CPSC Lawn Mower Safety

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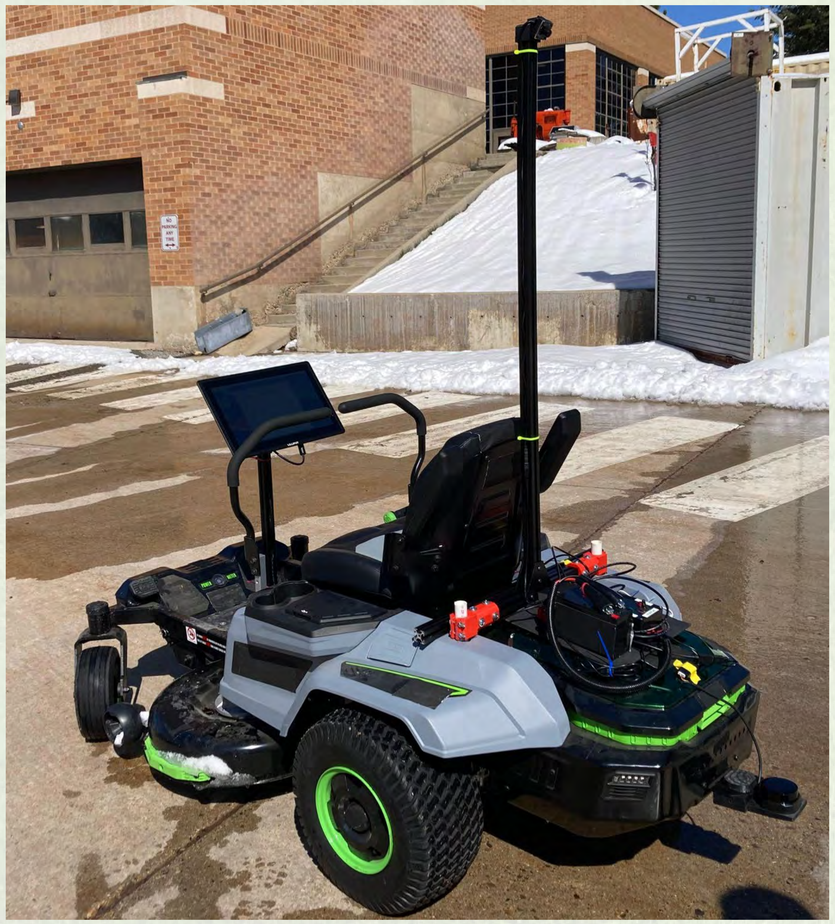
Introduction

Every year, More than 9,000 children are injured by lawnmowers. 8% of these cases require hospitalization and many cause lasting effects to the victims. These incidents occur primarily with riding lawn-mowers to bystanders. The CPSC requested a prototype that improves the safety of the lawn mower to reduce the number of incidents per year, and to gather ideas on possible future safety mandates for riding lawn mowers.

Objectives

- Find solutions that prevent rideover incidents from occurring
- Prevent consumer bypass of installed safety systems
- No permanent alterations to the mower (bolt-on solution)



Completed prototype

References
Research Into Riding Mower Back-Over and RunOver Hazards - Fors Marsh Group's Report (Feb 2023)
Lawnmowers Versus Children: The Devastation Continues - Garay et. al. (2016)

Safety Systems

The mower consists of systems that are non-intrusive, tamper-resistant, and have sufficient range to warn the operator and bystander of potential risk. The following were selected to increase operational safety:

- Rear-mounted LiDAR sensor
- Top-down blind-spot camera
- Operator UI with audio-visual alerts and bystander alarm

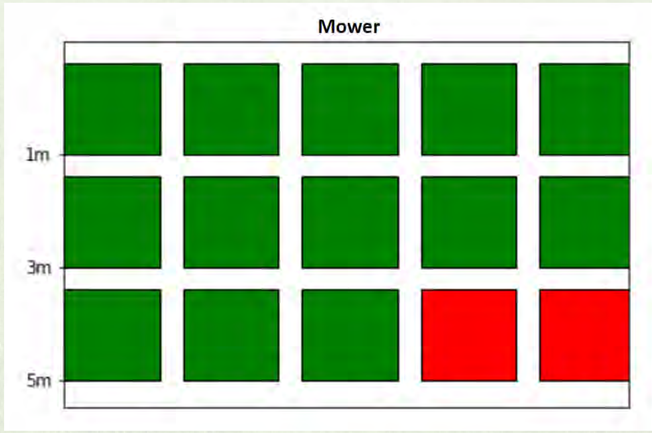
Top-down camera view covering the rear blindspots of the mower. Back of the mower can be seen in the bottom-center of the frame

Methodology

Object recognition has been integrated into both the camera and LIDAR modules running on a Raspberry Pi. The camera uses OpenCV library to find humans in the frame and mark them on the display. The LiDAR detects all objects distances from the mower and transforms this data into detection zones for ease of interpretation. Combining the human detection from the camera and object range data from the LiDAR, the mower alerts the driver and intruder of an intrusion into the safety zone

LiDAR Function

LiDAR (Light Detection and Ranging) is remote sensing technology using laser light to measure distance from the sensor. Light is emitted, reflected off of an object, and returned back to the emitter and distance is based on the time it takes for it to be sent and return. It is used prominently on autonomous vehicles to map its environment in incredible detail and speed. We use this data to create a plot of the environment behind the mower so the operator is more aware of their surroundings.



Detection zones from the LiDAR sensor. Data is transformed into xy plane and displayed where an object is behind the mower. Red Squares indicate an object in that vicinity.

Results

- Camera reliably detects humans from 2m to 5m behind mower, ~5% false positive rate at 700x700 resolution and 15fps.
- LiDAR output is accurate and detection zones consistently detect objects with >90% accuracy.
- LiDAR human detection algorithm misidentifies and fails to identify humans.
- Video display is increases situational awareness and audio alerts are timely and accurate.

Conclusion

The combination of LiDAR and rearward camera can produce an effective method of alerting operators to ride over incidents before they occur. Optimization would be needed to improve the system and its detection rate, video and LiDAR scan speeds need to be increased due to hardware limitation using a Pi. Further work is needed to create a discrete detection algorithm for the LiDAR sensor, doing this would increase the capability of the system.