LEARN-IN-DEPTH

Collision Avoidance

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Introduction

The Collision Avoidance System for Autonomous Vehicles is a critical component in ensuring the safety and reliability of self-driving vehicles. This case study delves into the development and implementation of a robust collision avoidance system that uses Ultrasonic sensors to detect obstacles and effectively control the vehicle's speed to prevent collisions.

Sequence

1. Ultrasonic Sensor (US) detects a distance.
2. Collision Avoidance (CA) enters state based on the distance.
3. CA instructs Drive Control (DC Motor) to set the speed.
4. DC motor enters the state with the speed.

Case Study

Project Overview:

- Objective**:** To design and implement a real-time collision avoidance system for autonomous vehicles using Ultrasonic sensors.
- Components**:** Ultrasonic Sensor (US), Collision Avoidance Module (CA), and Drive Control Module (DC).

Key Features:

- Real-time distance sensing.
- Adaptive speed control.
- State management for the collision avoidance module.

Methodology:

Ultrasonic Sensor (US):

- The US continuously monitors the vehicle's surroundings and provides distance readings.
- These readings serve as inputs to the Collision Avoidance Module.

Collision Avoidance Module (CA):

- CA receives distance readings from the US.
- It manages the system's state based on the received data:
  - "Waiting" state when an obstacle is detected but safe distance exists.
  - "Driving" state when no immediate obstacles are detected.
- CA instructs the Drive Control Module based on the current state.

Drive Control Module (DC):

- DC receives speed instructions from CA.
- It controls the vehicle's speed accordingly:
  - Sets speed to 0 for stopping the vehicle.
  - Sets speed to 30 for maintaining a constant speed.
- DC also has states such as "DC_busy" and "DC_idle" based on its speed setting.

Project Implementation:

- Hardware components: Ultrasonic sensor, microcontroller, and vehicle controls.
- Software components: Embedded software for real-time data processing and control.

Activity

Ultrasonic Sensor (US) Readings:

- US detects distances at various points in time.

Collision Avoidance (CA) Module:

- Receives distance readings from the US.
- Manages the state of the collision avoidance system.

Drive Control (DC) Module:

- Receives speed instructions from CA.
- Controls the speed of the vehicle.

States and Actions:

- CA has different states: "Waiting," "Driving," etc., based on the situation.
- CA instructs DC to set the speed as needed:
  - Speed = 0 for stopping the vehicle.
  - Speed = 30 for driving at a constant speed.
- DC has states such as "DC_busy" and "DC_idle" depending on its speed setting.

Sequence of Events:

- The project follows a sequence of events where US detects distances, and CA and DC respond accordingly to ensure collision avoidance.
- The sequence includes transitions between states and speed adjustments to manage the vehicle's behavior.

Requirements

Ultrasonic Sensor (US) Integration

- The system shall integrate an Ultrasonic sensor (US) for real-time distance measurement.

Distance Sensing

- The US shall provide accurate distance measurements with a range suitable for collision avoidance (e.g., 0-100 meters).

Collision Avoidance Module (CA)

- The system shall include a Collision Avoidance Module (CA) responsible for processing US data and making decisions.
- The CA shall manage different states, including "Waiting" and "Driving," based on the detected distance and safety criteria.

Speed Control

- The CA shall instruct the Drive Control Module (DC) to adjust the vehicle's speed based on the current state.
- Speed control shall include settings for
  - Setting speed to 0 for stopping the vehicle.
  - Setting speed to a predefined value (e.g., 30) for maintaining a constant speed.

Drive Control Module (DC)

- The system shall include a Drive Control Module (DC) responsible for controlling the vehicle's speed based on CA instructions. The DC shall have states like "DC_busy" and "DC_idle" based on the speed setting.

Design Diagrams

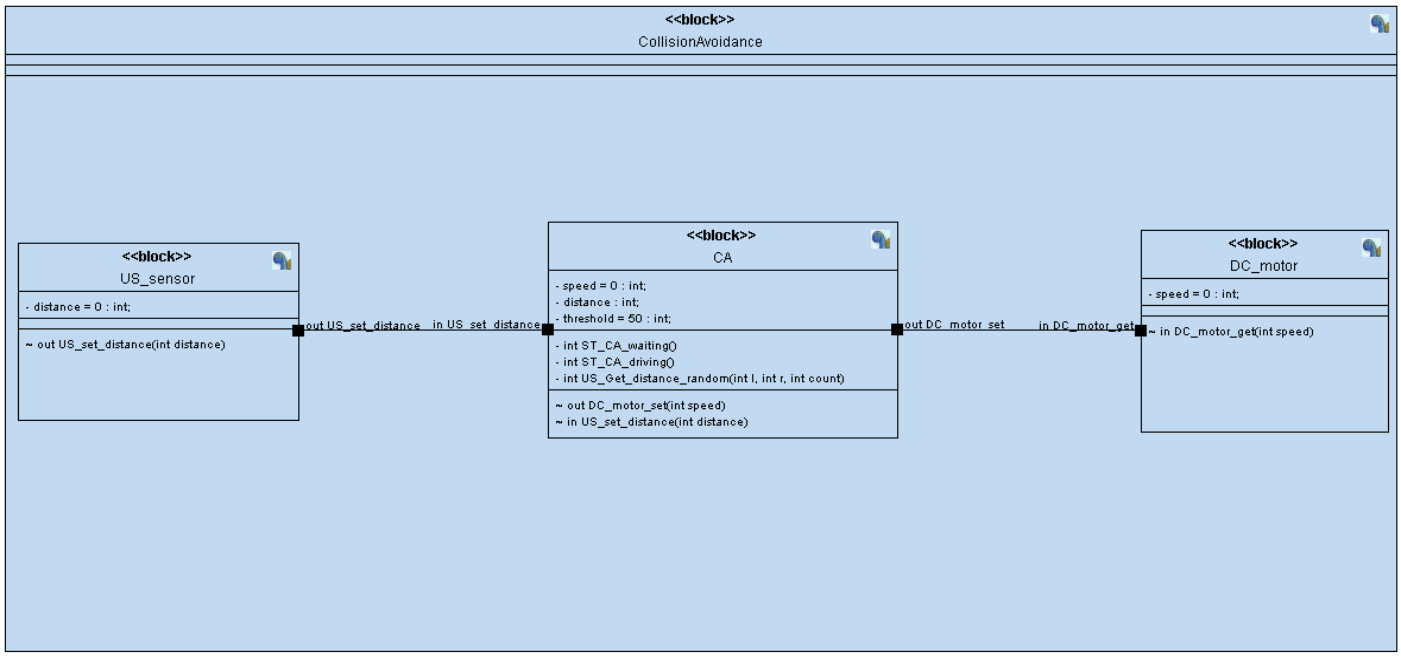

Figure 1 Collision Avoidance main Block

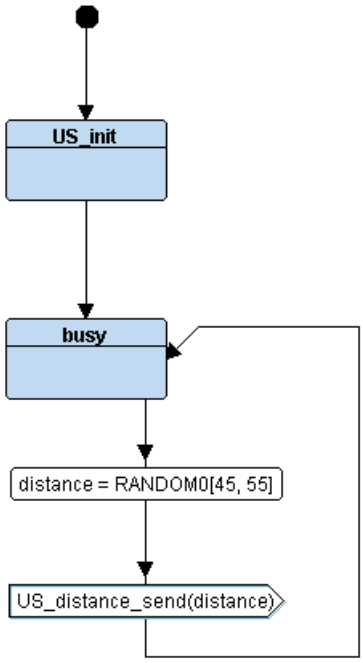

Figure 2 US Sensor

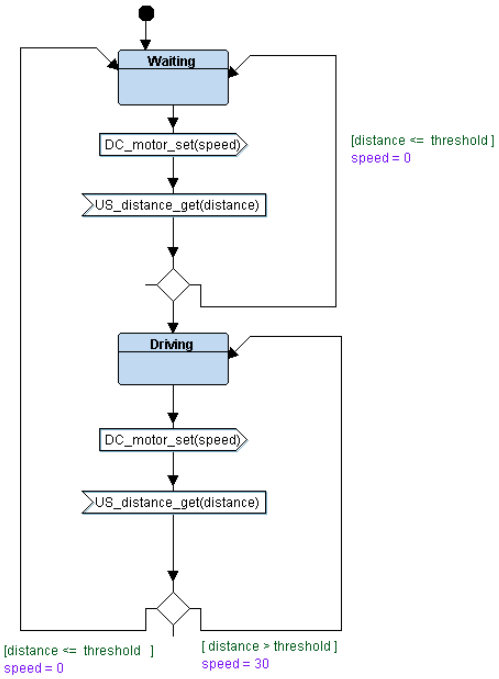

Figure 3 Collision Avoidance

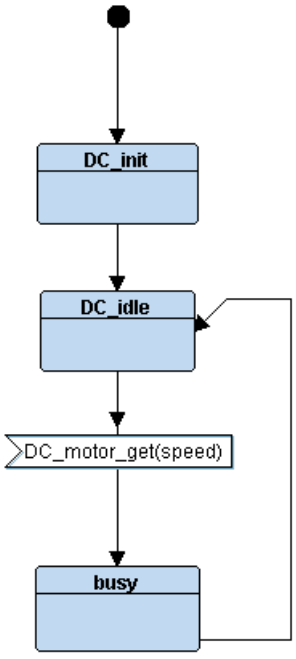

Figure 4 DC Motor