# Final Report

# WyldCats

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## Executive Summary

In this project, we aim to construct a computer automated traversal unit (CATU). This unit would travel in a specific setting as it will be either autonomously detecting a specific object that has been chosen by the user or controlled by a web app. In order for the autonomous detecting function to work, this unit has been installed with specific vision sensor capable of detecting the object as well as an ultrasonic sensor capable of relaying information like the distance of the object or facing obstacles. It is also equipped with Wifi card that enabled the unit to be connected to the developed web app over the network.

## Project Description

*This project contains two main components:*

The first is object detection capabilities, where when synced to an object the bot will follow it, in real time, as the synced object moves. In order to implement this portion we used a smart vision sensor (camera) to determine what object the device will follow and then look at how the image changes relative to the synced image to determine how the device should move in order to accurately mimic the object's motion.

The second portion will be controlling the bot with a web app when not synced. This second portion requires a WiFi card, and knowledge of socket programming. As well as an understanding of TCP/IP protocol. An android application is developed with simple buttons that move the bot in the four different directions: Forward, backward, left and right. It is also equipped with sensors in case of hitting an obstacles which warn the user by flashing the LEDs

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## Sensors/Components

- HC-SR04 Ultrasonic Range Finder
- Pixy (CMUcam5) Smart Vision Sensor
- SparkFun Ardumoto Shield Kit
- Digilent Pmod Wifi Shield

## Features and Implementations

- *Strong body for an autonomous mapping robot:* The project is built on a 3D printed chassis that was designed using Solidworks, it accommodate two motored wheels that will be used for moving the bot as well as carrying the pynq board, pixy camera, ultrasonic sensor and the wifi shield.

- *Measuring distance:* The ultrasonic sensor is responsible for measuring the distance of the facing obstacles in case of the reverse movements of the bot. it uses the pulse function to calculate the distance based on the duration of receiving the signal back after sending it through one of the sensor sides.

- *Object Recognition:* The vision sensor (camera) is able to allocate and track any object. It work best with bright colors as it enable the sensor to receive more accurate coordinates. The coordinates are then processed and signals to either motor are issued. This allows the CATU to follow objects set up by the camera by keeping a specific distance which correlate to specific coordinates captured by the vision sensor (camera). When the CATU boots up, the camera may be set to track solid-colored objects like a red ball or a solo cup.

- *Remote controlled bot Option:* An Android application may be used to control the robot. Simple up, down, left, right movements can be sent to a server. The server then relays the information to the CATU through the Microblaze processor on the PYNQ board. Finally, the information is passed along to the ARM processor and CATU will perform the appropriate movement.

## Challenges and Limitations

Originally, the project used a USB wifi dongle to communicate between the PYNQ board and the server. This aspect was functional but utilized our only USB port. Later component additions revealed that the camera was only functional through USB. Hence, we needed a different method for wireless communication. We ordered and attempted implementation of a pmod wifi shield. Several attempts at designing overlays and writing drivers have failed in vein. The server and Android application are written and functional but alas the wifi shield is not working.

Secondly, the camera, as previously mentioned, has an SPI interface which would have been an ideal alternative to USB. However, we were unable to get correct coordinates using this interface. Hence, our switching to the only provided USB on the pynq board.

Our last limitation involves the use of the Arduino shield. While testing the motors using the built-in PWM python function, the shield burnt out and was no longer functional which result in losing all the code. Fortunately, we were able to write the code again right on time. Another shield has been ordered and is being delivered at the time of this writing, which will unable us from deliver/showcase the fully functional bot during the final presentation appointment

## Project Goals/ Individual Contributions

**Justin** - Created a simple Android application to send direction commands to the CATU. Wrote server to assist with the communication between phone and PYNQ using the TCP/IP protocol. Created many non-functional overlays and IOPs using Vivado. Helped with the report.

**Conner** - Created a functional camera that detects objects and returns their coordinates. Wrote the software that acts as the brains of the CATU. Helped with report.

**Mena** - Provided a functional ultrasonic sensor and accompanying C code. Help translating the sensor arduino code to python. Designed and created the final report format as well as help write report.

**Ian** - Designed and 3D printed chassis. Soldered Arduino shields together and wrote software that drives the CATU. Compiled all of the code together to create the final version of our project. Helped with report.

## Conclusion

The project was large and consisted of many components. We managed to get the majority of these components working despite many failures. We learned a lot about FPGAs and more importantly how small components communicate with each other. In this project we utilized different sensors like vision and ultrasonic and the input signal using wifi shield and arduino shield. We have learned about the real interface between all these component (Hardware) and developing the software for it to make them functional together. This experience will prove invaluable for later professions whether it is a senior project or future career innovation.