

MODULE 8: RADAR AND LIDAR SYSTEMS IN INTELLIGENT TRANSPORTATION SYSTEMS

GRADE LEVEL: 6 - 12

Autonomous vehicles or self-driving vehicles are expected to remove the actions of human beings from the transportation equation, which contribute to more than 90% of motor vehicle crashes. Technologies already exist which enable “driverless” vehicles to operate on our roadways and promise many benefits. Innovations at work today are demonstrating the potential to significantly improve safety, make more efficient use of the roadways to increase capacity and reduce congestion, optimize fuel economy, and provide greater mobility for drivers vulnerable to limitations such as inexperience, increasing age, certain disabilities and other human factors

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RADAR and LIDAR Systems in ITS

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Grade Level: 6 - 12	Tasks in this Module: 7
Time Required: Depends on student level	Lesson Dependency: None
Keywords: Intelligent transportation systems, autonomous vehicles, Bluetooth, GPS, sensors	

Related Curriculum

Subject Areas	Science; technology; engineering; mathematics
Curricular Units	Intelligent transportation systems, autonomous vehicles, sensors
Activities	Modular robotics, cooperative learning

Educational Standards

This lesson plan and its associated activities are correlated to the national standards in the each of the core discipline areas of STEM: Next Generation Science Standards, American Association for the Advancement of Science Standards, Standards for Technological Literacy, International Society for Technology in Education Standards, Common Core Mathematics Standards, and the National Council of Teachers of Mathematics Standards.

Materials List

MOSS Robotics Kit(s) or other modular robotics kit such as Cubelets; iPad or other tablet.

Pre-Requisite Knowledge

None.

Learning Objectives

- Through videos and discussion, students will explore how autonomous vehicle systems work and how these systems can be simulated through robotics.
- Students will use a modular robotics system to understand and build sensors.
- Students will apply their knowledge of the robotics system to build a robot where power and data flow to multiple points on the robot.
- Students will explore the Bluetooth communication system.
- Students will design and construct a vehicle or other modular structure that is able to interact with the surrounding environment to simulate Connected Vehicle Technology.

Introduction/Motivation

Autonomous vehicles (also known as self-driving vehicles) are expected to remove from the transportation equation the actions of autonomous human beings which contribute to more than 90% of motor vehicle crashes. Although a fully autonomous transportation system is still a future possibility, technologies already enabling “driverless” vehicles to operate on our roadways promise many benefits. Innovations at work today are demonstrating the potential to significantly improve safety, make more efficient use of the roadways to increase capacity and reduce congestion, optimize fuel economy, and provide greater mobility for drivers vulnerable to limitations such as inexperience, increasing age, certain disabilities and a host of other human factors.

Autonomous vehicles generally involved three main components:

1. **A global positioning system (GPS)** similar to the units used in vehicles today
2. **A Radar or LiDAR** system, which emits radio waves or light pulses to bounce off nearby objects and captures the information it discovers, and
3. An interface and interpreter between GPS and radar/LiDAR, known as a **CAN (controller area network) bus**, which takes data from both components and turns it into actionable messages that control the vehicle.

In this STEM lesson, you will simulate how autonomous technology systems work by designing and constructing a connected vehicle that is able to autonomously interact with the surrounding environment.

Vocabulary/Definitions

Vocabulary Word	Definition
Autonomous Vehicle	A vehicle that is capable of sensing its environment and navigating without human input.
GPS	Global Positioning System is a global navigation satellite system that provides geographical and time information to a receiver anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.
Radar System	An object-detection system that uses radio waves to determine the range, angle, or velocity of objects. Radar is commonly used by police to determine vehicle speed. RADAR stands for Radio Detection and Ranging.
LIDAR System	A surveying method that measures distance to a target by illuminating the target with a pulsed laser light and then measuring the reflected pulses with a sensor. LIDAR stands for Light Imaging Detection and Ranging.
CAN bus	A Controller Area Network 'bus' designed to allow multiple devices to communicate with each other in applications without a host computer. It takes data from the components and turns it into actionable messages that control a vehicle.

Associated Activities

The activities/tasks in the worksheets are design to be self-paced or completed as a group. Once groups have completed each task, they can raise their hand and you can check off each task at the bottom of each activity page. Students should pay attention to the information in each task as they will be using the information gained to design and construct an autonomous vehicle that is capable of interacting with the surrounding environment. There are 2 sets of worksheets: a teacher version with suggested questions/answers/discussion topics in italics, and a student version with italicized words removed.