Executive Summary

Apple Vision

ECE 44x

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1 Executive Summary

In the 21st century the industry of agriculture faces a wide range of challenges, ranging from shortages of both supplies and labor, to wildly varying climate conditions [1]. To address these challenges and develop more robust and crisis-resistant infrastructure, a broad research effort is underway to apply modern technologies such as internet-enabled devices, artificial intelligence and robotics to this critical industry. Apple Vision is a research and development effort within an ongoing research initiative at Oregon State University to determine the effectiveness of robotics in the harvesting of high-value crops, particularly apples.

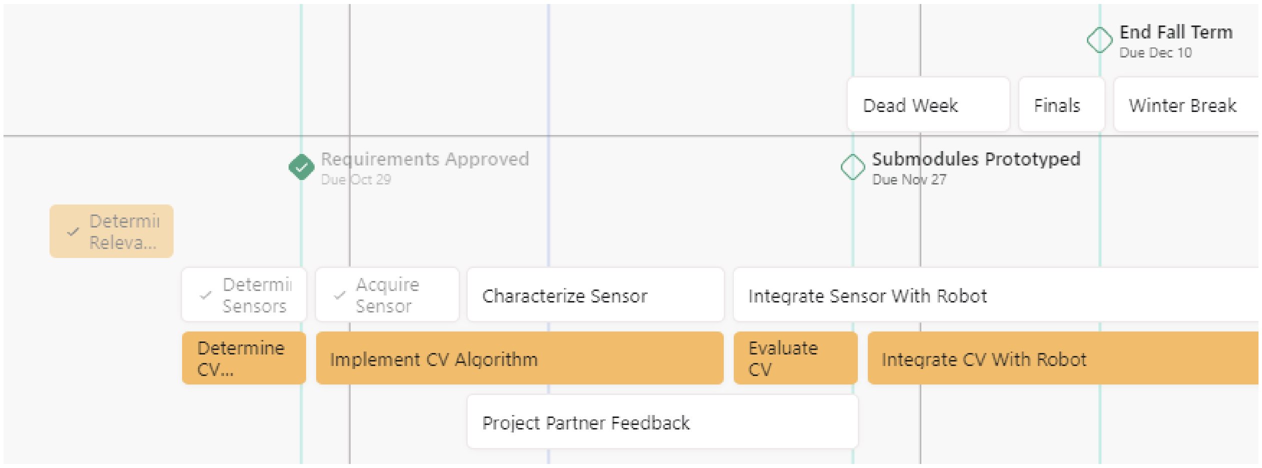
Previously, an Oregon State University (OSU) research team has successfully developed novel methods of controlling a conventional robotic hand to grasp apples, and pick them from a branch [2]. This work differs from previous robot gripping research, as it requires a certain degree of precision to avoid damaging the fruit, as well as precise positioning, to ensure that the apple breaks from the stem in a certain way to maximize shelf life. This research is related to Apple Vision because eventually this capstone project will serve as the main detection and control system for an apple picking approach.

We approached this challenge by splitting up challenge into separate tasks for each person, then integrating our individual contributions into one deliverable. As a team, Apple Vision began by developing a system which could identify an apple within view of a camera mounted to the robot. This was accomplished through a combination of both computer vision, and lidar distance sensing. The computer vision was built using a dataset of 77 images taken the summer before A custom 3D printed UR5e robot arm attachment was also developed to securely integrate our sensing hardware. After the system could confidently detect an apple relative to its position, a control system was implemented in ROS to guide the robot arm to the apple using both the camera and the lidar sensors, ending up within range and in proper position for a possible grasp gesture.

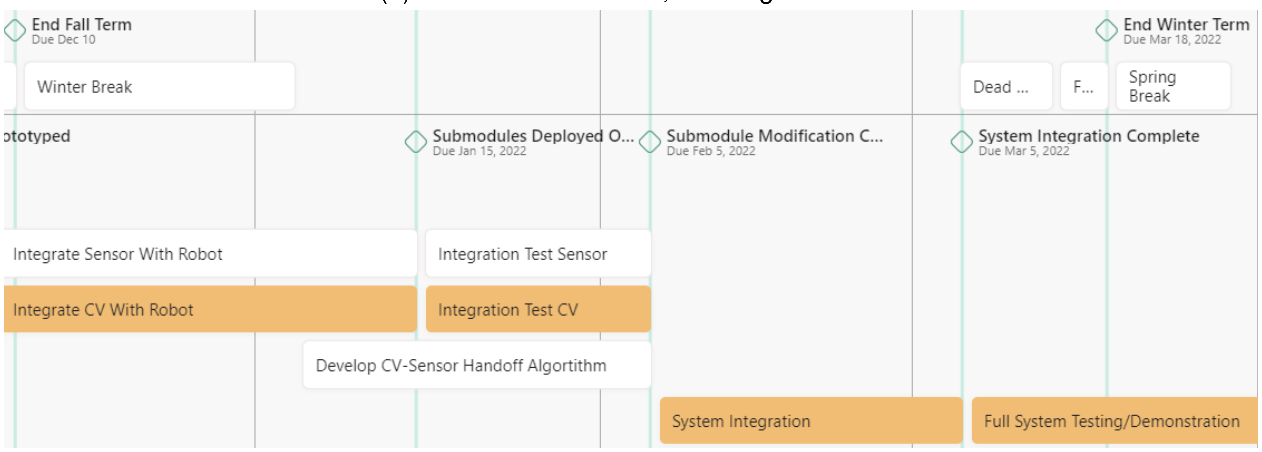
Over the course of this project, there were many lessons learned. First and perhaps most important among those was time management. With a 30-week project, making regular progress as well as setting internal team goals and deadlines was key to the success of Apple Vision. Next, project partner communication was an area where we improved immensely, as we had to coordinate for lab access weekly. Finally, saving our work regularly became critically important and part of our success. Working in the same environment as a major university research group is challenging, and when there were many build and run fails, we were grateful we had archived our progress well enough to retrace our steps and get our work running again.

2 Timeline

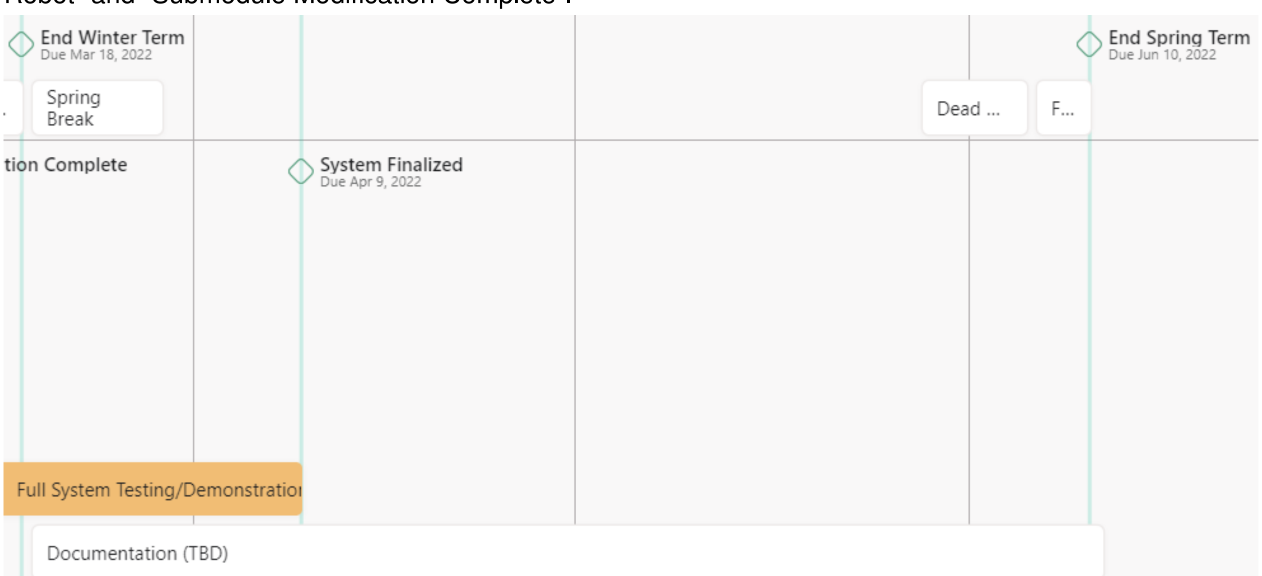
Our timeline was created in Asana and is shown in figure 1.



(a) Part 1 of the timeline, showing fall term.



(b) Part 2 of the timeline, showing winter term. The obscured milestones read "Submodules Deployed on Robot" and "Submodule Modification Complete".



(c) Part 3 of the timeline, showing spring term.

Figure 1: The complete project timeline in Asana broken into three parts (fall, winter, spring). School-related events are shown in the top division of the timeline and planned project tasks are shown in the bottom. The green diamonds indicate milestones, blocks of any color are tasks, and blocks highlighted in orange indicate the critical path.

3 References

[1] C. W. Bac, E. J. van Henten, J. Hemming, and Y. Edan, “Harvesting robots for high-value crops: State-of-the-art review and challenges ahead,” eng, *Journal of field robotics*, vol. 31, no. 6, pp. 888–911, 2014, ISSN: 1556-4959.

[2] G. Scott, P. Bloch, P. Soni, *et al.*, “Improving grasp classification through spatial metrics available from sensors,” eng, in *The Institute of Electrical and Electronics Engineers, Inc. (IEEE) Conference Proceedings*, Piscataway: The Institute of Electrical and Electronics Engineers, Inc. (IEEE), 2021.