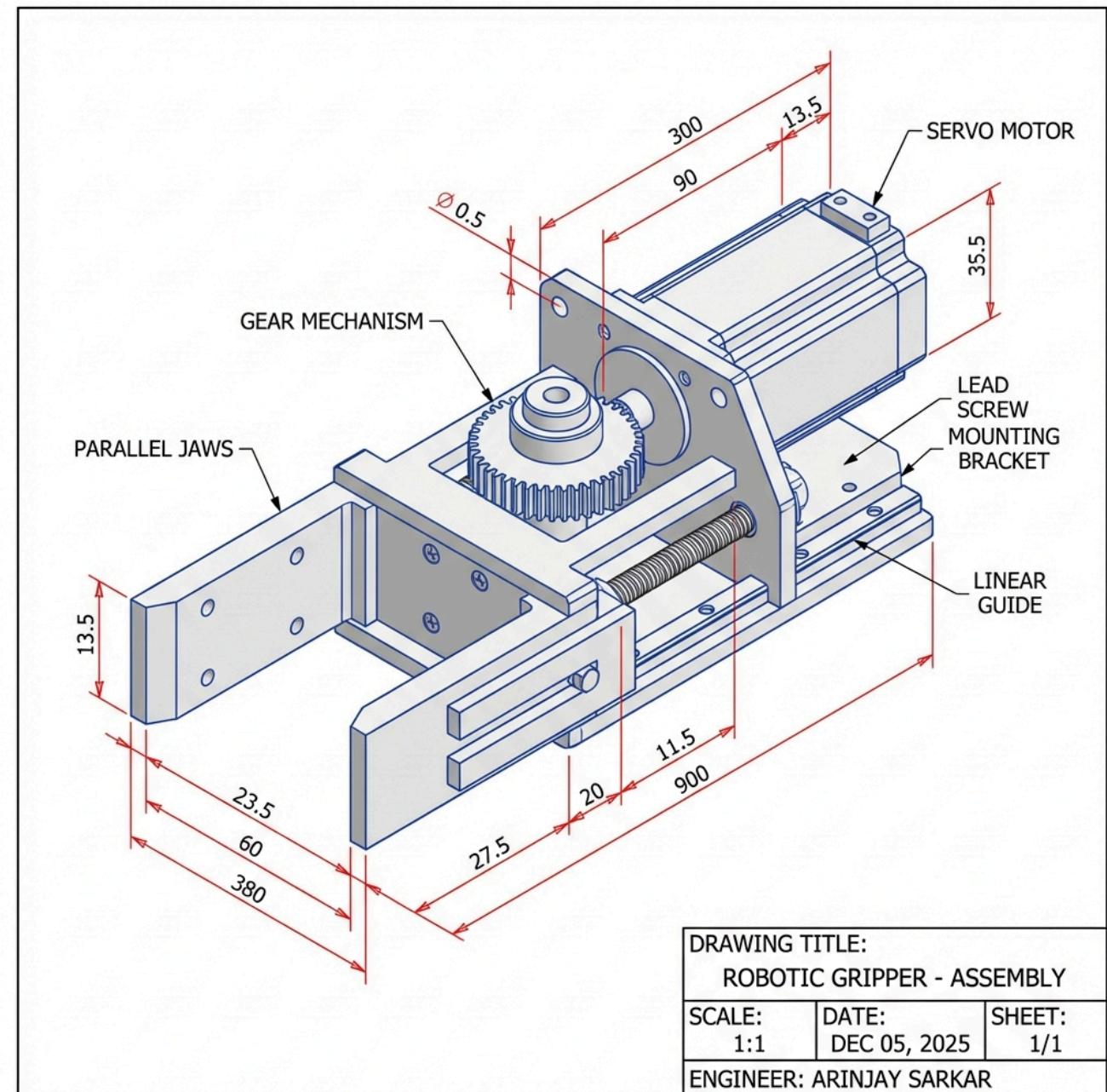


Figure 3: Gripper Mechanism CAD — Servo-actuated parallel jaw design

### 3.3 Control Strategy

The robot employs a state-machine based control architecture with the following operational states:

1. **SEARCH:** Navigate arena to locate objects using ultrasonic sensors.
2. **APPROACH:** Move towards detected object with precise positioning.
3. **PICK:** Lower gripper, close jaws, lift object securely.
4. **TRANSPORT:** Navigate to drop zone while maintaining object stability.
5. **PLACE:** Position over target, lower arm, release object gently.
6. **RETURN:** Resume search for next object.

## 4. Working Principle

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### 4.1 Movement & Navigation

The robot uses differential drive with 4 DC geared motors. Independent control of left and right wheel pairs enables:

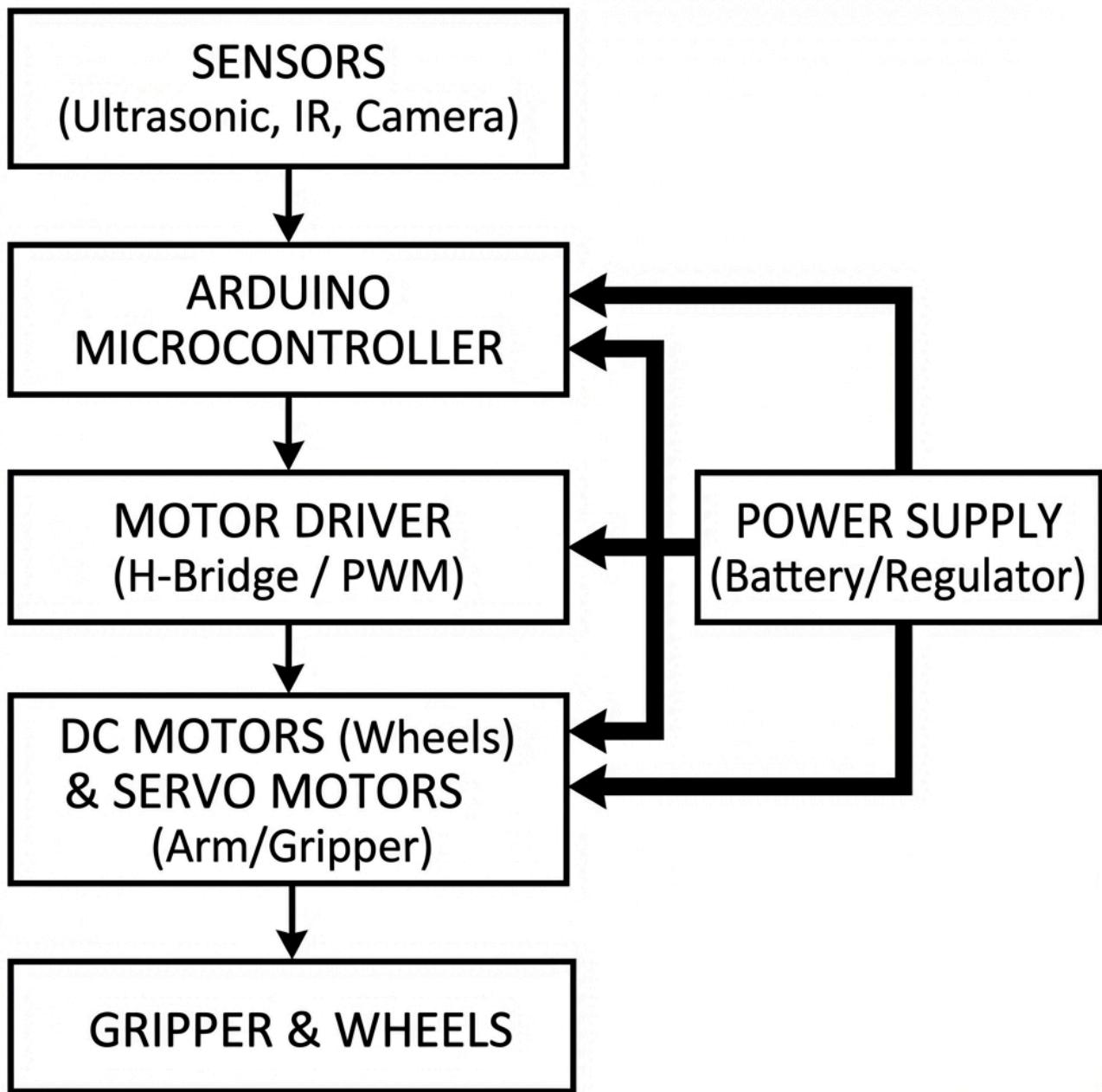
- **Forward/Backward Motion:** Equal PWM to all motors.
- **Turning:** Differential speed between left and right wheels.
- **Pivot Turn:** Opposite rotation of wheel pairs for in-place rotation.

Navigation is sensor-guided using ultrasonic readings to detect objects and IR sensors to recognize arena boundaries, preventing the robot from exiting the competition area.

### 4.2 Sensing & Object Detection

The sensing system operates on multiple levels:

- **Distance Sensing:** Three ultrasonic sensors (front, left, right) continuously scan for objects within range (2cm–400cm).
- **Edge Detection:** IR sensors mounted at chassis corners detect arena boundaries (white/black surface transitions).
- **Object Alignment:** Front-facing sensor array ensures robot approaches object head-on for optimal grip.



*Figure 4: Control System Block Diagram — Sensor inputs, processing, and actuator outputs*

#### 4.3 Control Logic & Task Execution

The Arduino executes a decision tree algorithm:

1. **Initialization:** Calibrate sensors, set gripper to open position, arm to neutral.
2. **Object Search:** Rotate and scan using ultrasonics; lock onto nearest object.
3. **Approach Sequence:** Move towards object; slow down when within 15cm.
4. **Pick Sequence:** Stop at 5cm, lower arm, close gripper (verify grip via current sensing or limit switch).
5. **Transport:** Raise arm to safe height, navigate to drop zone (either pre-programmed coordinates or sensor-guided).
6. **Drop Sequence:** Position over target, lower arm, open gripper, raise arm.
7. **Loop:** Return to search state until time limit or all objects placed.

#### 4.4 Motor Control Table

Action	Left Motors	Right Motors	Arm/Gripper
Forward	Forward PWM	Forward PWM	—
Turn Left	Low/Stop	Forward	—
Turn Right	Forward	Low/Stop	—
Pick Object	Stop	Stop	Lower, Close, Raise
Drop Object	Stop	Stop	Lower, Open, Raise

## 5. Innovation & Special Features

### Adaptive Grip Force

Servo-controlled gripper adjusts closure based on object size, preventing damage to delicate objects while ensuring secure hold.

### Multi-Object Detection

Ultrasonic array scans in sweeping pattern to identify multiple objects and prioritize nearest target for efficient cycles.

### Modular Arm Design

Quick-release mounting allows rapid gripper swaps for different object types during competition debugging.

### Fail-Safe Positioning

If grip verification fails, robot repositions and reattempts pick sequence to minimize dropped objects.

### Low Center of Gravity

Battery and heavy components mounted at chassis base for stability during arm extension and object transport.

### Speed Optimization

Path planning algorithm minimizes travel distance between objects and drop zone for faster cycle times.

## 5.1 Proposed Enhancements

Future iterations may incorporate:

- Camera-based object recognition for color/shape identification.
- PID-controlled arm positioning for smoother, faster movements.
- Bluetooth/WiFi telemetry for real-time debugging.
- Encoder feedback on wheel motors for precise dead-reckoning navigation.

## 6. References

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Pravega 2025 Pick & Drop Competition Rulebook — IISc Bangalore

Arduino Mega 2560 Technical Documentation

L298N Dual H-Bridge Motor Driver Datasheet

HC-SR04 Ultrasonic Sensor Specifications

SG90/MG996R Servo Motor Technical Data

Robotics: Modelling, Planning and Control — Siciliano et al.

Jadavpur University Robotics Club Technical Resources

### **Pick & Drop Robot — Technical Report**

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