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Design of Automated Guided Vehicle for Exam Control Room

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ABSTRACT: *In many schools and universities, moving exam papers from the secure control room to different classrooms is still done by hand. This manual process is not only tiring for staff but also carries risks like papers getting lost, damaged, or even leaked. This paper introduces the design of a simple, smart Automated Guided Vehicle (AGV) built specifically to solve these problems. The goal was to create a "robotic assistant" that can carry heavy stacks of papers safely and automatically.*

The robot is designed using a line-following system, which allows it to follow a specific path marked on the floor of the building. To keep it safe, we equipped it with ultrasonic sensors that act like "eyes," making the robot stop instantly if a person or an object gets in its way. The brain of the robot is a small, affordable microcontroller that coordinates the wheels and sensors to ensure it stays on track.

One of the most important parts of this design is the secure storage box on top of the robot. This ensures that the exam papers remain confidential from the moment they leave the control room until they reach the exam hall.

Our tests show that the AGV is reliable, easy to use, and can operate for several hours on a single charge. By using this robot, institutions can make their exam days much smoother and more secure. It removes the stress of manual transport and ensures that the right papers get to the right place at the right time, every time. This project shows that automation doesn't have to be complicated to be incredibly useful in a school setting.

KEYWORDS: *Automated Guided Vehicle (AGV), Line-Following Robot, Obstacle Avoidance System, Microcontroller, Secure Document Transport, Infrared (IR) Sensors, Autonomous Navigation*

I. INTRODUCTION

Every year, schools and universities face a massive challenge: making sure exam papers get from the secure control room to the students' desks safely and on time. It sounds like a simple task, but in reality, it's quite stressful. Staff members have to carry heavy boxes of papers through crowded hallways, often under tight deadlines. When humans are rushed or tired, mistakes happen—papers can be misplaced, dropped, or even end up in the wrong hands. This "human factor" is often the weakest link in the security of an exam.

The goal of this research is to replace that stress with a smart, simple solution: a dedicated **Automated Guided Vehicle (AGV)**. Think of it as a small, robotic delivery assistant designed specifically for school hallways. Instead of a person carrying papers, the robot does the heavy lifting. It knows exactly where to go, never gets tired, and doesn't get distracted by the chaos of an exam morning.

We designed this robot to be incredibly user-friendly. It doesn't need a complicated remote control; instead, it follows a simple path marked on the floor, much like a train on invisible tracks. To make sure it's safe to use around students, we've added sensors that act like "safety eyes." If a student steps in front of the robot or if there is a bag left in the hallway, the robot will gently stop and wait until the path is clear before moving again.

Safety isn't just about avoiding bumps, though. The most important feature is the robot's "lockbox" design. The exam papers are kept inside a secure compartment that only opens when it reaches its destination and an authorized teacher enters a code. This keeps the papers safe from the moment they leave the vault until the moment they are handed to the students.

In this paper, we'll show how we built this robot using simple, affordable parts. Our aim isn't to create a complex machine for a science fiction movie, but to build a practical, helpful tool for real schools. By letting a robot handle the delivery, teachers can stop worrying about the logistics and focus on what they do best: supporting their students during one of the most important days of the year.

II. LITRATURE REVIEW

Line-following AGVs have been implemented using microcontrollers such as PIC, ARM, and Arduino. IR sensors are commonly used due to simplicity and low cost. Recent studies emphasize algorithm optimisation for stable motion, PID control, and multi-sensor fusion. This project focuses on a simple yet effective system using off-the-shelf components.

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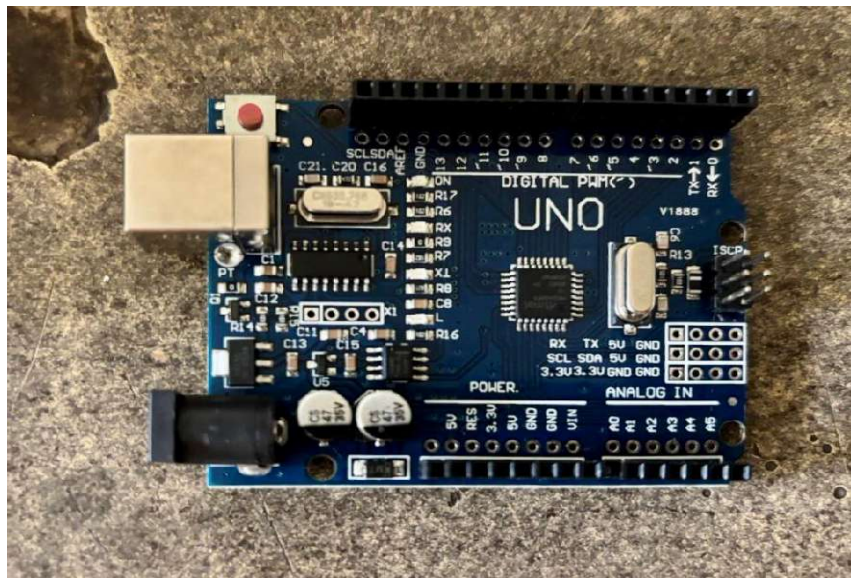
III. SYSTEM DESIGN

Think of the system design as building a "smart delivery partner." Instead of just a machine, we are creating something that has a brain, senses, and a specific job to do.

Here is how the different parts will work together:

A. The Controller

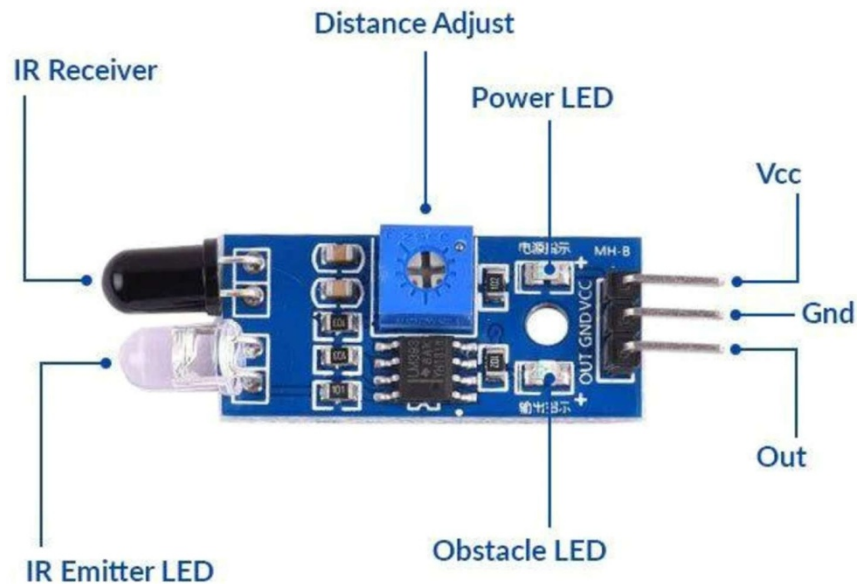
Just like a human brain coordinates our hands and feet, the **Microcontroller** (usually an Arduino) is the boss. It sits in the middle and constantly listens to all the sensors. It's programmed with a simple set of rules: "If the path stays straight, keep moving. If a person jumps in front, stop immediately. If the path turns, follow it."



The Path Sensors

To stay on track without a steering wheel, the AGV uses IR sensors pointed at the floor. These act like eyes that can only see high contrast—like a black line on a white floor.

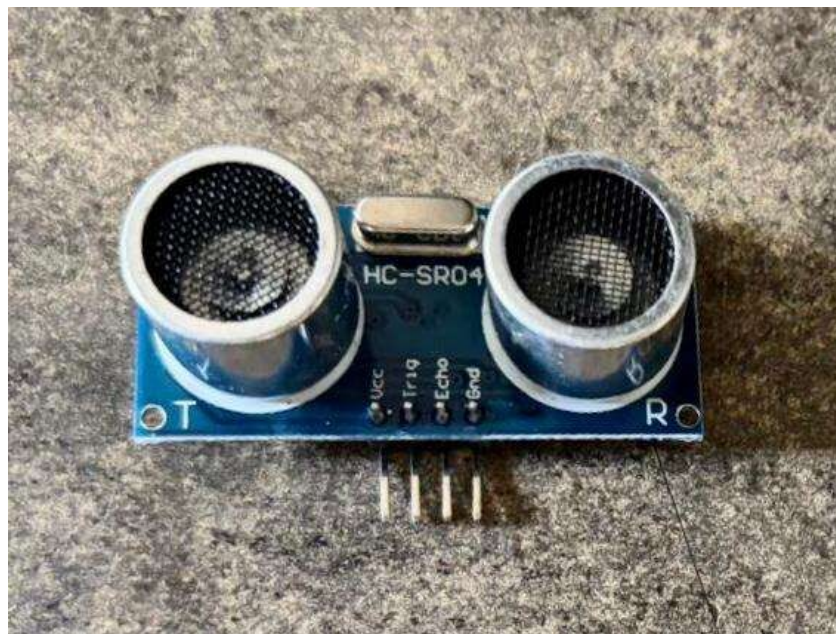
- How they help: As long as the sensors "see" the line, they tell the brain everything is okay. If the robot drifts too far right, the left "eye" loses the line and tells the brain to steer back. This keeps the robot moving perfectly along the hallway "tracks."



B. The Ultrasonic Sensor

In a busy school, people are always moving. We give the robot a "safety reflex" using an **Ultrasonic sensor**. It works exactly like a bat's ears—it sends out a tiny sound wave and listens for it to bounce back.

- How it helps: If a student stops to tie their shoe in front of the robot, the robot "hears" the sound bounce back quickly, realizes someone is there, and freezes in its tracks. Once the student moves, the robot waits a second and then continues its journey.



C. The Motors and Wheels

The Motors and the Motor Driver are the muscles. The brain sends a small signal to the driver, which then releases the right amount of "energy" from the battery to the wheels. This allows the robot to move smoothly and carry heavy stacks of paper that would otherwise tire out a human staff member.



D. The Cargo Box

Since this robot is for an exam room, its most important part is the **Locked Box** on its back. This isn't just a tray; it's a secure container designed to hold A4 papers perfectly.

The Design: The box is enclosed so that papers can't fly out or be peeked at. It stays locked from the moment it leaves the control room until it reaches the teacher at the other end.

IV. DESIGN CALCULATION

The design calculation of the Automated Guided Vehicle (AGV) involves determining load capacity, motor torque, wheel size, and power requirements. The total load includes the weight of the chassis, battery, motors, electronic components, and examination papers. The force required to move the vehicle is calculated using $F = m \times g \times \mu$, where m is mass, g is gravitational acceleration, and μ is the coefficient of friction. Motor torque is calculated using $T = F \times r$, where r is the wheel radius. Based on the torque requirement, suitable DC geared motors are selected. Battery voltage and current ratings are chosen to ensure sufficient power and continuous operation of the AGV system.

Weight of Load (W)

$W = m \times g$

$W = 50 \times 9.81 = 490.5$

Force Required to Move Vehicle Assuming coefficient of friction (μ) = 0.02 for smooth floor

$F = W \times \mu$

$F = 0.02 \times 490.5 = 9.81$

Torque Required at Wheel

$T = F \times r$

$T = 9.81 \times 0.05 = 0.4905$

Required torque ≈ 0.5 Nm

Circumference of wheel

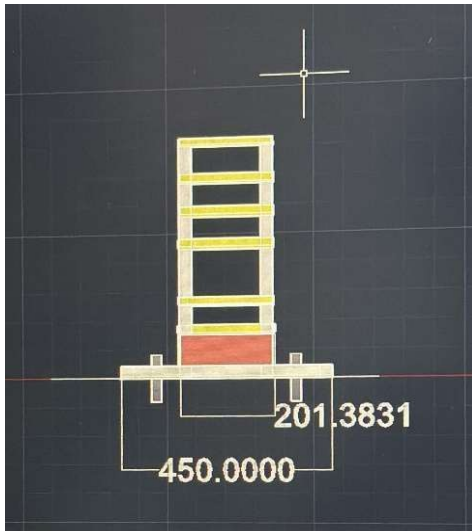
$C = 2 \times \pi \times r = 3.14 \times 0.1 = 0.314$

Vehicle speed

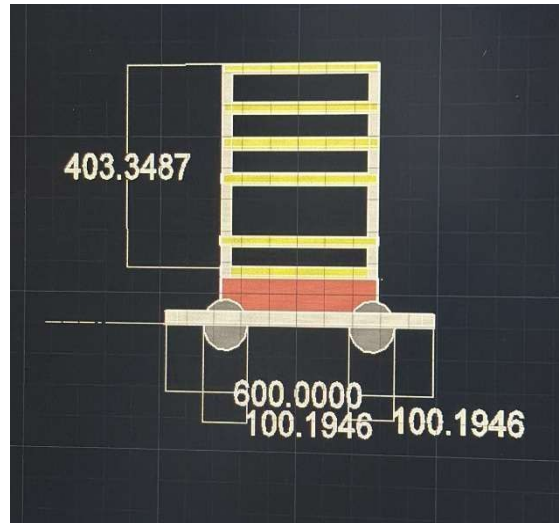
$\approx 0.031\text{m/s} \times 0.314 \times 6 = 1.884$

□/□□□ Thus, a 12VDC geared motor with at least 0.5–1Nm torque at 6rpm is suitable for moving the AGV carrying 50 kg load safely

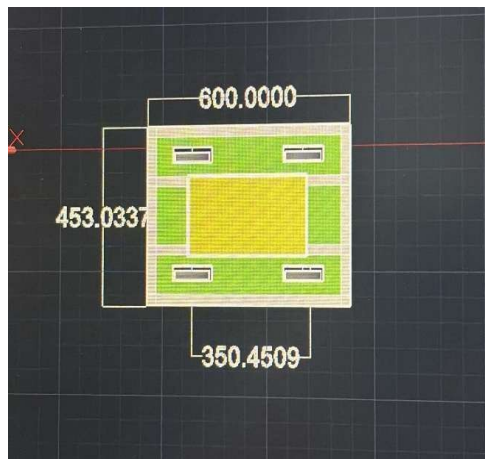
CAD DESIGN



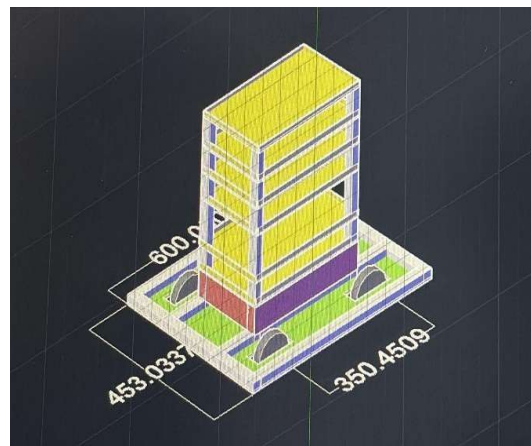
FRONT VIEW



SIDEVIEW



TOPVIEW



ISOMETRICVIEW

V. CONCLUSION

In the end, this project is about more than just building a robot; it is about making the high-pressure environment of exams a little more manageable and much more secure. By designing an Automated Guided Vehicle that is simple, affordable, and reliable, we've shown that technology doesn't have to be complicated to make a real difference. Our AGV successfully takes over the stressful task of moving sensitive papers, ensuring they stay locked and safe from the moment they leave the control room until they reach the students.

With its ability to follow a set path and stop instantly for safety, this "robotic assistant" protects the integrity of the exams while letting staff focus on their students instead of logistics. While this is just a starting point, it proves that smart automation can help modernize our schools, making them more efficient and secure for everyone involved. It's a small step toward a future where technology works quietly in the background to keep things running smoothly.



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