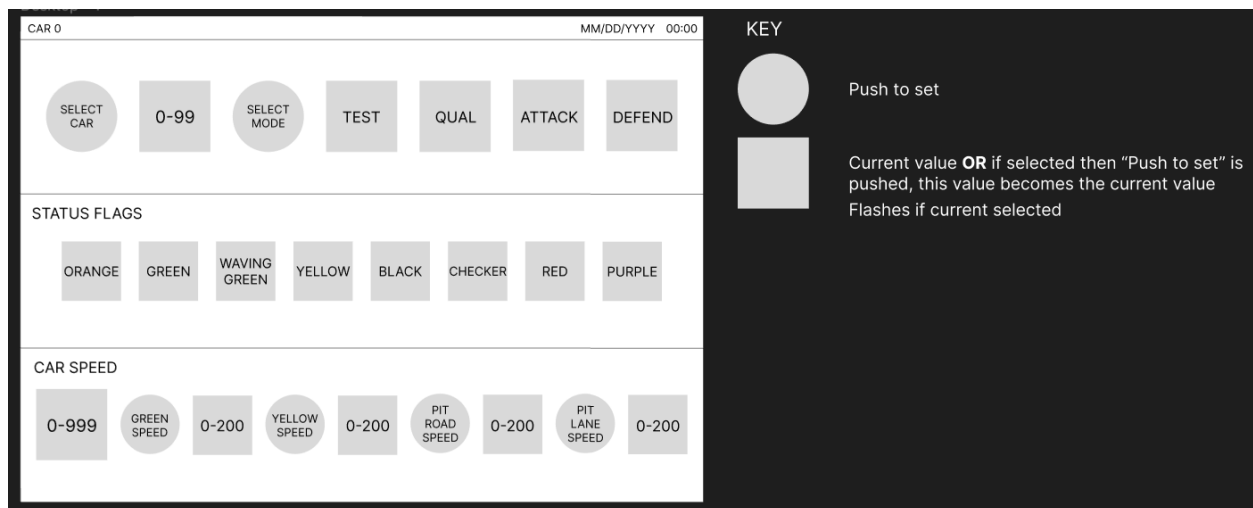


Triton AI - Autonomous Racing HMI

Milestone Report

The goal of this project is to build a human-machine interface (HMI) for easier control and monitoring of an autonomous racecar. The minimum viable product (MVP) consists of an HMI which allows an operator to set the racecar's mode, set the current status flag, and both view and set the racecar's speed (basic design shown below).



The project was planned to be completed in a series of milestones and deliverables, which are listed below along with the progress on each (deliverables are bolded and completed milestones are marked with green):

Team Attributions

- Alexis Morales Flores
 - All milestones marked with AF below were assigned to this team member
- William Chung
 - All milestones marked with WC below were assigned to this team member

Project Milestones

- **Prototype HMI (Week 5):** complete MVP with must-have virtual instruments and controls
 - Research open-source and/or affordable solutions to implement virtual instrumentation on a web app (*Week 3*) *AF, WC*
 - Define list of virtual instruments and controls that are must-haves and nice-to-have (*Week 3*) *AF*
 - Develop prototype virtual instruments and controls (*Week 4*) *WC*
 - Present project at Jacobs School of Engineering Research Expo (*Week 4*) *AF, WC*
 - Begin testing (either using static data or real-time data) (*Week 5*) *AF*
 - First version of prototype (V0.1) with must-have virtual instruments and controls the IAC team requested (*Week 5*) *WC*
- **Final HMI (Week 10):** HMI improved based on feedback from IAC team
 - Improve V0.1 to V0.2 based on customer feedback (*Week 6*) *AF, WC*
 - Connect HMI to simulator showing real-time data on car analytics (*Week 6*) *WC*
 - Improve V0.2 to V0.3 based on customer feedback (*Week 7*) *AF, WC*
 - Connect HMI to hardware for real time display, if feasible (VPN to hardware located in Hawaii) (*Week 7*) *WC*
 - Improve V0.3 to V0.4 based on customer feedback (*Week 8*) *AF, WC*
 - Begin to work on the nice-to-have instruments* (*Week 8*) *AF*
 - Improve V0.4 to V1.4 based on customer feedback (*Week 9*) *AF, WC*
 - Refine repository and train other people (*Week 10*) *AF, WC*

After an initial HMI was built (frontend only, not connected to hardware) the project faced a setback deciding which tooling should be used to build the HMI. The initial HMI was built from scratch using only standard web development technologies (HTML, CSS, Javascript) without the aid of any frameworks. However, after discussion with Dr. Silberman, it was decided it would be best for the future maintenance and development of the project for a modern, well-documented framework to be integrated into the project. The use of such a framework would not only ease future maintenance and development of the project, but also aid current development as not everything would have to be built from scratch. However, integrating a new tool into the project did not come without a cost. Development on the HMI had to be reset for the new tool to be learned and then applied. This delayed progress on the project milestones, forcing a new schedule to be devised:

Updated Project Milestones

- **Final HMI (Week 10):** improve MVP based on feedback from IAC team
 - Improve V0.1 to V0.2 based on customer feedback (***Week 8***) *AF, WC*
 - Connect HMI to simulator showing real-time data on car analytics (***Week 8***) *WC*
 - Improve V0.2 to V0.3 based on customer feedback (***Week 9***) *AF, WC*
 - Connect HMI to hardware for real-time display, if feasible (VPN to hardware located in Hawaii) (***Week 9***) *WC*
 - Improve V0.3 to V1.0 based on customer feedback (***Week 10***) *AF, WC*
 - Refine repository and train other people (***Week 10***) *AF, WC*
 - The project will have extensive documentation of the development process so that future maintenance and development is easier
 - All this documentation will be centralized in the GitHub repository

MVP Completion

The frontend portion of the MVP has been completed. In other words, the graphical user interface for the HMI has been developed ([video](#)). What remains to be done is connecting the HMI to hardware (either simulated or real). Again, project progress was delayed due to the integration of a new tool into the project after the initial HMI had already been built. The use of such a tool would simplify future maintenance of the project and also ease current and future development of the project, at the cost of time. More specifically, the integration of a new tool forced a reset in development so that the new tool could be learned and then applied.

To give further details about the development process so far, below is a breakdown of what has been accomplished. Things marked with AF or WC were completed or will be completed by team members Alexis Morales Flores and William Chung, respectively.

Project Requirements

- I. Consulted with Dr. Silberman and Dr. Passon (mentors from Triton AI and the IAC team) on what the HMI should contain.
 - A. After consulting with Dr. Silberman and Dr. Passon we were instructed to begin working on a web application that will serve as the HMI for the autonomous race car. Our goal is to have an app which contains multiple tools such as flag buttons, speed monitoring gauges, car health, and potentially even a map. (Completed AF WC)
- II. Set up a GitHub repository with the team and schedule weekly meetings with Dr. Silberman to stay up to date with progress.

- A. Our team has successfully created a GitHub repository which will be where we keep our code and document all of the changes and modifications as well as how to run the program. (Completed WC)
- B. We have also agreed to meet once a week with Dr. Silberman on Wednesdays at 8:00 p.m. to discuss our progress and or setbacks. Dr. Silberman can also give us feedback on our project and inform us of any changes we should make. (In Progress AF WC)

Development

- I. Began development on our web application which will serve as the HMI for operating the vehicle.
 - A. The first few iterations have been made and we normally worked separately due schedule differences but met remotely to discuss the progress and merge our existing code. (In Progress AF WC)
- II. Worked on the project separately then merged the code as each iteration improved over the last.
 - A. As each version improves over the last, we are iteratively working towards making the app resemble our story board and preparing for the eventual merging with the vehicle's data. (In Progress AF WC)

Features

- I. Create a range slider and on/off toggles. (Completed AF)

Round Range Slider

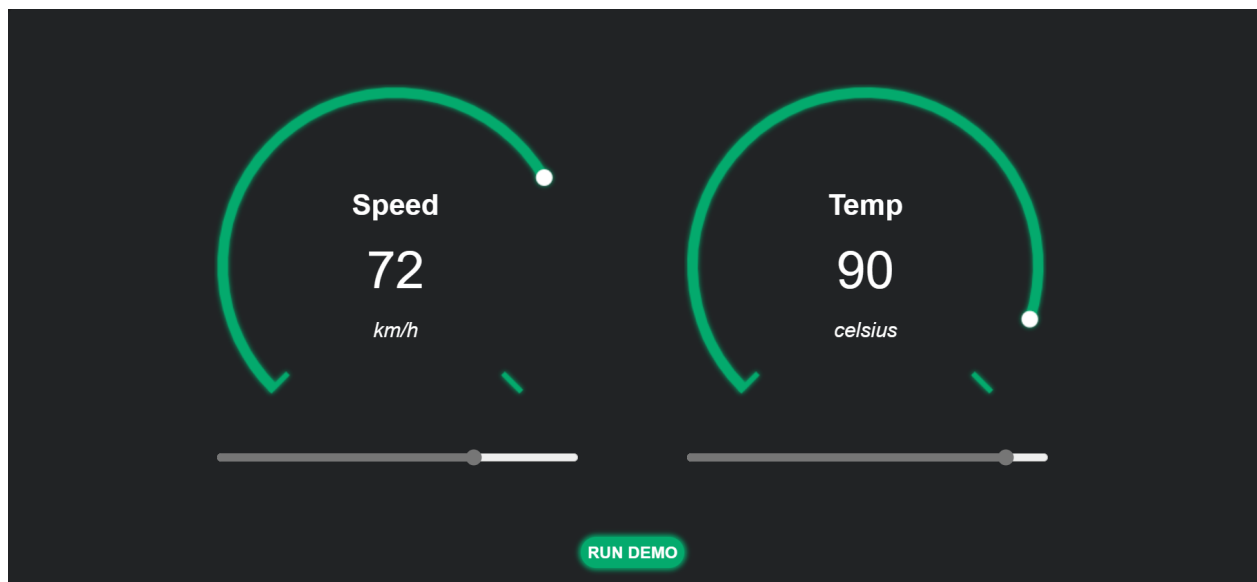


Value:

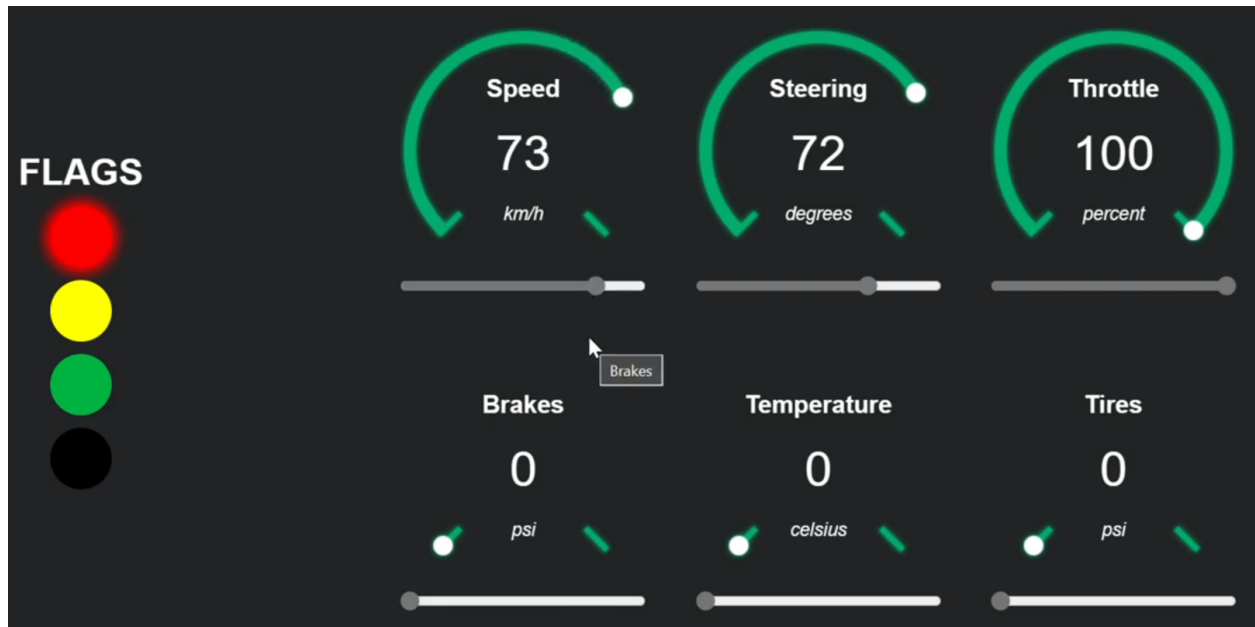
ON/OFF Toggle



- II. Create speedometers for vehicle health information. (Completed WC)



III. Create buttons for flags being waved by flag marshals. (Completed WC)



Challenges

- I. Development for the backend will be somewhat difficult considering the vehicle is in Hawaii and we must coordinate with Dr. Passon to find out a way to work with the car.
 - A. One of the workarounds for this challenge is to test our application by receiving data from another go-kart from Triton AI which will send data to our app via transmission control protocol (TCP/IP).
 - B. If for some reason that is not feasible, we will create a server which transmits false data just to test whether our application functions correctly.
- II. Another challenge will be to find out what sort of tools the HMI will contain because to develop the front end and portions of the backend without understanding how to connect certain features of the car without the data.

- A. Through conversation with Dr. Silberman we will ask for guidance on the development of the app and raise concerns regarding certain tools built into the application.

Feedback Integration

I. Communication Structure

- A. After reviewing the feedback from our project overview, we decided that if we cannot reach a consensus on any matter, we will consult with Dr. Silberman to split the tie.
- B. Another potential method of solving a tie is using a decision matrix to weigh the pros and cons of a feature to see which is the better path to take considering things like time.

II. Schedule Management

- A. In the event that we fall behind schedule we will fall back on our MVP as the final product because since there is only a few more weeks left it may not be possible to implement our full idea of the design.

With the remaining time left in the quarter, we are confident we will be able to complete the MVP and lay the foundation for further development of the HMI. Despite some initial setbacks, the project now has a clear schedule (outlined earlier) which will allow the MVP to be finished in a timely manner and eventually serve as a useful tool for Triton AI and the IAC team to control and monitor their autonomous vehicles easily and efficiently.