MODULE 10: INTELLIGENT TRANSPORTATION SYSTEMS: SMART WORK ZONES
LESSON 1: WORK ZONE SAFETY

Connected vehicle (CV) safety applications are designed to increase awareness of what is happening in the environment as people drive, walk, or bike within our transportation system. In this lesson, students will recognize the need for intelligent transportation technology and connected vehicles within work zones on the roadway. Students will develop ideas on how ITS systems can improve both worker and driver safety within these areas

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Lesson 1: Work Zone Safety

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Grade Level: Adaptable to Grades 6-12	**Lesson in this Module: 1 of 4**
Time Required: 60 – 90 minutes	**Lesson Dependency:** None
Keywords: transportation engineering, intelligent transportation systems, vehicle to infrastructure (V2I), smart work zones	

Materials List

LilyPad Arduino ProtoSnap Development Board, Highway Safety Attire (helmet, vest, pants, gloves), Mini USB cable, Felt, Fabric Marker, Needle Threader, Seam Ripper, Velcro

Pre-Requisite Knowledge

None.

Introduction/Motivation

As drivers, we depend on multiple visual and aural inputs to drive safely along roadways that provide ever-changing conditions. How and how quickly we respond to those inputs is important to our own safety as well as to the safety of other drivers. How quickly we can react to inputs is introduced to students in this lesson plan. Through discussion, analysis, some hands-on experiments and group conclusions, students will be able to understand that their own reaction times are not instantaneous and practical reaction time limits affect how driving and driving safety can be affected.

Lesson Background & Concepts for Teachers

Background

Connected vehicle (CV) safety applications are designed to increase awareness of what is happening in the environment as people drive, walk, or bike within our transportation system. This "situational awareness" can be leveraged to reduce or eliminate crashes through vehicle-to-infrastructure (V2I), vehicle-to-vehicle (V2V), and vehicle-to-pedestrian (V2P) communications. Each of these methods involves vehicles using data transmissions to communicate with and gain feedback about their surroundings. The following lesson will focus on how Connected Vehicle technology and other Intelligent Transportation Systems can be utilized specifically within work zones to increase safety for both the driver as well as the work zone personnel.

Vehicle To Infrastructure (V2I)

V2I technology enables the roadway infrastructure to communicate with vehicles, sending and receiving information that triggers driver, vehicle and infrastructure actions. Roadway infrastructure includes any physical object or feature that regulates or affects traffic, including intersections, work zones, environmental elements (like weather conditions that affect vehicles or pavement), curves and other aspects of the road's geometry, as well as tolls and commercial vehicle weight or inspection facilities, among many other elements.

The potential exists for this technology to include any application that allows vehicles to "talk" to any type of roadway infrastructure. Examples might include signs, sensors or structures along the roadway that indicate to the vehicle that it is approaching a curve, a work zone, tolls, a vehicle inspection station, or an environmental concern such as weather that impacts driving conditions, among many other features.   Experts have already developed some of these applications specifically related to work zones:

> **Reduced Speed/Work Zone Warning.** This application broadcasts information from a roadside device that alerts drivers to slow down, change lanes, or come to a stop within work zones or reduced speed areas. These alerts are sent from a transportation agency to roadside devices.

> **Warnings About Hazards in a Work Zone.** This application provides warnings to hand-held devices carried by maintenance personnel and/or initiates an audible siren alerting workers to potential hazards or intrusions into the work zone (e.g., a vehicle moving at a high speed or an unauthorized vehicle trying to enter the area). The warning originates from the potentially intrusive vehicle. The vehicle's CV technology senses that its own speed, trajectory, and distance from the work zone put it on a likely collision course, which triggers a message to another CV unit within the work zone that then broadcasts an alert to workers.

> **Warnings about Upcoming Work Zone (WUWZ).** This application provides approaching vehicles with information about work zone activities, such as travel lane obstructions, lane closures or shifts, speed reductions, or equipment entering and exiting the work zone. The information is broadcast from a pre-programmed unit within the work zone.

In these lessons, students will explore connected vehicle applications that currently exist for work zone areas and consider what future technologies could be developed to increase the safety of both oncoming drivers and highway personnel within the work zone area. Students

will specifically examine how sensor technology could be implement within the work zone area and as part of the connected vehicle technology to improve safety.

Activities

The activities contained within these lessons ask students to expand upon current connected vehicle technologies for work zone areas to think about how future technologies could be developed and implemented within the larger Intelligent Transportation System to improve safety in work zone areas. Students will be using LilyPad Arduinos to explore how sensors and other programmable devices could be utilized in the development of a "Highway Smart Suit." Students will develop a "Smart Suit" and then consider how its usage in conjunction with other connected vehicle technologies could improve safety in highway work zones by alerting both oncoming drivers and highway personnel to potentially hazardous situations.

Lesson 1 Activities

The activities in this lesson will help students recognize the need for intelligent transportation technology and connected vehicles within work zones on the roadway. Students will develop ideas on how ITS systems can improve both worker and driver safety within these areas.

- **Activity 1: Video (10 minutes)**

  Teacher Directions: This first activity is designed to give students background information on highway work zone sites and to get them thinking about potential hazards within work zone areas. If the following video is not available, try searching for another video using search terms such as "work zone safety."

  Watch the following video on work zones.

  https://www.youtube.com/watch?v=VrlmIAaSkO4

- **Activity 2: Discussion - Identifying Work Zone Hazards (10 minutes)**

  Teacher Directions: *In this discussion, ask students to recognize the hazards that exist for both drivers and workers within work zone areas. The discussion should include hazards related to low visibility of workers, speed of oncoming traffic, changing traffic patterns, etc.*

  After watching the video, think about potential hazards that exist within a work zone area to both drivers as well as highway workers. Make a list of those potential hazards.

- **Activity 3: Video (5 minutes)**

Teacher Directions: In this video, transportation engineers discuss current ITS systems in work zone areas and how these systems are being used to inform drivers of work zones, improve traffic flow, and improve safety.

Watch the following video on "Smart Work Zones" and how these technologies are improving safety for both drivers and workers.

https://www.youtube.com/watch?v=DJN-_24-9kY

After watching the video, think about what current ITS systems are available to improve safety within work zones. Make a list of these technologies. Can you think of other technologies that could be developed to improve safety for both the driver and worker within work zone areas? Include these "future" technologies in your list. (10 minutes)

Teacher Direction: In the discussion about future technologies, lead students to understand that worker safety apparel, roadway sensors, and roadway signs could be tied together to alert a worker of oncoming traffic or to alert a driver that a highway worker is present.

- **Activity 4: Guest Speaker (20-30 minutes)**

   Teacher Directions: Consider having a local transportation official come and discuss work zone safety with students. A transportation official might discuss how work zones are configured and considerations made for traffic in work zones. In addition, the discussion could include different safety precautions taken for highway workers and the grade of work zone apparel based on the highway speed limit.

   At the end of this lesson, students should recognize that Intelligent Transportation Systems and Connected Vehicles are comprised of a variety of technologies that are interconnected to allow drivers and infrastructure to communicate with each other in order to improve the safety of all highway users. One future technology of an ITS system could be a "Smart Suit" in which a highway worker could be alerted to a driver or made more visible to a driver using the ITS systems and connected vehicle technology.

- **Task 5 (Optional): E-textiles Video**

   The videos below are examples of current wearable technologies that are in development. These videos will give students some ideas on technologies that could be developed as part of their Smart Suit design.

Volvo: Life Saving Wearable Cycling Tech Concept

https://www.youtube.com/watch?v=tRxjtJ__WIQ&list=PL-FY_JaVnZRojd2P3zB_B5ldwMckBZnUs&index=10

AIG & Human Condition Safety: Wearable And Worker Safety

https://www.youtube.com/watch?v=UC40wGiIWHc

Safety++ Jacket: Wearable Technologies By Eni&MIT

https://www.youtube.com/watch?v=NQrlcq4rqPU