OMNIDIRECTIONAL VISION SYSTEM FOR CONTINUOS OBJECT TRACKING

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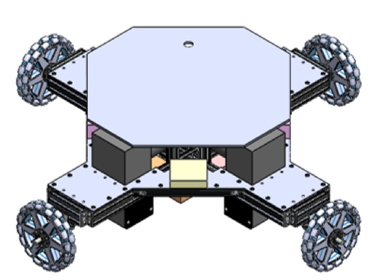
Abstract

Fast and accurate object detection from live video streams is an important requirement for robots that can seamlessly sense the surrounding environment.
This capability allows robots to monitor the environment and perform early object detection and anticipation (such as object trajectories). Indoor environments (spaces where humans work closely with robots) are complicated, and this capability will help improve indoor tracking and localization performance.

Project Marketing



Key characteristics for Omni robot:
- See a 360-degree perspective
- Run smoothly
- Swift movements
- Obstruction avoidance
- Ultrafast tracking of object trajectories in 3D space

Potential projects/use cases:
- Sport game playing robot
- Factory service robot

Figure 1: Project Marketing for Omnidirectional Robot

Introduction

1) We face significant challenges in selecting the cameras that will cover the robot's 360° degree field of vision (FOV) and be able to track very tiny objects moving fast. We have two potential cameras: The *Dreamvu's PAL USB 360°* and the *ZED 2i* with a 2.1 mm lens.
2) Building a robot control system that can properly and swiftly collect data from the sensor is another challenging task.
3) Another difficulty is creating a system foundation so that the next team may concentrate on building the project rather than acquiring it from scratch.

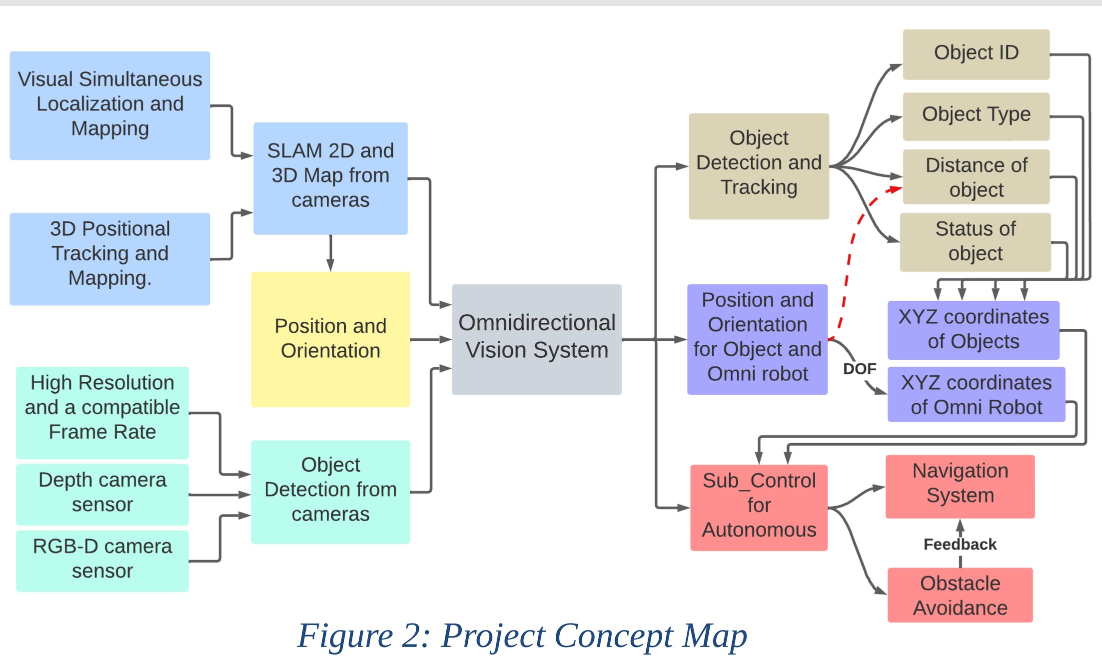


Figure 2: Project Concept Map

Materials

We utilize Turltebot2 for the application's sub-control system while another research mechanical team is still working on the omnidirectional robot platform.
One crucial aspect of image processing is the architecture of the computer hardware. We separated the system into two components in order to optimize the operating system and utilize the lab's current infrastructure:
Master Operation Omnibot: Main Computer Jetson AGX Xavier, PAL 360° camera, Kinect camera, Turltebot 2, Power Bank supply, and other interfaces (keyboard, monitor, etc....)
Slave Operation Tracking Object: Slave Computer Jetson TX2, ZED 2i 2.1mm lens camera and other interfaces (keyboard, monitor, etc....).
Through our setup of the ROS multiple machines and Nomachine application, two computers can communicate with one another.

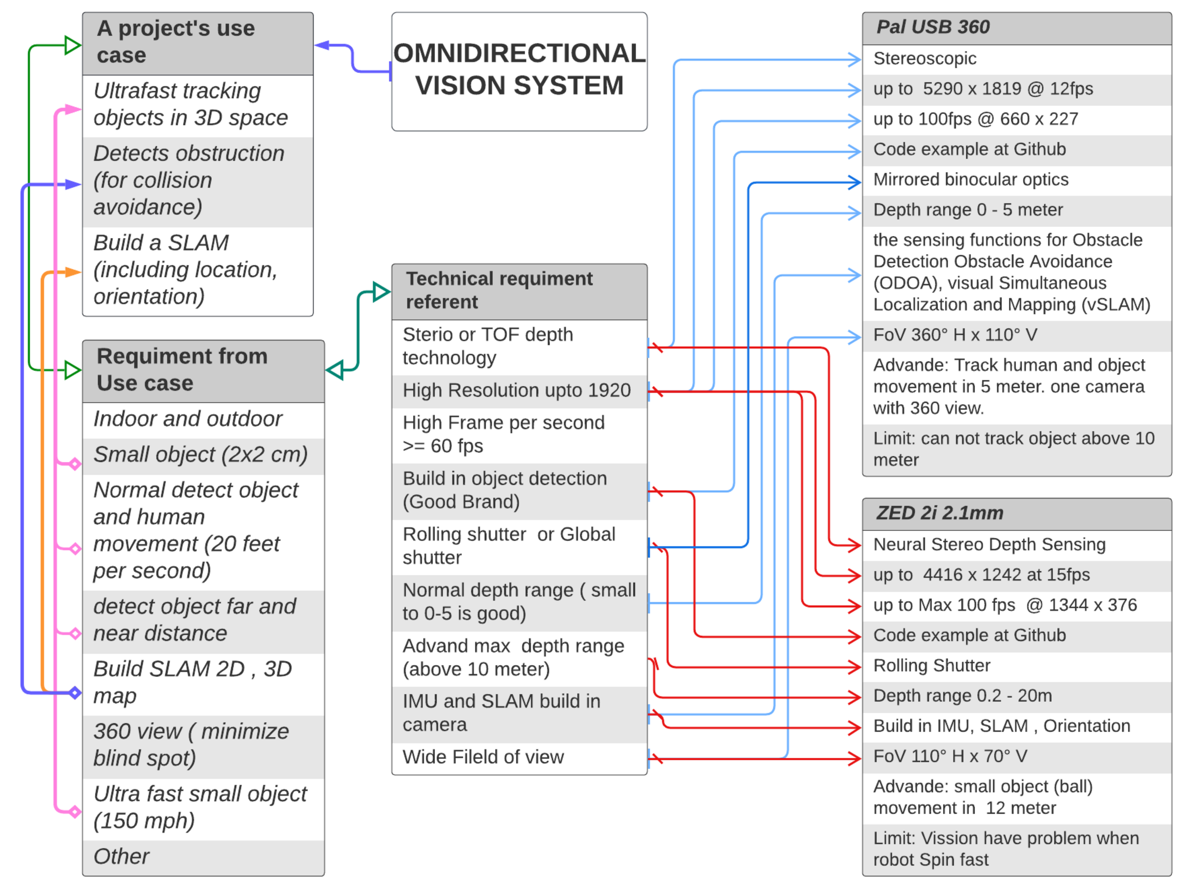


Figure 3: Flowchart diagram Technical Requirements for Depth Sensor camera

Methodology

We will use a separate purpose for each camera to prevent errors caused by synchronizing multiple brands of cameras.
PAL 360° the camera always focuses on detecting the big object or humans and the wall whenever they come closer to the robot and the robot needs to make avoidance.

Figure 4: Object Detection by using PAL 360° camera

ZED 2i is used for tracking ultrafast small objects. The ZED camera might not be able to capture all the movement the ball travels. However, with the application of Machine Learning, we can compute and predict where the ball will arrive by identifying the ball's journey.
In this potential, our team conducts research and learns how to enhance the present accomplishments as well as, if practical, create new ones.

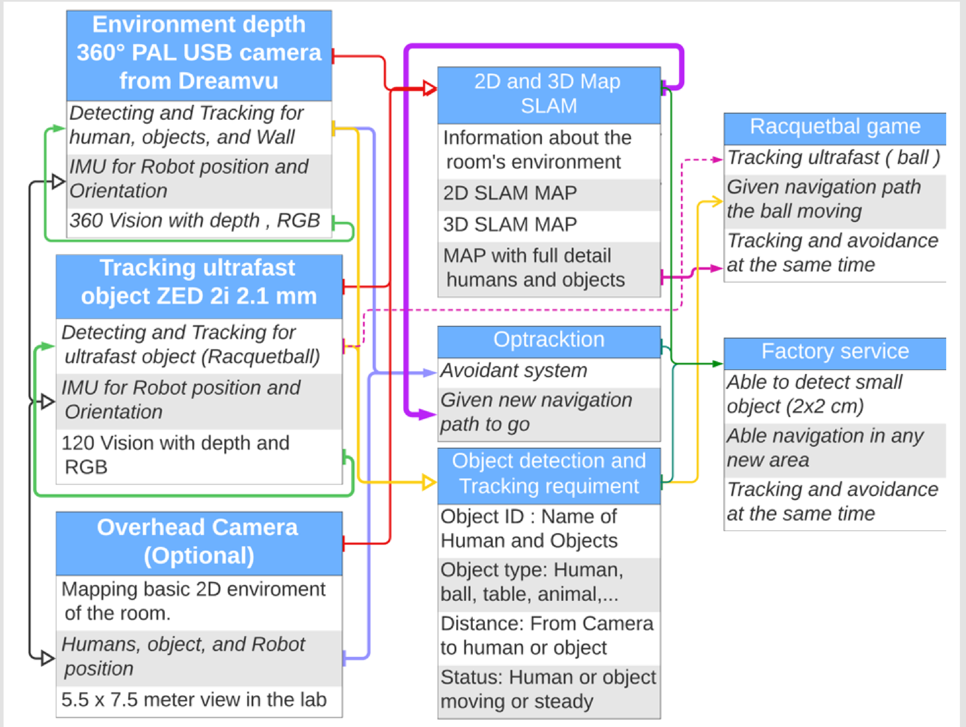


Figure 5: Flowchart of information from Two main Operation System

For performance testing and system training, we choose the *racquetball sport*. If the robot can perform well in this game, it can likely handle many other applications.
Robot Operating System (ROS) Multiple Machines application: Intercommunication between processors operating on several computers is necessary for our Omnibot systems.

Results

The goal of this project was to build a perception module for an Omnidirectional robot utilizing two cameras: a ***Zed 2i*** and a ***PAL USB 360°***. Because the main movement base has not yet been completed, we have temporarily replaced the ***TurtleBot2***.
Finally, we were able to complete this project. The main challenge was installing the software and connecting the two different computer vision systems for the sub-control Omnibot.

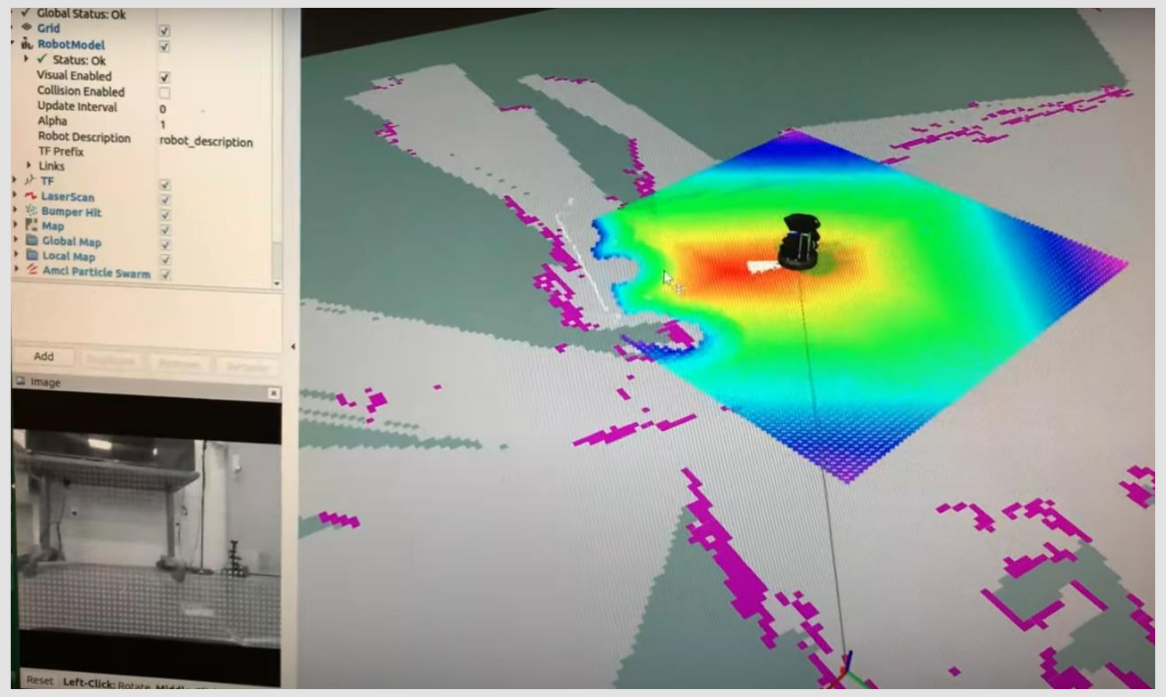


Figure 6: Navigation with Turtlebot2 with Kinect camera only

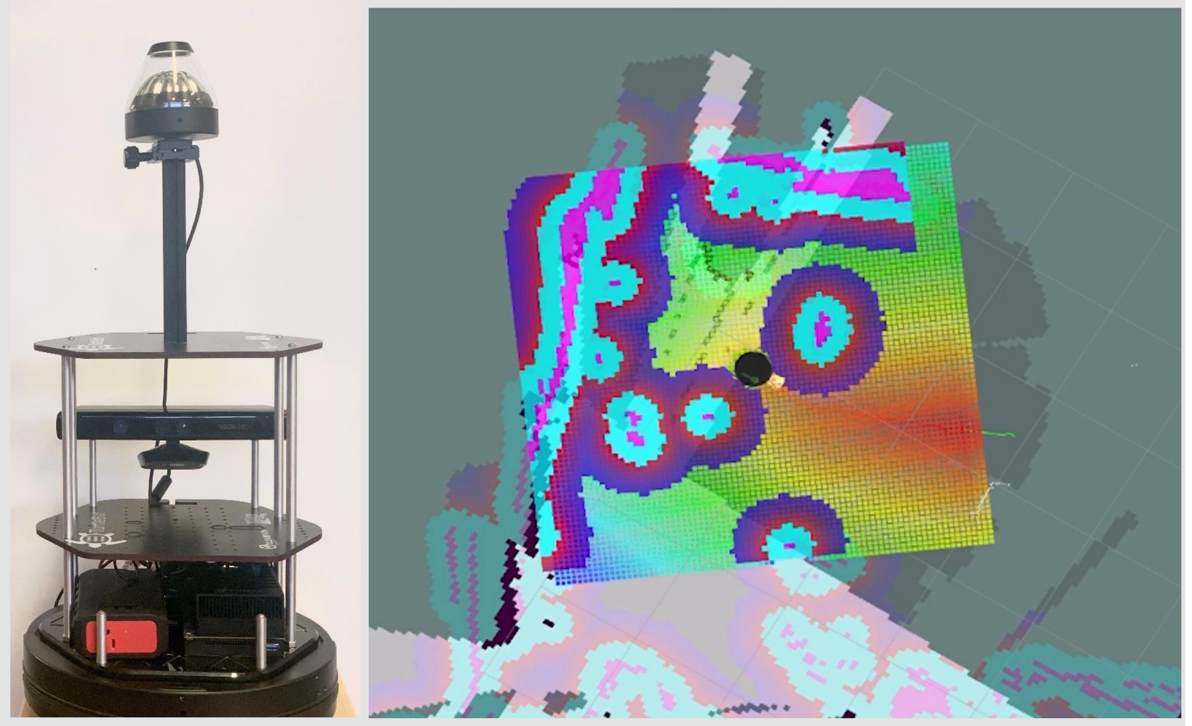


Figure 7: Autonomous system with PAL 360° camera and Kinect camera

The Slave Operation Tracking Object (***ZED 2i***) sends all information on object detection into the primary Master Operation Omnibot in order to assist Sub control system Navigation for ***TurtleBot 2*** while performing Object avoidance.

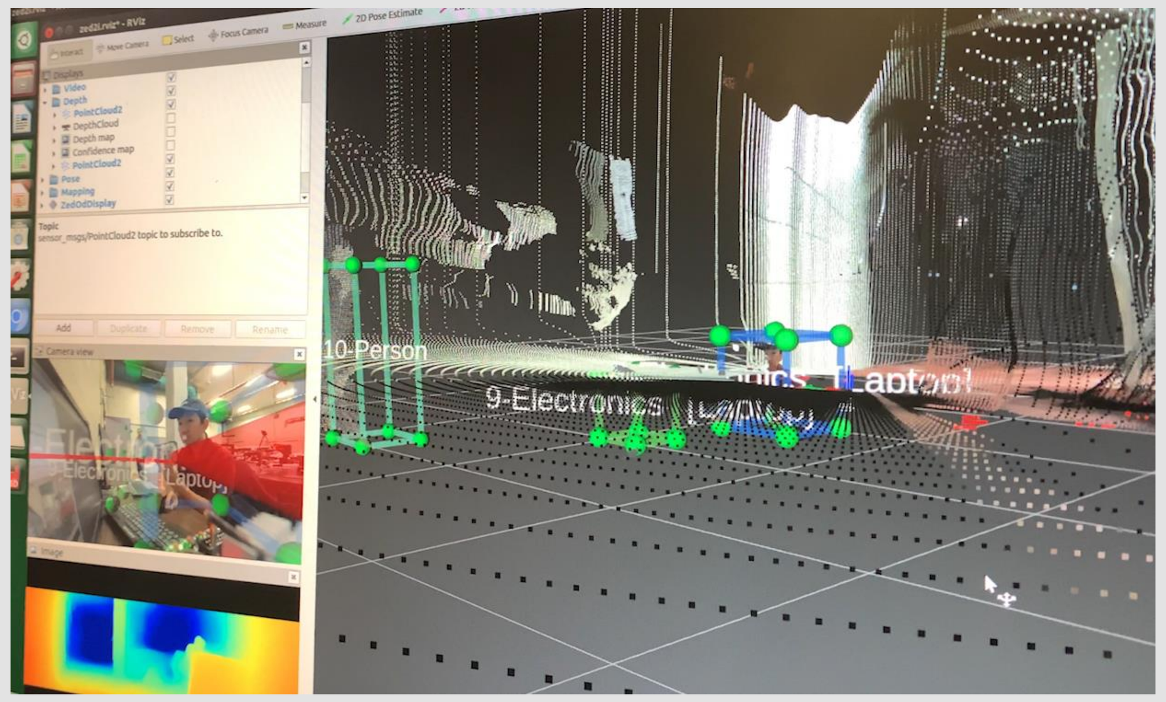


Figure 8: ROS multiple machine send info of ZED 2i Object detection

Depthpmap (heat color) and Pointcloud are the *PAL 360°* camera's depth measurements.
Information from the ***ZED 2i*** camera's object detection process includes RGB-D and bounding boxes.

Conclusion

Since this project is still in the design phase, documentation is one of the crucial components. We make every effort to complete test experiment documentation, install the program, and interact with the system. Technology changes annually, so it's possible that in five years our system will be unusable. However, we've left the concept of selecting the appropriate sensor and depth camera as well as the notion of how the system was developed in our documentation. One of our primary goals with this next team is to figure out how to get the correct system fitted with a new design for greater performance.

Recommendations

This project has many opportunities to enhance performance with Jetson AGX Orin computer hardware. Apply 5G to new open environments and outdoor work opportunities for Ros Rviz without limitation on an Internet connection.
Other suggestions are to include in our document recommendation for the next team to conduct research and recommend that the mentor collaborates with them to discover the most effective approach for resolving the issue and improving the system.

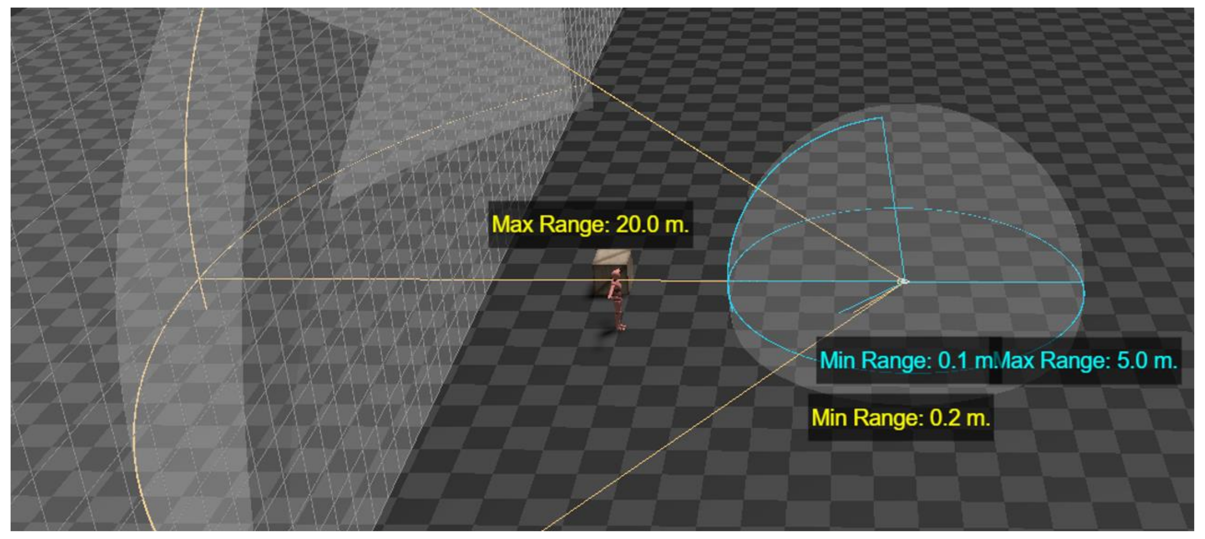


Figure 9: Combine two systems when upgrading to a more powerful machine.

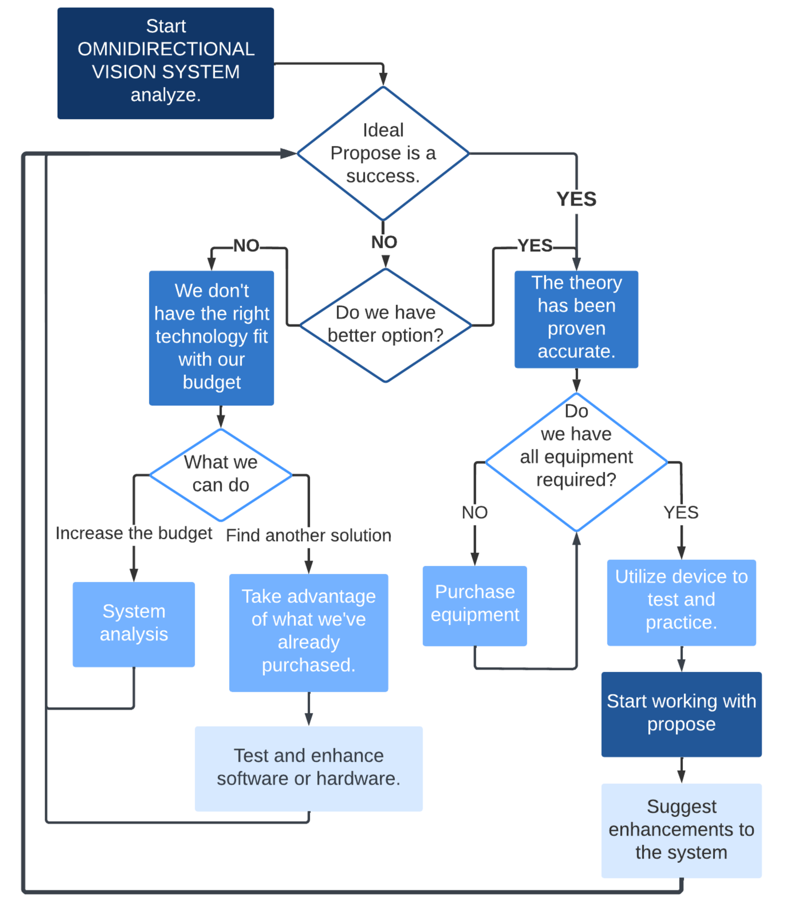


Figure 10: From our documentation, a guide for system development nominations

Acknowledgments

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