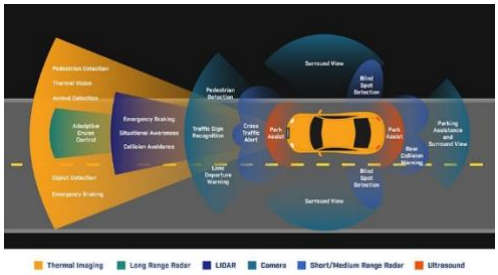
Multi Discipline Project

Thermal-Aided Autonomous Food Delivery Robot

Background

One of the most publicized technological efforts in the world today is autonomous vehicle development. Many companies are working hard to solve the problem of autonomous delivery of everything from mail to packages to people **safely** and **reliably**. To make braking, acceleration, and steering decisions, these vehicles interpret the world using a combination of inputs from many sensors. Ultimately, the sensor combinations that are required, their orientation, and refresh rate depend on the application and operability requirements. As an example, a collision avoidance system on an autonomous passenger airplane requires orders of magnitude quicker identification and reaction time to an object in its flight path than a food delivery robot traveling at 5MPH that is attempting to avoid collisions with slow moving pedestrians.



FLIR is engaging the autonomous vehicle market as a long wave infrared (LWIR) camera provider using FLIR ADK. LWIR cameras are a passive sensing technology that does not require active illumination but instead see the inherent radiation emitted from heated bodies as modeled by Planck's law. This gives IR a unique advantage in an autonomous vehicle's sensor suite in many corner cases like navigation at night or in foggy conditions.

The goal of this capstone project is for the multi-disciplinary capstone team to design an autonomous delivery vehicle that delivers the college student's most important resource, **food**, safely and reliably. The autonomous food delivery bot shall make use of infrared cameras to deliver food in night conditions at <20MPH speeds while avoiding collisions with pedestrians, skateboards, and bicycles. The team is expected to define an appropriate path-finding strategy (GPS, stored maps, etc.) and execute on their planned approach. Appropriate consideration shall be given for theft and tampering as well as vehicle runtime given the application. DonkeyCar is a possible platform that could be used for the vehicle body and control and the NVIDIA Jetson TX2 is a possible computing platform that could be used for sensor fusion and decision making. Copilot is a possible alternative software platform that could be tweaked for the application. An interface between the infrared camera and the computing platform shall be designed with assistance from FLIR. The capstone group shall set system specifications in conjunction with FLIR and shall analyze and design all aspects of the vehicle to ensure compliance to the system specification. Our end of year expectation is a functional autonomous food delivery vehicle prototype with analysis explaining sensor selection and placement for the application as well as a great deal of hard work, creativity, and fun.

Electrical

- Design or modify high speed video capture system, interconnects between vehicle control platform and decision analysis platform
- Analyze battery requirements, maximum runtime, power budgeting
- Design power delivery and battery recharging system/plan
- Analyze and calculate sensor suite reaction time with team
- Analyze sync requirements and incorporate sensor synchronization into sensor suite design
- Design anti-tamper system for food storage
- Analyze and design-in fault detection (no unintended hazardous acceleration)

Mechanical

- Analyze field of view cones for sensor suite, how many sensors are required, and in which locations in order to avoid unsafe collisions
- Design mounting equipment for sensor collection, considering sensor calibration requirements (parallax, boresighting, etc.)
- Modify or design from scratch the autonomous vehicle body considering weight requirements for maximum vehicle runtime
- Analyze torque requirements for vehicle motors given weight of the vehicle
- Analyze weather-proofing requirements

Software

- Choose a software platform for vehicle control and sensor fusion
- Analyze detection latency and control latency based on application requirements
- Design control algorithms and detection architecture, leveraging existing open source platforms where possible.
- Make use of thermal imagery in the detection loop
- Determine best sensors to rely on in a given operating scenario.
- Analyze and design-in fault detection (no unintended hazardous acceleration)