#transparentbuckets

CSC 591, Spring 2019

Stage 1 - Research

Team

#	Name	UnityId
1	Arjun Madhusudan	amadhus2
2	Pooja Patel	pkpatel5
3	Prachi Gupta	pgupta24
4	Rahul Sethi	rsethi3
5	Zachariah Mathews	zmathew
6	Zelin Sun	zsun12

Client

David Hedley, Caterpillar UX

Long Term Goals

Caterpillar is one of the market leaders in the production of construction vehicles. They have given us an opportunity to work on a very unique project. The main focus of our project is to increase visibility for the construction vehicle operators so as to improve the productivity and safety of their co-workers and the environment. We want to increase the amount of payload dug per day by a novice worker as well. The project will have a primary focus on user experience.

Challenges

Robustness

Digital solutions are generally delicate. Evolving the finest of technologies to withstand adverse conditions has taken decades of meddling with them and to some extent still remains a challenge that probably cannot be overcome in a short span of time.

Since these vehicles are meant to be operated mainly on construction sites, that are usually characterized by rough terrain and adverse weather conditions, they need to be robust enough to withstand such circumstances.

Questionable accuracy
Along with robustness we also. might face the issue of judging the accuracy of sensor devices. The operating environment is susceptible to adverse conditions, and there is a possibility that these devices can be damaged if installed on the outer sides of the vehicles. In such situations, it can be difficult to comprehend whether the sensing devices are intercepting accurate information.

Generalizing the solution
Coming to a general solution that can be applied across all types of machines is important to enable users to efficiently switch from a machine to another. This aspect of design plays a crucial role in increasing the productivity for clients that employ various kinds of machines.

Complicated Perspective
Achieving an almost transparent solution would require the processing of multiple images from different cameras/devices capturing various angles which can then be aligned to achieve the desired perspective. This can prove to be a difficult task to achieve.

Mode of Communication with the actor
Devising an optimal means of communication with the operator is crucial to ensure good usability of the system. The way these details are provided to the operator will play a huge role in how helpful this feature can be.

Usability Consistency
While designing the dashboard, one of the important things to keep in mind is interactions that take place between human cognition and the screen. Making things easier for users means not forcing them to learn new representations or toolsets for each task. Reducing the length of the thinking process by eliminating confusion is also a sure bet.

Lighting conditions
The solution we provide should work in darker sites or dusty environments.

Interfering with existing practices

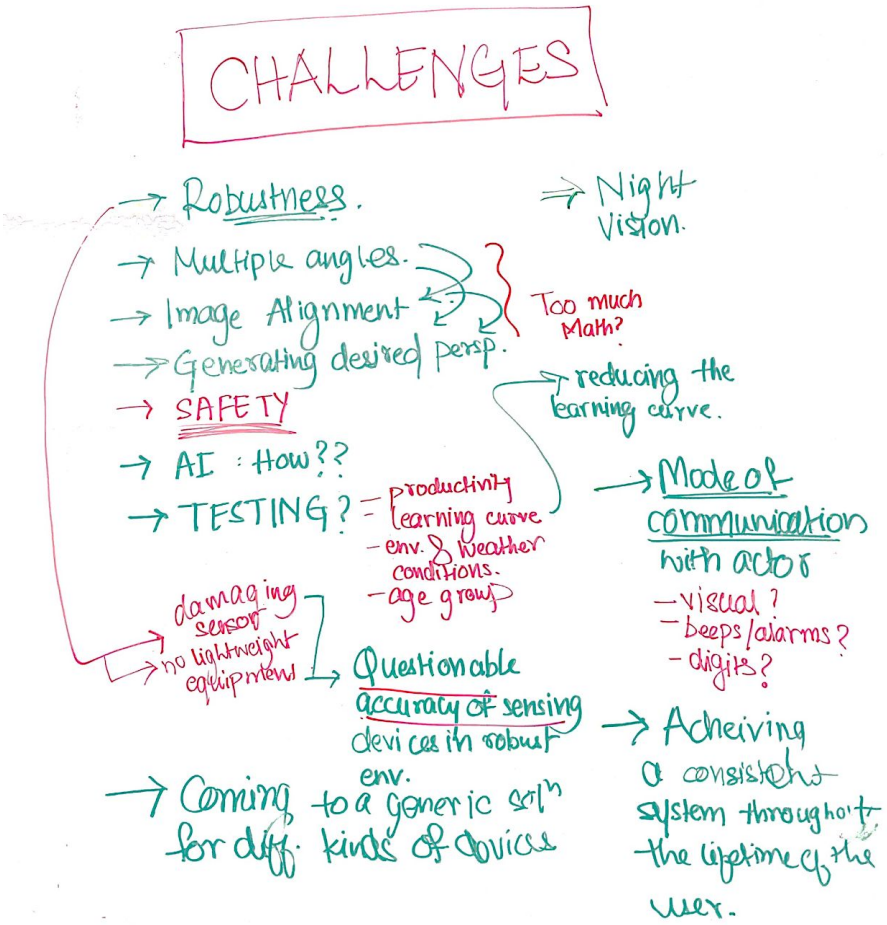
In order to reach our goal, we might have to incorporate complex implementations. Even though the purpose is to help make things easier, there is a high chance of altering and modifying the current setup. The solution should not in any manner change the method of performing the task itself, but rather only augment that method and make it better to use.

Testing

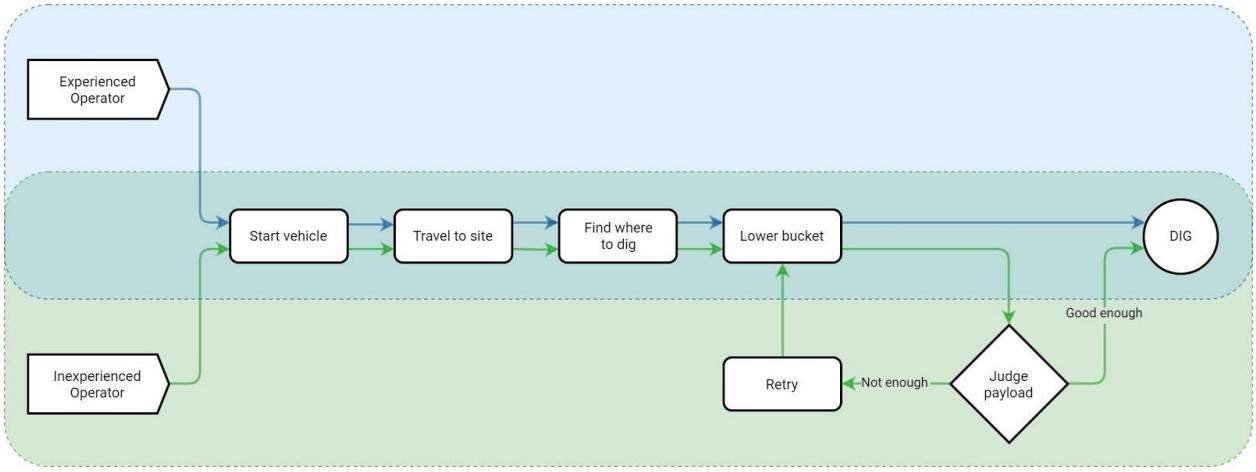
Vehicle-level testing won't be enough to ensure safety. It has long been known that it is infeasible to test systems thoroughly enough to ensure ultra-dependable system operation.

Overlaying the field of view and operation

A field of view that overlays the field of operation can enhance user focus towards the task at hand and thus increase productivity for the clients. Such a solution, however, would require something on the lines of real-time display on the windshield itself and can hence be difficult to achieve.



Experience Map



Expert Notes

Mr. David Hedley, Caterpillar's representative and the mentor for this project, explained to us the current scenario and the problems they're trying to solve. After a detailed and enjoyable discussion with him, along with Dr. Watson, we document the most important points made through the meeting.

What the current issue is:

- With all the vehicles being constructed in specific ways, the visibility from the cabs is very restrictive when it comes to the bucket and its contents.
- This leads to the operator have to approximate his work, and it takes a long while to get accustomed to using it skillfully.
- Having less vision also leads to safety issues, where the operator might not be able to see any obstacle near and around the bucket, which may lead to damaging the vehicle itself, or the other object. (the object could even be a person, which could be fatal)
- Also, since the approximation is required, new operators who are yet inexperienced, are very inefficient in operating and lose out on a lot of payload per trip.

Challenges:

- Creating a viable method that lets the operator gain the information about the bucket in any manner, examples of which might be an AR display on the screen or a separate display dash.

- It is highly inconvenient to look at the display situation somewhere else to the side and control the arms and buckets in front of you. There should be a way to let the user have vision over both the information display and the actual site itself.

Previous attempts:

- There have been attempts to add a camera over the bucket giving you vision over the site, but this camera is a very difficult component to protect amidst the construction sites.

Suggestions by the expert:

- There could be some sort of display available to the user providing him vital information while not having to look alternatively at two different locations.
- Since these vehicles move around in a controlled and monitored environment, adding sensing devices in the environment rather than the vehicle itself is a very valid solution if we can take it in that direction.

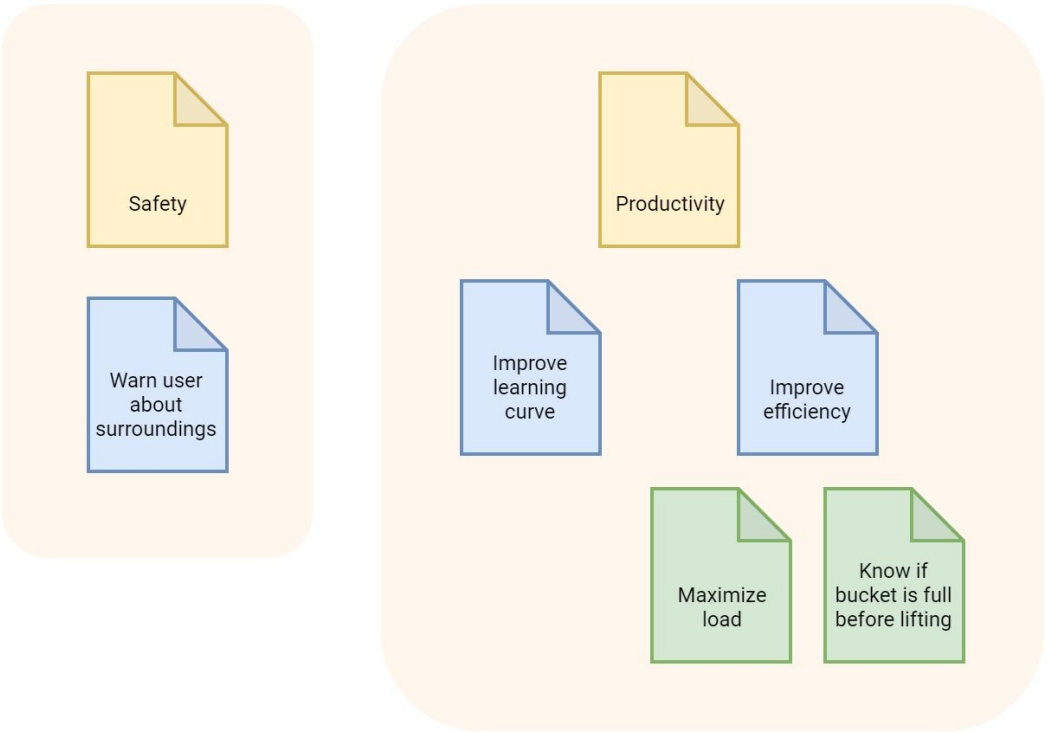
Problems/Opportunities

Safety:

- How might we warn operators when people, animals, and other machines are approaching the bucket during construction?

Productivity:

- Learning curve:
    - How might we improve learning curves for inexperienced operators?
- Efficiency:
    - As per the conversation with Mr. David, the load capacity of a bucket is often wasted by 20 percent or more. How might we maximize the use of the load capacity of the bucket?
    - How might the operator know whether the bucket reached its capacity before lifting the bucket?



Target

Our team will try to focus on solving the productivity issues that arise when new operators are on-site. Matching their skill levels to those of the experienced ones through the help of an augmentation system will help increase efficiency, reduce the cost and time required to complete a particular task, and even increase their morale.