Brigham Young University

AUVSI Capstone Team (Team 45)

Vision Subsystem Concept Definition

ID	Rev.	Date	Description	Author	Checked By
CD-002	0.1	10-25-2018	Initial release	Tyler Miller	Derek Knowles
CD-002	0.2	11-09-2018	Feedback edits	Tyler Miller	Connor Olsen

1 Introduction

Last year's vision subsystem achieved less than 25% of the possible points related to the subsystem. Vision's key success measure for this year is achieving at least 40% classification with a stretch goal of 80%. Given this measure, it was determined that major improvements must be made in both the manual and autonomous recognition systems.

2 Purpose

The competition gives points for correct classification of ground targets' shape, shape color, alphanumeric, alphanumeric color, alphanumeric orientation, and geolocation. Additional points are given if the process between taking the image and submitting the classified image to the judges' server is fully autonomous without the intervention of a human. There is a penalty, however, if false positive targets are submitted to the judges' server. The purpose of these concepts is to maximize accurate classification performance and thus our key success measure.

3 Concept Selected

Vision's competition requirements are complex and as such required multiple concepts to fit into a larger system. After internal discussion, we decided to pursue a base concept of manual and autonomous classification systems running in parallel.

4 Definition

This year's vision team is changing our system architecture for classifying targets which will allow for better communication and organization. Instead of downloading each image and image state onto someone's personal computer, the computer oboard the plane will send image and vehicle state data to a server on the ground. This server will have a compiled database of all images captured and will attach classification data onto each image as it is manually processed. Our autonomous detection script will also be querying the server image database and classifying images. One team member will be monitoring the autonomous output ready to kill the program if it is sending too many false positives (which cause the team to incur a penalty). Our system architecture is outlined in Figure 1.

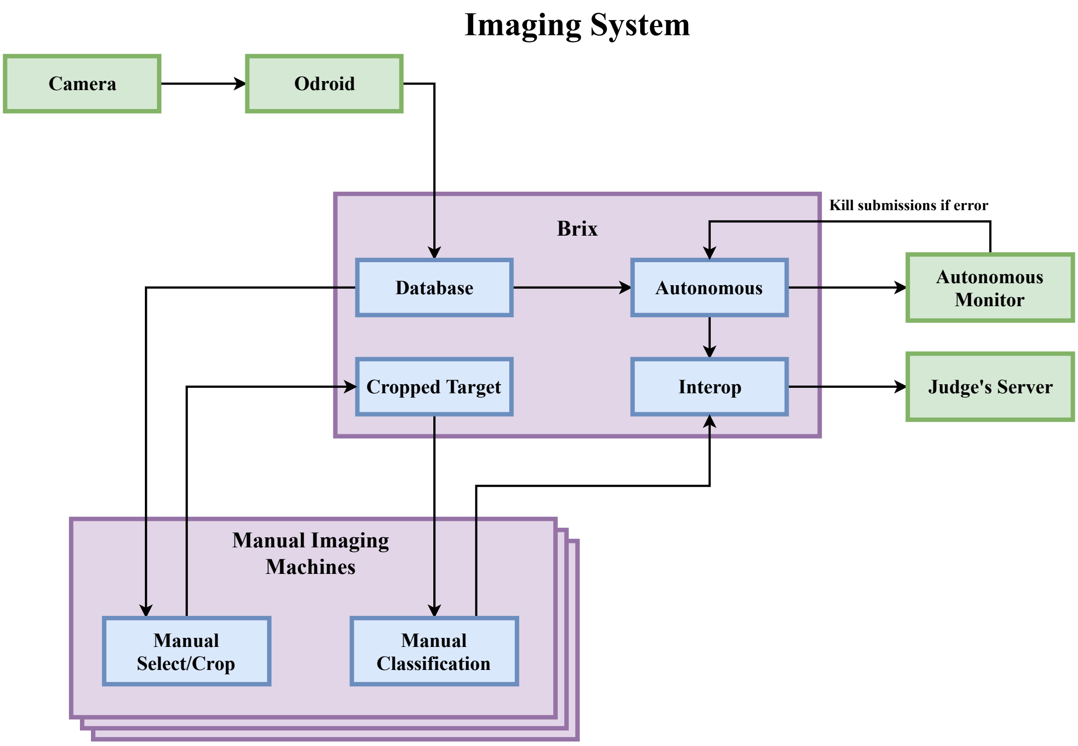

Figure 1: Target classification system architecture

Our autonomous classification system design is outlined in Figure 2. These concepts for autonomous target recognition are based on methods that other competition teams were able to successfully use at the comptition to identify targets. We will continue to iterate on the autonomous process, but we are confident that we can create a reliable and robust system for autonomous target classification.

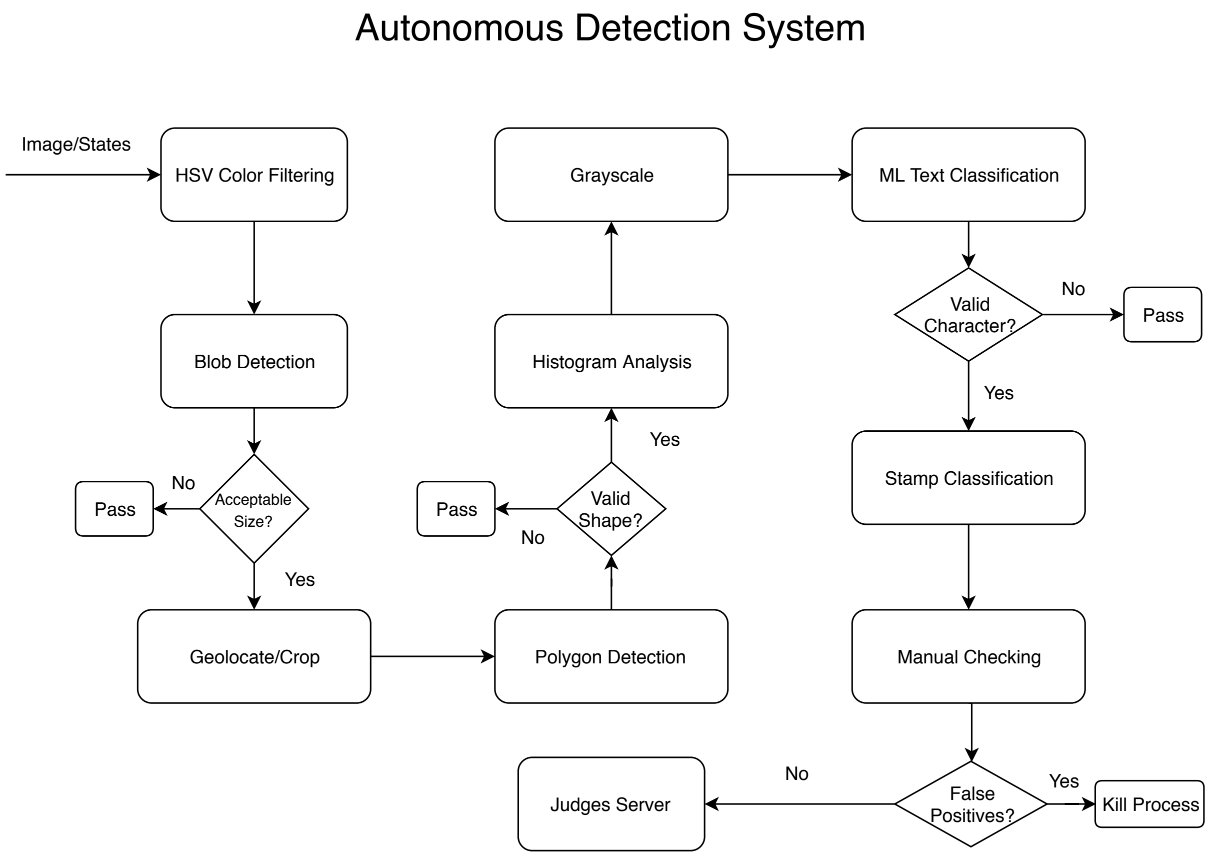

Figure 2: Autonomous classification system design

5 Justification

Since all of our high-level concepts depend on our imaging hardware, we decided it would be beneficial for us to choose a camera as soon as possible. Our list of potential cameras came from previous years systems as well as cameras used by last years top-placing teams. Critical performance measures are shown in our measured camera values table (CS-002). This table was directly translated into a selection matrix (CS-002). Based off the camera concept selection matrix, it was decided that the Sony a6000 would give us the greatest cost to performance. Its large 24MP sensor will improve image quality when flying at higher altitudes and make autonomous classification easier. Its auto-stabilization and fast exposure time also remove a lot of burden from the user to adjust settings mid-flight. Additionally 7 of the top 15 teams used the a6000 or the earlier generation (but basically equivalent) a5100.

The autonomous classification system is the largest undertaking of this year's vision subteam. Each of the 6 characteristics we are required to identify could potentially be done using a different method. Given the high-enumeration of concepts this generates, we determined it would be most beneficial for us to select one high level concept which would help define the rest of the system.

Concepts for autonomous classification were formed in three ways. The first was discussing our system requirements with market experts. They offered excellent advice on how to best go about the classification problem. The second was researching how top-placing teams from previous years tackled the problem. Teams are required to submit a design report which is made publicly available, allowing us understand from a high level how their image classification systems worked. Third, we did extensive online research on available software libraries and tools that could be used. As we pursued these three methods, our best concept for autonomous classification evolved into its current form. We feel that this final concept is the best combination of these three sources.

6 Conclusion

Changes to the vision subsystem will allow us to achieve our key success measure. The winning concepts allow us to reuse much of the code from last year, while improving the reliability and ease of use of the system. The addition of autonomous recognition allows us to maximize possible competition points.