Project Title: Electric Go-Kart

Team Members:

- Vani Kapoor (Electrical Engineering)
- Andie Groeling (Computer Engineering)
- Ryan Guidice (Computer Engineering)
- Nikola Durand (Electrical Engineering)
- David Neitenbach (Electrical Engineering)
- Rico Barela (Electrical Engineering)
- Matt Gilmore (Junior Electrical Engineering)

Supervising Professor: Olivera Notaros

Engineer-in-Residence (Team Mentor): Doug Bartlett

Project Summary:

The Electric Go-Kart project is a continuation senior design project focused on improving upon the work done by last year's team. Already equipped with an electric motor system and embedded control system, our team was allowed the creative opportunity to expand on the go-kart's capabilities in a way that improved the kart's main use-case: taking to ECE Outreach events to inspire students to pursue electrical and computer engineering disciplines. Our main goals for the kart include adding an autonomous pedestrian detection system, adding a 7" touchscreen display with a new user interface to show the kart's readings, adding a solar charging system to one of the kart's power systems, and changing the embedded control system's communication protocol to improve efficiency and reliability. All of these tasks are either completed or in-progress, and all are expected to be completed by the end of the semester.

Why This Project Is Important:

This project is important because of its target use case: to be taken to ECE Outreach events and used to inspire potential future engineering students. The kart has many features spanning across a variety of ECE disciplines, and will be a great tool to show the range of areas ECE is applicable in. By showing students all the cool things engineering students can achieve, it will help to influence their career goals, and hopefully pique their interest into engineering.

Part 1: Volkswagen Emissions Scandal

1) The main Ethical Dilemma is that engineers and corporate higher ups designed and implemented emissions "defeat devices" on their cars to pass emissions tests. In 2005 Volkswagen did not want to pay for a preexisting expensive diesel emission reducer to put into their cars. They decided to design their own emission reducer for a lower cost instead. The problem was that the new emission reducer did not work well enough. Instead of redesigning the emission reducer the decision was made to create a device to pass emissions tests when an emission tester was detected. The consequences for Volkwagen were that they had to pay fines from multiple countries as well as recalling and refitting the affected vehicles. Volkswagen had to pay over $20,000,000,000 in fines as well as having to recall millions of vehicles.
2) Violations and Roles
    a) Engineers - The engineers knew that they were designing a part that was for the purpose of falsifying emissions tests. Although they did not make the decision to make the device they have blame in deciding to make it.
    b) Corporate employees - The most blame has to fall on the higher up corporate employees. Although they did not create the product they decided to have it made instead of coming up with a better solution whether it was to buy a device that works or make a better emission reducer. Seemingly this was just to save and/or make more money.
    c) Regulators - The regulators didn't necessarily make any mistakes but could have done a better job. The reason that the device was able to work was the emissions testing facility only tested the vehicles in an idle state where the car wasn't on the road driving.
    d) Testers - Scientists at West Virginia University got a grant to test vehicle emission in real world settings and found that the Volkswagens emissions were well above the regulations.
    e) Governments - Various governments fined Volkswagen for violating regulations. Germany investigated Volkswagen and charged four executives with fraud. The CEO Rupert Stadler was also charged with fraud.
3) This ethical dilemma could be prevented in the future by changing emissions testing practices. The reason this event was able to occur was because the testing process wasn't as thorough as it could have been. If there is a possibility to cheat the system someone will most likely find that cheat. Another thing to consider would be trying to instill engineers with more ethical knowledge.
4) The way this could be corrected at the time the violations were discovered was exactly what the governments and Volkswagen did. First you have to limit the damage the vehicles could do by recalling them and reducing the emissions of the cars. The next step is to hold Volkswagen accountable. With this being an international incident the most countries outside of Germany could do was to have Volkswagen pay fines. Germany went a step further and investigated Volkswagen for fraud and ended up charging some executives and the CEO.
5) This violation was unacceptable in my opinion because it could hurt people and the planet while also being very hard to detect. If it had not been for the study done by West Virginia University, Volkswagen could have done this indefinitely. Most of the blame falls on the executives of Volkswagen. They are the ones who made the decision to

violate regulations. The engineers are also partially responsible, but their decision between working and being fired is a position they never should have been put in by management in the first place.

Part 2: Go-Kart Ethics

Our senior design project is creating an electric go-kart for the purposes of demonstrating electrical engineering and computer engineering to younger students. With our project not having to be submitted to any kind of standard for product or official testing, we don't have any legal standards to adhere to, so all of the ethical focus is on safety. The go-kart will be around a lot of young children and anything that could potentially hurt them is our responsibility as the engineers. The general safety of the kart is a large part of the ethics but there is also an Autonomous Pedestrian Detection system on the kart that could theoretically be used in an autonomous braking system that also presents an ethical dilemma.

The general safety of the kart can be broken down by spectators and users. The spectators need to be able to be around the kart in a semi confined space such as a school basketball gym. The spectators may be close to the kart without barriers while it is being driven. The spectators may also touch the kart when it is not being driven so all the electronics have to be as safe as possible to touch when not in use. The users will be driving the kart so the main concern is their safety while driving the kart. One of the most dangerous parts of the go-kart is the speed it can reach. The motors on the kart are potentially able to reach speeds of 60 miles per hour. This is a problem considering the spectators and user will be in danger if speeds like this occur. Limiting the capability of the motors has to be done so even if it is desired high speeds will not be reached. The other safety concern has to do with the exposed wiring. Since school children are expected to be touching the kart at points it is very important that they do not get electrocuted. Making the kart safe enough for a child to touch anywhere on the kart is important. The ethics involved are determining how safe the kart can be so that no one can accidentally be hurt by it.

The Autonomous Pedestrian Detection (APD) system on the kart uses a machine learning model to detect pedestrians and other traffic-related objects, and draws bounding boxes around them on a live webcam video feed from the front of the kart. As previously mentioned, this system could serve as a gateway to autonomous braking functionality, which opens an enormous can of worms on the ethical side. In an autonomous braking scenario, there are several issues to consider. What happens when the model misses the detection of an object it should have caught? What happens if there's a false positive, and it believes an object is there when it actually isn't? If there actually is a pedestrian in front of the kart and the system detects it correctly, how accurately can the system decide if the pedestrian is in the kart's projected path or if they are off to the side? Assuming the pedestrian is in the way of the kart's projected path, how hard does the system autonomously press the brakes? Can it make these decisions on different braking surfaces, such as concrete vs. dirt? Since the system relies only on webcam data as its input, it lacks any understanding of the range of a detected object, which will also influence these decisions. This results in a system that should not be deployed for this use case in its current state. As shown, the potential risk of an actual autonomous braking system is incredibly high when discussing the concept of user safety. There's the obvious threat to pedestrians, but also a hidden threat to the driver of the kart. If the kart brakes too quickly from high speed following a detection, it could result in serious injury to the driver. The kart's electric motors result in fantastic braking performance, so a neck injury due to quick kart stopping is not out of the

question. All of these concerns contributed to our group's design decision to scrap the possibility of autonomous braking due to the ethical concerns surrounding its deployment, and leave the APD system as solely a cool demo of real-time object detection capabilities for future engineers.