OPERATOR PRESENCE SOLUTION

HIGH-TECH HORTICULTURISTS

Trimble POWERED ™

ECEE Department CU Boulder Team Members:
Olivia Filkoski, Natalie Hellman, Davis Landry, Calvin Mooz, and Arash Yousefzadeh

BACKGROUND

The advent of Trimble's automated steering systems in agricultural vehicles has increased the efficiency and accuracy of these implements.

However, this technology has freed driver's attention during normal operation. Drivers can leave the cab and wander outside the vehicle cab while it is in motion.

While there is a seat switch present, it is easily bypassed. The High-Tech Horticulturists have been tasked with creating a monitoring system to ensure the operator is truly present in the seat.

Figure 1: A Typical Tractor Operator

DESIGN OBJECTIVES

The Operator Presence Solution (OPS) was designed to meet the following benchmarks:

- The OPS will be able to detect an Operator is not present within at least 8 seconds
- Status messages of should be sent at a minimum of 1 Hertz
- The OPS will be able to work in a variety of environmental conditions
- The OPS will be integrated into Trimble's Vehicle Systems and a standard agricultural vehicle
- The OPS will be able to self-diagnose tampering from the user and report such events
- The final Bill of Materials of the OPS will be at most $50

HARDWARE DESIGN

For the hardware we have created our own microcontroller to be able to run the machine learning and pressure sensor systems while communicating with the Trimble GFX-750. To do this we used a ESP-32 WROOM module and connected it to a camera and pressure sensor. The camera is connected by a ribbon cable and it mounted on the top corner of the board. The pressure sensor is embedded under the right arm rest of the operators chair. The ESP-32 WROOM module was ideal because it can run TensorFlow which gives us the ability to upgrade the system to communicate wirelessly as it supports both bluetooth and wifi. Additionally, in order to communicate over USB we added a FTDI CP2102 chip. This chip is ideal as it gets the job done without needing extra components which kept the project under $50 final BOM costs. On the board we also included a PSRAM chip and the possibility of additional flash. This allows the system the possibility of additional memory so the microcontroller can run larger control and reporting programs in the future.

MACHINE LEARNING

The OPS uses machine learning to analyze the images passed in through the camera. Tensorflow-Lite for Microcontrollers is an open source machine learning platform which is supported on embedded devices.

A Human-Detection model was chosen for this product. The model inputs an image file and outputs whether or not it believes that someone is sitting in the chair. This decision is more complex and harder to tamper with than a traditional hardware solution.

TensorFlow

PCB

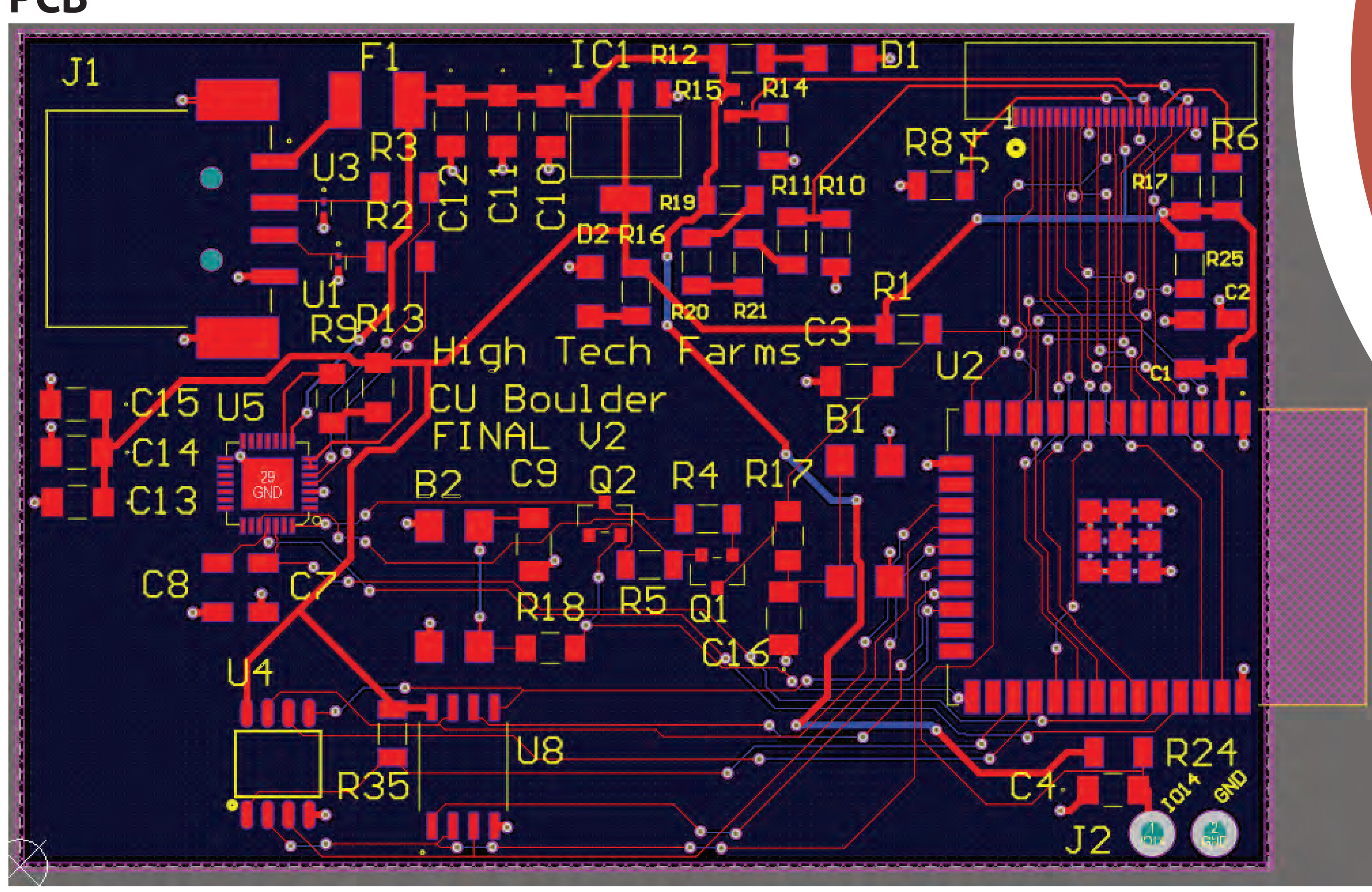

Figure 2: The Custom Hardware Layout

Figure 3: View of Operator from Camera

From Left to Right: Calvin Mooz, Olivia Filkoski, Davis Landry, Natalie Hellman, Arash Yousefzadeh

SOFTWARE DESIGN

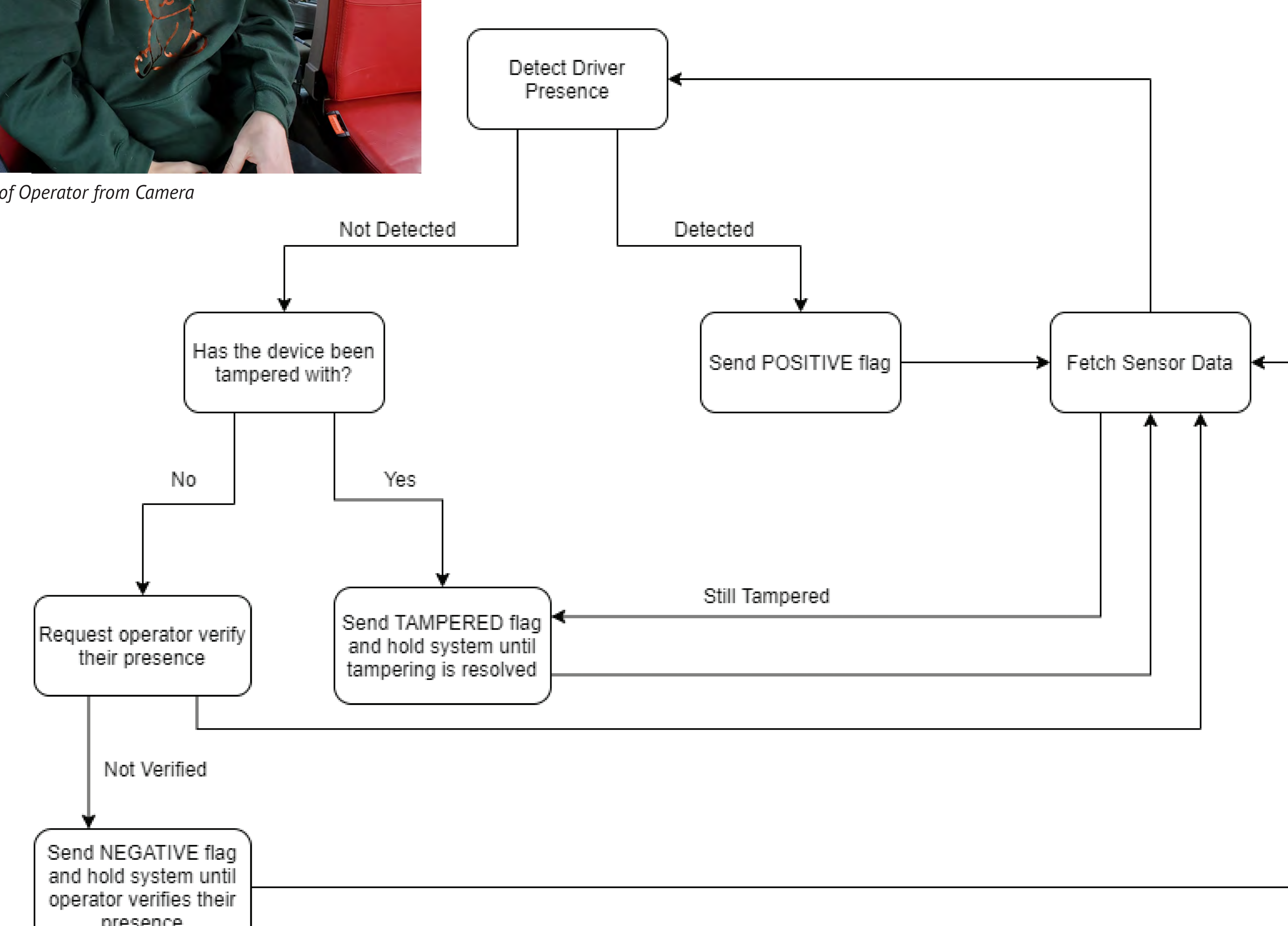

Figure 4: A Typical Tractor Operator

ACKNOWLEDGEMENTS

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