Remote Control Tractors

Team 2

Stage 4 - Prototype

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Client: David Hedley and Shelby Spivey, Caterpillar.

Tools

We have used the 'Justinmind' Prototyping tool to build the prototype. The main part of our prototype is a Mobile App. To better demonstrate our prototype, we also made a walkthrough video using QuickTime Player and iMovie.

Roles

We discussed use cases/scenarios together and allocated the prototyping work based on those scenarios. Different possible use cases were put forward by each of us. Then, we finalized the key scenarios to make prototypes and selected 'Justinmind' as our prototyping tool. Finally, after we finished our part of prototyping, all the parts were put together to create the final prototype. The detailed division of work is as follows:

- Shreya Tangri worked on the prototype of the remote controller and included all the functions of the remote controller.
- Hongyi worked on the prototype of the phone app and then integrated all the different sections.
- Yudong worked on the prototype of the tutoring system. The tutoring system was designed for the scenario in which an inexperienced user wants to use our control system to operate tractors.
- Rithish worked on the prototype of the physical warning button system functionality.
- Srinivas Nethra worked on the power on-off indicator light system on the remote control.
- Ge worked on 1) the prototype of object detection and warning system; 2) demo video design, record, edit, and upload; demo project export and share; 3) prototype test.

Prototype

Summary:

Our prototype is available on the below link of Google Drive:
https://drive.google.com/drive/folders/1YH6i6M0w81lpK-L56ujP9U664FVBVM65?usp=sharing.

To interact with the prototype, you need to download the whole folder and then open the index.html. For convenience, we made a demo video to present how we interact with the prototype on the below link of the youtube:
https://youtu.be/6sFXXeZlncw

The prototype shows how we intended to achieve all the three features selected in the last stage i.e. Embed a phone app with the physical controller, tutoring system for the inexperienced users and a sensor to detect objects and give feedback, as a whole with the functions such as operating the tractor and using the tutoring system, cameras, and sensors.

Prototype Scenarios:

Scenario 1: A driver wants to remotely operate the tractor

In this scenario, a driver can easily operate the tractor by using a controller remotely. There are different functions such as the power button to switch on/off the tractor. If the tractor is on, the green button shows up along with the lights on and vice versa. The operator can lift or lower the bucket as well as move the tractor in all the directions. The above image shows the tractor moves in the forward direction due to an arrow. The interesting thing is it has a phone app embedded with it and with the help of the app, the operator can learn how to operate the tractor, can see where the tractor is because the phone app also has a camera as well as a sensor feature.

Scenario 2: Inexperienced user wants to operate skid-steer loader and needs help

The demo is available in the link we provided in the summary.

Screenshot:

In this scenario, we designed a tutoring system for new users of our remote control system. In the tutoring system, a tutorial about the usage of remote controllers and mobile apps is given inside the mobile app. With the tutoring system, new users can learn about the basic operations with carefully-designed visual guidance. Users can tap text bubbles on the screen to get more information.

Scenario 3: User pushes the physical warning button as the vehicle is in a dangerous situation

When the user operating the vehicle notices that the vehicle in operation met with an accident or is in a dangerous situation, he/she can push the red "**W**" button on the controller. Once the button is pushed, all the emergency services and responsible authorities will be contacted immediately.

Scenario 4: The tractor detects an alive object in surroundings during work

Scenario presentation:

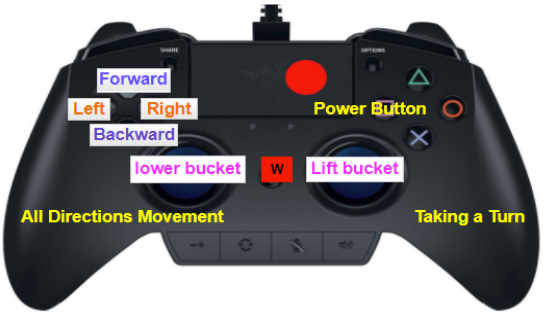
Prototype screenshot:

In this scenario, the sensors on a tractor detected that there is an alive object (squirrel) in the surroundings. The tractor gets locked immediately by stopping working and a warning message is popped up on the app's screen as shown above in the screenshot figure. To be more clear, the warning message mainly contains three parts: 1) Object Information, including object height and

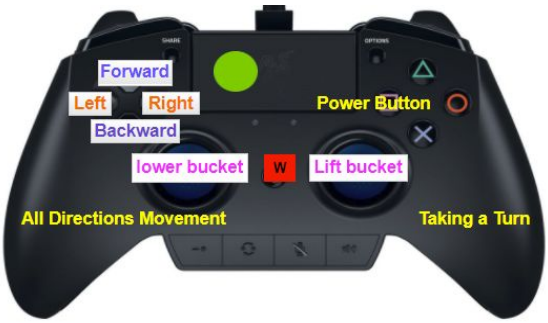
width; 2) Warning Sign, which is used for attracting user's attention; 3) An unlock button, which is used for unlocking the tractor to control the tractor for the next steps to be performed after the user check the surroundings and clear the way. When the unlock button is pressed, the tractor is unlocked and hence returns to the main interface of the app.

Scenario 5: User can identify if the vehicle is turned ON/OFF with the help of indicators

Red indicator - Ignition Off



Green Indicator - Ignition On



The remote control is integrated with LED light indicators that indicate when the vehicle is turned on/off. Since there is a possibility for the vehicle to work far from the user, it is crucial for the user to read if the vehicle is in the ignition or not. The remote controller has two indicator lights at the top - RED and GREEN. When the ignition is ON, the green indicator lights up and when the ignition is turned off, the red indicator lights up. These lights are linked with the power button on the controller, the respective light turns on/off as feedback to the user.

Trial

We developed our prototype using 'Justinmind', which is a prototyping tool for web and phone apps. We tested our prototype by exporting it to an HTML file and interacting with the mimic user interface. During this procedure, we encountered some problems from both the technical and the user experience sides:

1) **Technical problem:** When we added object detection function into the prototype and tested it, we noticed that the warning message was not triggered on the mimic interface

though we designed it in a way that if a detector on tractors noticed an obvious object, it would send an alarm. But, it was hard to design the real scenario using virtual tools for prototyping. Therefore, to present our work, we designed the warning message to be shown up when the “sensors” button was pressed and the users can interact with the message to get back to the main interface. Thus, the functional consistency of the prototype can be kept.

2) **User experience problem**: To begin with, we designed the moving (forward, backward) and turning (left, right) buttons on joysticks to be the two separate parts i.e. having two moving buttons on the left side while the two turning buttons on the right side. However, when three of our team members tested the prototype, we noticed this was not intuitive for the users to put the four buttons separately. Thus, we improved our prototype by aggregating the moving and turning buttons together on the same side of the joysticks.
