LINE FOLLOWING ROBOT

Robotics Club of WRC

Pashchimanchal Campus

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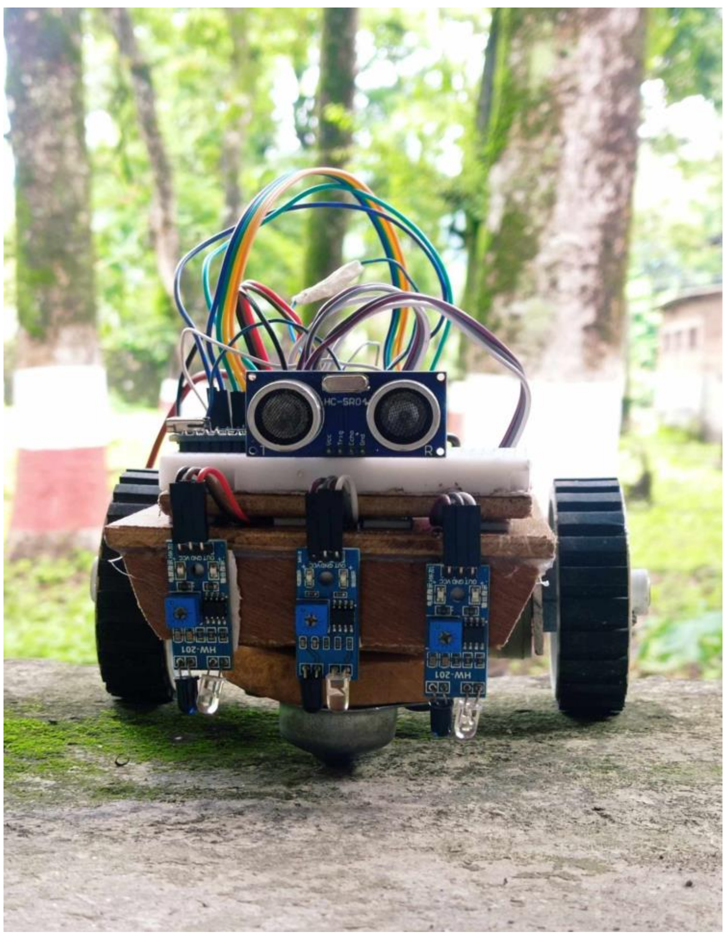
“T-800”



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INTRODUCTION (LINE FOLLOWING ROBOT)

Line following robot is an autonomous device designed to detect and track lines on a surface and navigate along them. This robot utilizes the combination of sensors, actuators and control system to follow or track a line marked on the ground.

The primary objective of the line following robot is to maintain its position relative to a line or track, allowing it to move along the desired path without human intervention. This technology has applications in various fields including industrial automation, logistics, robotics competition and educational purposes. A line following robot is a type of autonomous robot that is designed to detect and track a line on the ground and follow it. These robots are commonly used in various applications such as industrial automation, warehouse logistics, and even in educational settings to introduce robotics and programming concepts to students.

The most commonly used sensor for line following robots is an array of infrared sensors or reflectance sensors positioned on the bottom of the robot. These sensors emit infrared light and measure the amount of light reflected back. By analyzing the readings from these sensors, the robot can determine the position of the line relative to itself. Based on this information, it can make decisions on whether to turn left, right, or continue straight to stay on the line.

BACKGROUND

The design of the robot is intended to foster interdisciplinary connections by combining mechanical, electronics, electrical, and programming skills. Unlike projects that focus solely on a specific discipline, this approach encourages engineers to broaden their knowledge and expertise. By integrating various fields, the project offers several benefits:

1. It provides a visual grasp of math and science, allowing engineers to see the practical application of theoretical concepts.

2. It enhances logical thinking by requiring engineers to analyze and synthesize information from multiple disciplines to create a cohesive solution.

3. It stimulates innovation and creativity by challenging engineers to think beyond the confines of a single discipline, leading to novel and unique approaches.

4. It improves problem-solving skills as engineers must tackle complex challenges that require a comprehensive understanding of different technologies.

In terms of functionality, the robot is designed not only to track and follow a designated path but also to detect obstacles using ultrasonic sensors. This capability allows the robot to navigate its environment intelligently and avoid potential collisions.

MOTIVATION

Consider the intriguing behavior of migrating birds that navigate long distances following specific migration routes. They possess an innate ability to sense the Earth's magnetic field and use it as a guide during their journeys. Drawing inspiration from this natural phenomenon, imagine developing a robot that can mimic the navigational process of migrating birds, creating a machine capable of following predetermined routes with precision and accuracy.

Such a robot could find applications in a range of areas, including:

1. Environmental monitoring: The bird-inspired robot could be deployed to monitor ecological changes or collect data in remote and challenging environments, providing valuable insights for conservation efforts.

2. Precision agriculture: By following designated paths, the robot could assist in agricultural practices such as crop monitoring, planting, and harvesting, optimizing efficiency and reducing human labor.

3. Search and rescue operations: In scenarios where search and rescue missions are required, the robot's ability to navigate specific routes could aid in locating and assisting individuals in distress, increasing the effectiveness of rescue efforts.

4. Exploration of hazardous terrains: Inspired by the migratory behavior of birds, the robot could be employed in exploring dangerous or hard-to-reach terrains, such as disaster-stricken areas or hazardous industrial sites, providing valuable data without risking human lives.

By imitating the natural navigational abilities of migrating birds, this project opens up possibilities for innovative applications in various fields, improving efficiency, safety, and effectiveness in diverse tasks.

MATERIAL USED

The line follower robot utilizes various components and materials to operate effectively:

1. Arduino NANO: Serving as the central processing unit, the Arduino NANO is responsible for making decisions based on sensor feedback. It is an open-source electronic platform, and in this project, the Arduino NANO board is used.

2. Motor Driver: To meet the current requirements of the motors, a motor driver is employed. It acts as an interface between the motors and the Arduino, ensuring proper control and power distribution.

3. Geared DC Motor: Geared DC motors are the primary actuators of the line follower robot. They enable movement and provide the necessary propulsion for the robot to follow the line.

4. Sensor Array: The sensor array consists of IR leds and phototransistors as sensors.

5. Ultrasonic Sensor: The ultrasonic sensor is utilized to detect obstacles encountered by the robot while following the line. It aids in obstacle avoidance and enhances the robot's navigational capabilities.

6. Power Supply: A 12V battery is regulated to 5V using a motor driver module, providing the necessary power for the robot's components to function.

7. Wheels & Castor Wheels: The robot utilizes two wheels for locomotion, while castor wheels are employed to ensure stability and smooth movement.

8. Plywood Chassis: The chassis serves as the framework or body of the robot, providing support and housing for the various components.

9. Jumper Wires: Jumper wires are used to establish electrical connections between different components, enabling the flow of signals and power throughout the robot.

These materials and components work together to create a functional line follower robot capable of tracking and navigating along a designated path, while also detecting and avoiding obstacles.

CODE

```
//ir sensors
#define ir1 2
#define ir2 3
#define ir3 4
// Motors
#define leftmotor1 6
#define leftmotor2 7
#define rightmotor1 9
#define rightmotor2 8
//ultrasonic sensor
#define echo 12
#define trig 11
//pwm
#define pwm1 5
#define pwm2 10
int ms=190;
double x,distance;
void setup(){
```

```
pinMode(ir1,INPUT);
pinMode(ir2,INPUT);
pinMode(ir3,INPUT);
pinMode(leftmotor1,OUTPUT);
pinMode(leftmotor2,OUTPUT);
pinMode(rightmotor1,OUTPUT);
pinMode(rightmotor2,OUTPUT);
}
void loop(){
digitalWrite(trig,0);
digitalWrite(trig,1);
delayMicroseconds(10);
digitalWrite(trig,0);
x=pulseIn(echo,1);
distance=x*0.032/2;
Serial.println(distance);
if(distance>20){
int l =!digitalRead(ir1);
int m =!digitalRead(ir2);
int r =!digitalRead(ir3);
if((l==0)&&(m==0)&&(r==0)) Stop();
else if((l==0)&&(m==1)&&(r==0)) forward();
else if((l==0)&&(m==0)&&(r==1)) SturnRight();
else if((l==1)&&(m==0)&&(r==0)) SturnLeft
else if((l==0)&&(m==1)&&(r==1)) turnRight();
else if((l==1)&&(m==1)&&(r==0)) turnLeft();
else if((l==0)&&(m==0)&&(r==0)) Back();
}
```

```
 else {
 Stop();
 }
 } void forward(){
 analogWrite(pwm1,ms);
 analogWrite(pwm2,ms);
digitalWrite(leftmotor1, HIGH);
digitalWrite(leftmotor2, LOW);
 digitalWrite(rightmotor1, HIGH);
 digitalWrite(rightmotor2, LOW);
}
 void SturnLeft(){
 analogWrite(pwm1,ms);
 analogWrite(pwm2,ms);
 digitalWrite(leftmotor1, LOW);
 digitalWrite(leftmotor2, HIGH);
 digitalWrite(rightmotor1, HIGH);
 digitalWrite(rightmotor2, LOW);
 }
 void turnLeft(){
analogWrite(pwm1,ms);
 analogWrite(pwm2,ms);
 digitalWrite(leftmotor1, LOW);
 digitalWrite(leftmotor2, LOW);
 digitalWrite(rightmotor1, HIGH);
 digitalWrite(rightmotor2, LOW);
 }
 void SturnRight(){
```

```
 analogWrite(pwm1,ms);
 analogWrite(pwm2,ms);
 digitalWrite(leftmotor1, HIGH);
 digitalWrite(leftmotor2, LOW);
 digitalWrite(rightmotor1, LOW);
 digitalWrite(rightmotor2, HIGH);
 }
 void turnRight(){
 analogWrite(pwm1,ms);
 analogWrite(pwm2,ms);
 digitalWrite(leftmotor1, HIGH);
 digitalWrite(leftmotor2, LOW);
 digitalWrite(rightmotor1, LOW);
 digitalWrite(rightmotor2, LOW);
 }
void Stop(){
 digitalWrite(leftmotor1, LOW);
 digitalWrite(leftmotor2, LOW);
 digitalWrite(rightmotor1, LOW);
digitalWrite(rightmotor2, LOW);
 }
void Back(){
 analogWrite(pwm1,75);
 analogWrite(pwm2,75);
 digitalWrite(leftmotor1, LOW);
 digitalWrite(leftmotor2, HIGH);
 digitalWrite(rightmotor1, LOW);
 digitalWrite(rightmotor2, HIGH);
```

}

Application of *Line following robots*

1. Industrial Automation: Line following robots can be employed in manufacturing plants to move materials from one station to another, or they can transport finished products to packaging or storage areas. They can also be used for quality inspection and testing processes along assembly lines.
2. Warehousing and Logistics: Line following robots can be used in warehouses to transport goods between different locations efficiently. They can navigate predefined paths to deliver items to the required destinations, saving time and reducing the need for manual labor.
3. Agricultural Applications: In agriculture, line following robots can assist in tasks like planting, seeding, and weeding. They can follow lines in the field and perform tasks accurately with reduced human intervention.
4. Service Robots: Line following robots can be employed in places like hospitals, airports, and shopping malls to deliver goods, medication, or documents to different departments or rooms.
5. Educational Purposes: Line following robots are often used in educational settings to teach robotics and programming concepts. They offer an engaging platform for students to learn about sensors, algorithms, and control systems.
6. Entertainment and Amusement: Line following robots can be designed as toys or attractions in amusement parks and other recreational facilities. They can follow predefined paths to provide entertainment and fun for visitors.
7. Surveillance and Security: Line following robots equipped with cameras and sensors can be used for patrolling areas in security applications. They can navigate through specific routes to monitor and detect any unauthorized activities.
8. Environmental Monitoring: Line following robots can be employed for environmental monitoring in hard-to-reach locations. They can follow paths to collect data on air quality, temperature, or other environmental parameters.

9. Personal Assistance: Line following robots can be developed to aid people with disabilities or the elderly in navigating around their homes or assist with simple tasks like fetching items.
10. Research and Development: Line following robots are commonly used in research projects to explore autonomous navigation and path-planning algorithms. They serve as a platform for testing and improving robotic system

Challenge

Designing a line-following robot can be a challenging task, but with the right approach and some problem-solving techniques, you can overcome the challenges. Here are some common challenges you might encounter and suggestions on how to tackle them:

1. Sensor Calibration: The line-following robot relies on sensors to detect the line. Calibrating the sensors accurately is crucial for reliable line detection. Ensure that the sensor readings are stable and consistent. You may need to experiment with different calibration techniques and thresholds to achieve optimal performance.
2. Line Detection: Depending on the surface and lighting conditions, detecting the line accurately can be challenging. Ambient light, reflections, and shadows can interfere with the sensor readings. To overcome this, consider using multiple sensors or specialized line-detection sensors that are designed to work under various lighting conditions. Additionally, implementing filtering and smoothing techniques on the sensor data can help reduce noise and improve line detection.
3. Line Following Algorithm: Developing an effective line-following algorithm is crucial. A basic algorithm might involve turning left or right based on the sensor readings, but it may not handle complex line patterns or intersections well. Consider using more advanced algorithms like PID (Proportional-Integral-Derivative) control, which can provide better control and stability. You may need to tune the algorithm parameters to achieve the desired performance.
4. Line Intersections: When encountering intersections or junctions, the robot needs to make decisions on which path to follow. Implementing decision-making logic based on the sensor readings or incorporating additional sensors like proximity sensors can help the robot navigate intersections effectively. You

might also consider using machine learning techniques to train the robot to make intelligent decisions based on past experiences.

5. Motor Control and Stability: The robot's motors should respond quickly and accurately to the line-following algorithm to maintain stability. Implementing an appropriate motor control mechanism, such as PWM (Pulse Width Modulation), can help achieve precise control over the motors. Ensure that the robot's weight is distributed evenly, and the motors have enough power to handle the required speed and maneuverability.
6. Environmental Factors: External factors like varying line colors, surface conditions, or obstacles on the path can affect the robot's performance. Try to test the robot under different environmental conditions to ensure its robustness.

Future Developments

In the field of robotics, future developments in line-following robots are likely to focus on enhancing their capabilities, performance, and versatility.

7. Machine Learning and AI: Future line-following robots may leverage machine learning and artificial intelligence techniques to enhance their decision-making and adaptability. By analyzing data from their sensors, they can learn to handle complex line patterns, adjust their speed, and make real-time decisions to navigate obstacles or unexpected situations.
8. Multi-Terrain Capabilities: Line-following robots are currently designed for smooth, flat surfaces. However, future developments may enable them to operate on various terrains, including uneven or rough surfaces. This could involve implementing more robust suspension systems, optimizing wheel designs, or even incorporating leg-like mechanisms to traverse challenging environments.
9. Obstacle Avoidance: Line-following robots could incorporate advanced obstacle detection and avoidance systems to navigate around objects or unexpected obstacles while staying on track. This might involve integrating additional sensors like proximity sensors, depth cameras, or even using advanced computer vision techniques to identify and navigate around obstacles.
10. Cooperative Navigation: In certain scenarios, multiple line-following robots may need to work together to accomplish tasks efficiently. Future developments might focus on enabling collaboration and coordination between these robots. They could communicate and share information to optimize their paths, avoid collisions, or even perform cooperative tasks such as object transportation.

11. Energy Efficiency: Future line-following robots may prioritize energy efficiency by implementing more efficient motors, optimizing power management systems, or even exploring alternative power sources such as solar panels or advanced battery technologies. This would allow for longer operation times and reduce the need for frequent recharging or battery replacement.
12. Integration with IoT and Smart Systems: Line-following robots could be integrated into larger smart systems and the Internet of Things (IoT) infrastructure. This would enable them to interact and communicate with other devices or systems, allowing for seamless integration into various applications and workflows.
13. Miniaturization and Swarm Robotics: Advances in miniaturization may lead to the development of smaller line-following robots capable of working together as a swarm. Swarm robotics enables a collective behavior that can achieve complex tasks more efficiently. These miniaturized robots could be used in applications such as inspection, environmental monitoring, or search and rescue missions.

It's important to note that the future development of line-following robots will depend on technological advancements, research, and market demands. These are potential areas of development, but the actual progress will depend on various factors and emerging trends in robotics.

Conclusion

In conclusion, line following robots have become an increasingly important technology in various industries such as manufacturing, agriculture, and healthcare. They offer a range of benefits including increased efficiency, accuracy, and safety.

By using advanced sensors and algorithms, line following robots are able to navigate through complex environments with ease. As we continue to develop new technologies and improve existing ones, the potential for these robots will only continue to grow.

Line following robots offer a reliable and precise solution for tasks that require following a predetermined path. Their versatility, educational value, and potential industrial applications make them an exciting area of robotics research and development. However, it's important to recognize their limitations and consider alternative robotic systems for scenarios where line following is not feasible.

Thank you!