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Design of Automated Guided Vehicle for Exam Control Room

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ABSTRACT: In many schoolsanduniversities, movingexampapersfrom thesecure 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 GuidedVehicle(AGV) builtspecificallytosolvetheseproblems.Thegoalwasto 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 specificpathmarkedonthe floorofthebuilding.Tokeepitsafe,weequippedit 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.

Oneofthemostimportantpartsofthisdesignisthesecurestorageboxontop 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.

OurtestsshowthattheAGVisreliable,easytouse,andcanoperateforseveral 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: AutomatedGuidedVehicle (AGV), Line-Following Robot, Obstacle Avoidance System, Microcontroller, Secure Document Transport, Infrared (IR) Sensors, Autonomous Navigation

I. INTRODUCTION

Everyyear, schoolsanduniversities faceamassive challenge:makingsureexam 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 throughcrowdedhallways,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,muchlike atrainoninvisibletracks.Tomakesureit'ssafetousearound 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 anauthorized teacher enters a code. This keepsthe papers safe fromthe moment they leave the vault until the moment they are handed to the students.

Inthis paper, we'll show how we builtthis 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 canstopworrying aboutthe logistics and focus on what they do best: supporting their students during one of the most important days ofthe 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 algorithmoptimisation 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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No.,Author(s),Year,Title,Publication Source

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No.,Author(s),Year,Title,PublicationSource

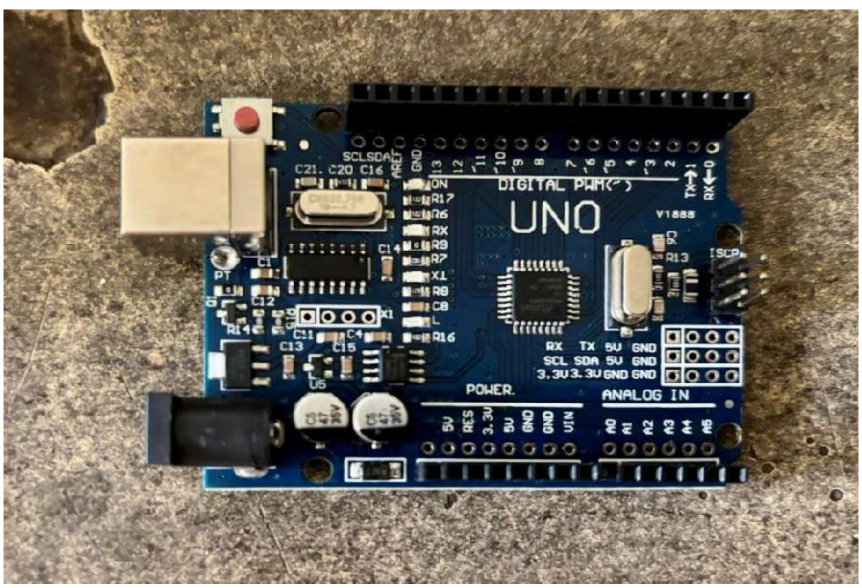
III. SYSTEM DESIGN

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

Hereishowthedifferentpartswillworktogether:

A. The Controller

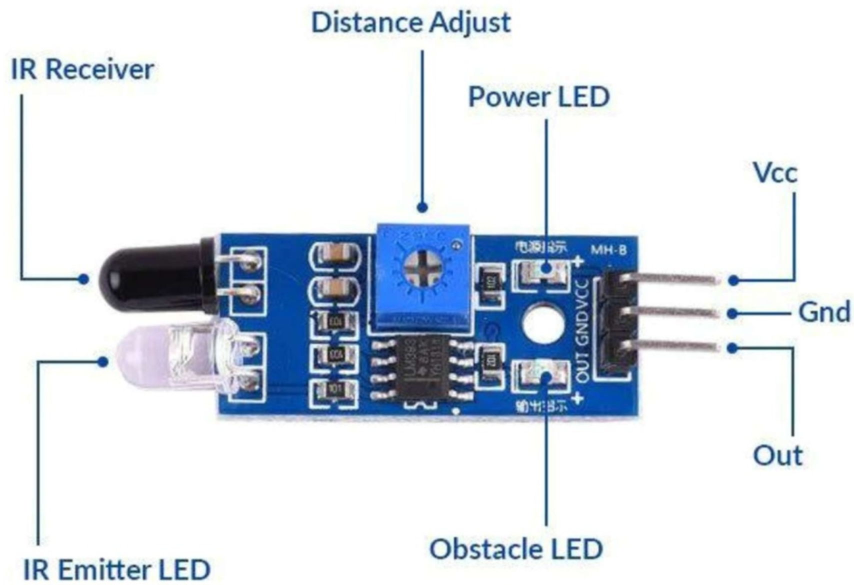
Just like a human brain coordinates our hands and feet, the **Microcontroller** (usually an Arduino) is theboss. It sits in the middle and constantly listens to all the sensors. It’s programmed with a simple set of rules: "If the path stays straight, keep moving. If a person jumps in front, stop immediately.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



The PathSensors

To stay ontrackwithoutasteering wheel, the AGVuses IR sensors pointedat the floor. These act like eyes that can only see highcontrast—like a black line on a white floor.

- How they help: As long as the sensors "see" the line, they tell the brain everythingisokay.Iftherobotdriftstoo farright,theleft "eye" loses the line and tells the brain to steer back. This keeps the robot moving perfectly along the hallway "tracks."



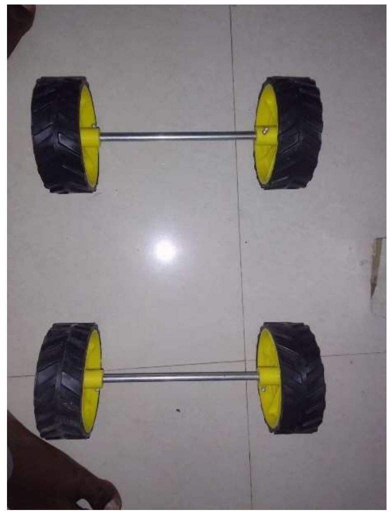
B. The Ultrasonic Sensor

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

- Howit helps: Ifa 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, whichthen releases the right amountof "energy" from the battery tothe wheels. This allows the robot to move smoothly and carry heavy stacks of paper that would otherwise tire out a human staff member.



D. TheCargoBox

Since this robot is foran 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 enclosedso 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 × g × μ, where m is mass, g is gravitational acceleration, and μ is the coefficient of friction. Motor torque is calculated using T = F × r, where r is the wheel radius. Based on the torque requirement, suitableDCgearedmotorsareselected. Batteryvoltageandcurrentratings are chosen to ensure sufficient power and continuous operation of the AGV system.

 WeightofLoad(W)

□=□×□

□=50×9.81=490.5□

ForceRequiredtoMoveVehicleAssumingcoefficientoffriction(μ)=0.02 for smooth floor

□=□×□

□=0.02×490.5=9.81□

TorqueRequiredatWheel

□=□×□

□=9.81×0.05=0.4905□□

Requiredtorque≈0.5Nm

Circumferenceofwheel

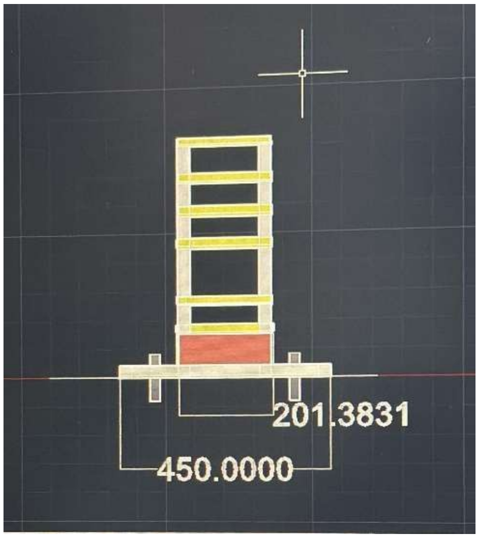
=□□=3.14×0.1=0.314□

 Vehiclespeed

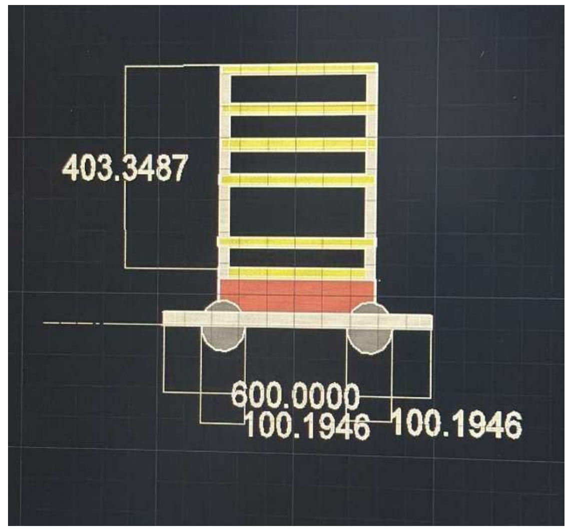
≈0.031m/s0.314×6=1.884

□/□□□Thus,a12VDCgearedmotorwithatleast0.5–1Nmtorqueat6rpmissuitable for moving the AGV carrying 50 kg load safely

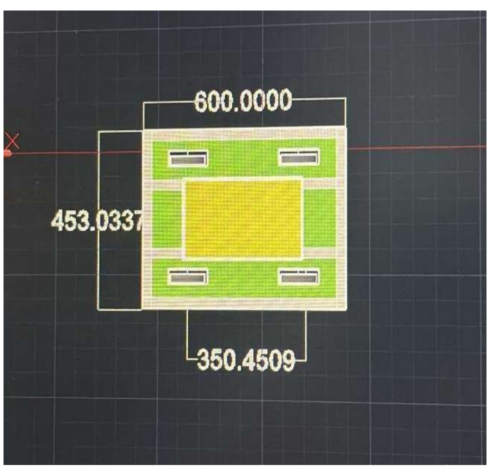
CADDESIGN



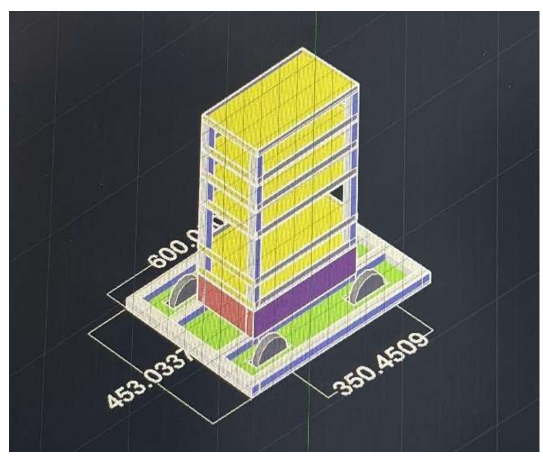
FRONT VIEW



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 examdays a little moremanageable 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 successfullytakes 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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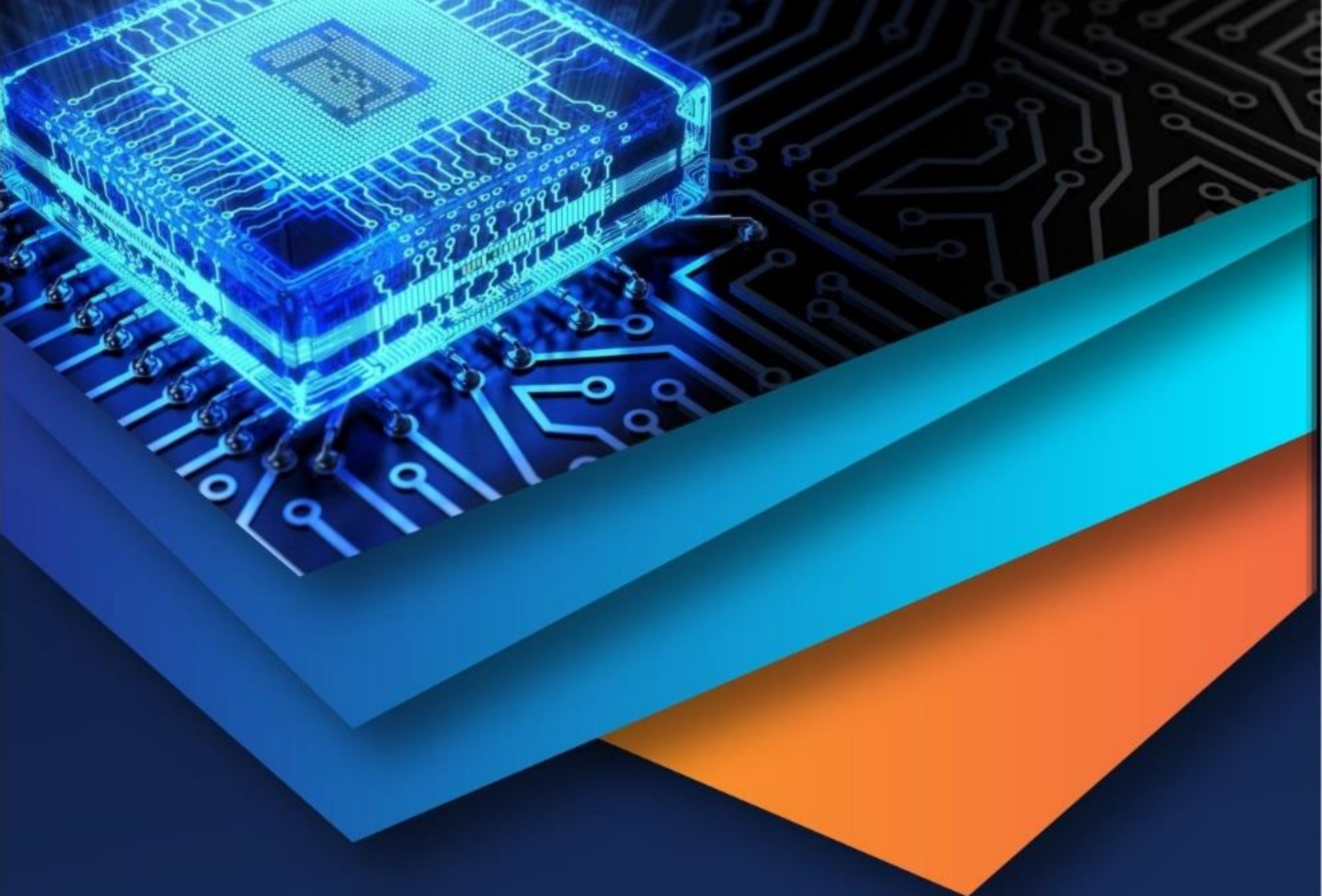

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