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Infrared Sensor based material handling vehicle

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Abstract - *In today's world, there is an increasing need for automation to enhance the creation and application of technologies in producing and delivering goods and services with minimal human intervention. The use of automated technologies, techniques, and processes improves the efficiency, reliability, and speed of many activities previously performed by humans. To meet this need, an automatic line-following sensor-based material handling vehicle is required to decrease human effort and increase productivity within a short period. This research focuses on the working of an Infrared sensor attached to a small four-wheel trolley. The interest in robots is dramatically increasing in various fields, including medicine, industry, hospitality, security, and business. Many international companies are adopting robots in the storage, packaging, and distribution of their products, which raises production efficiency and multi functionality. In line with the circular economy, this project aims to control the flow of a vehicle that follows a specific path using an open-source microcontroller (Arduino Uno).The vehicle is equipped with optical resistance sensors located in the front and lower side, where the transmitter sends rays to the surface and determines the color of the surface on which the vehicle is traveling by measuring the intensity of the reflected light. With the help of DC motors, the direction and movement of the vehicle are controlled effectively.*

1.INTRODUCTION

The practice of manual material handling, which involves moving or handling items through lifting, pushing, pulling, carrying, holding, or restraining, is widespread. However, it is also a major contributor to occupational fatigue, low back pain, and injuries in the lower back. These activities can be observed daily at construction sites, warehouses, railway stations, airports, shopping malls, supermarkets, restaurants, and other locations. In this fast-paced technological world, automation is an emerging technology in research and development. By automating a manual process, it is possible to reduce manpower and save time. This project aims to model a versatile vehicle that automatically follows a human to transport items, making carrying loads more manageable and efficient. As technology continues to grow in importance, Not only is it important to learn how to use technology, but it is also crucial to understand how to create it. As an engineer, having a strong comprehension of other disciplines is essential. Typically, projects have narrow scopes and only involve specific fields, which limits innovation and creativity. The goal of this project is to establish connections between multiple disciplines, such as mechanical, electronic, electrical, and programming skills, to encourage innovation and creativity.

Line-following vehicle are inspired by the natural behavior of ants and the usefulness of lanes on roads. Such robots can mimic the natural process of following a line to accomplish a task. The application of line following robots is diverse, ranging from industrial automated equipment carriers to small household applications, and even in entertainment. These robots can also act as tour guides in museums or other similar settings. As such, the development of line following robots has the potential to benefit various industries and areas, making it a promising area of research and development.

1.1 Problem Statement

Transporting products between manufacturing plants is a critical aspect of the industrial sector. Traditionally, human-driven vehicles or trucks have been utilized for this purpose, resulting in inefficiencies and unreliability. This transportation segment is often seen as the weakest link in the assembly line. As a solution, researchers have explored the possibility of automating this sector. The objective is to use vehicles that can follow a line instead of using costly and inconvenient railway tracks. This would lead to a significant improvement in the efficiency and reliability of the transportation process between manufacturing plants in separate buildings or blocks.

1.2 Objectives

- The objective of this project is to develop a mechatronics system that can be utilized in a workshop. The system involves replacing the manual tool container with an automated guided vehicle that incorporates both mechanical and electrical components.

- The vehicle had to not only follow a straight path but also follow a curved path, navigate through an intersection, and correct its position in the event that it went off course.
- This was accomplished by using a microcontroller, sensor, DC motors, motor controllers etc.

2. DESIGN PROCESS

Design of vehicle we required

Speed of vehicle 10 cm/sec

Load carry 10 kg

Vehicle self-weight 5 kg

2.1 To calculate the required RPM and torque for the DC gear motor:

Torque = (Load + Vehicle weight) x Wheel radius Angular velocity (ω) = Linear velocity / Wheel radius RPM = ω x 60 / (2π)

Given: Required linear velocity = 10 cm/s

Load = 10 kg

Vehicle weight = 5 kg

Number of wheels = 4

Wheel radius = Assuming 5 cm

- Calculations:

Total weight = Load + Vehicle weight = 10 kg + 5 kg = 15 kg

Torque = (Load + Vehicle weight) x Wheel radius x Number of wheels

15 kg x 0.05 m x 4

Torque = **3 N-m**

2.2 Checking assuming radius of wheel safe or not

v = r * w

r = 10 cm/sec / 300 radians/sec

r = 0.033 m = 3.2 cm

2.3 Design of frame for vehicle

Frame= 380*250*110 mm

Square pipe= 20*20*2 mm

Assuming the rectangular frame is a beam fixed at both ends, the maximum bending stress can be calculated as,

σ = (M * c) / I

M = (W/2 + SW) * L^2 / 8

W = 10 kg

SW = 5 kg

L = 380 mm = 0.38 m

c = 55 mm = 0.055 m

I = (bh^3)/12 = (0.020.11^3)/12 = 0.000002163 m^4

M = (W/2 + SW) * L^2 / 8

= (10/2 + 5) * 0.38^2 / 8 = 0.4309 Nm

σ = (M * c) / I

= (0.4309 * 0.055) / 0.000002163

= 10,956 which is in units of Pa (Pascal)

Frame is safe for 10 kg load and 5 kg vehicle self-weight.

3. MODEL DRAWING

Figure 3.1:3D Drawing

4. COMPONENT SELECTION

4.1 Electronic Components

- Arduino UNO.
- IR Sensors.
- DC Gear Motor.
- Breed Board and Jump Wiring
- Battery

Arduino UNO

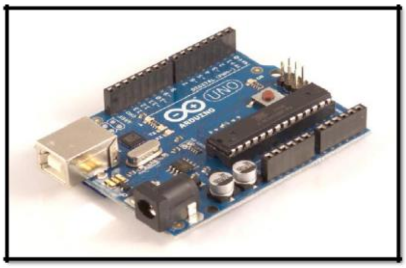

Figure 4.1: Arduino UNO

The Arduino board is composed of an AVR microcontroller, which can be 8, 16, or 32 bits. The board is accompanied by components that make programming and integration with other circuits easier. A significant feature of the Arduino is its standard connectors that allow users to connect the board to interchangeable add-on modules called shields. Some shields communicate with the Arduino board directly through different pins, while others can be addressed through an IC serial bus.

IR Sensor

Figure 4.2: IR Sensor

An infrared sensor is an electronic device that is designed to sense various aspects of its surroundings by emitting and detecting infrared radiation. Unlike active IR sensors, passive IR sensors only measure infrared radiation without emitting any radiation themselves. In the infrared spectrum, all objects emit some form of thermal radiation, which is invisible to the human eye but can be detected by an infrared sensor.

Table 4.1: Specifications of IR Sensor

Features	Data
Supply voltage	-0.3 to 6.0 V
Output voltage	-0.3 to 6.0 V
Operating temperature	-2.5 to 85 C

DC Gear Motor:

Figure 4.3: DC Motor

A gear motor is a motor and gearbox combination that reduces speed while increasing torque output. The three most significant parameters when considering gear motors are speed (measured in rpm), torque (measured in lb-in), and efficiency (measured as a percentage). It is crucial to calculate the load, speed, and torque requirements for your specific application to select the most appropriate gear motor.

Table 4.2: Specification of DC Motor

Features	Data
Supply voltage	12 V
Speed	200 RPM
Shaft diameter	6mm
Torque	2.74 N-m

5. TESTING

Figure 5.1 Testing

The vehicle is tested by placing a black line on a white surface. The vehicle should follow the line and transport materials from one point to another.

Table 5.1: Testing Time

Sr.no	Load carry	speed
1	4 kg	9 cm/sec
2	6 kg	8 cm/sec
3	8 kg	8 cm/sec

6. CONCLUSION

The line following material handling vehicle is system that has ability to recognize its path , move and change the robot's position toward the line in the best way to remain in track. This project report presents a Infrared sensor based line follower vehicle design of 10 kg weigh which always directs along the black line on white surface. The electromechanically vehicle dimension is 380×250×320 mm with max rpm of vehicle is10 cm/sec at load condition. The vehicle is able to detect it's path in case it is out of path. The line following vehicle project challenged the group to cooperate, communicate, and expand understanding of electronics, mechanical systems, and their integration with programming. The successful completion of every task demonstrated the potential of mechatronic systems and a positive group dynamic.

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