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**Problem** **Definition** **and** **Design** **thinking**

**Project Title:** Autonomous Line-Following Delivery Robot for College Campus

**Problem Statement:**

In large college campuses, transporting items like documents, lab samples, library books, and food between departments, offices, or hostels is time-consuming and often inefficient. Manual delivery takes up staff time and leads to delays. There’s a need for an automated, cost-effective solution that ensures timely, secure, and contactless delivery within campus grounds.

**Target Audience:**

* College administrative staff
* Faculty members
* Campus delivery/logistics team
* Hostel and library staff
* Students (for food/books delivery)

**Objective:**

* To design an autonomous robot capable of following a predefined path (line) to deliver packages across a college campus.
* To reduce the manual effort and time needed for on-campus deliveries.
* To ensure reliable, low-cost, and contactless transportation of small items within campus zones.

**Design Thinking Approach:**

**Empathize:**

Understanding the delivery challenges faced by campus staff and students.

**Key User Concerns:**

* Delayed or missed deliveries
* lightweight body with storage compartment.

**Define:**

The robot should autonomously follow a marked path, detect obstacles, and securely carry items to a destination point.

**Key Features Required:**

* IR sensors for line detection.
* Ultrasonic sensors for obstacle detection.
* A secure delivery compartment.
* Rechargeable battery power.
* Campus map or line-coded routing.

**Ideate:**

The focus was on creating a robot that is affordable, easy to maintain, and capable of navigating predefined paths without human intervention. Ideas included using line-following IR sensors for navigation, integrating obstacle detection for safety, adding a secure compartment for items, and optionally using a mobile app for delivery scheduling and tracking.

**Brainstorming Results**:

* A robot that navigates using black tape/lines on the ground.
* Smart delivery lockers that open only at the correct destination.
* Rechargeable battery with solar top-up option for outdoor paths.
* Mobile app to track delivery or book a delivery time slot.

**Prototype:**

A working robot that follows a black line to deliver a package from one building to another.

**Key Components of Prototype:**

* Arduino/NodeMCU microcontroller
* IR sensors for line tracking
* Ultrasonic sensors for collision avoidance
* Motor driver module (L298N)
* DC geared motors and wheels

**Test:**

The prototype will be tested in real-time scenarios within the college campus to evaluate its performance, reliability, and user-friendliness. Test cases will include different routes, load conditions, and obstacles to ensure the robot can navigate effectively and deliver items safely.

**Testing Goals:**

* Ensure the robot accurately follows the line across varied surfaces.
* Test obstacle detection and avoidance efficiency.
* Assess item security during movement.
* Verify successful delivery at correct destination.
* Evaluate user-friendliness for student and staffs.
* Loss or misplacement of items during delivery.
* Safety of the robot and its surroundings.
* Ease of use and accessibility of the system.
* Weather resistance for outdoor movement.