Mizzou Unmanned Systems Team IIF Final Report

Background

Over the past year and a half, the Mizzou Unmanned Systems Team (MUST) has empowered dozens of Mizzou students to take their interest in unmanned systems and transform it into a passion. While we have witnessed a drastic decrease in the cost of obtaining such systems, even in the relatively short period of time the Team has been established, the initial cost of building and utilizing an unmanned system (suitable for academic purposes) is still in the area of $500-$1,000. The majority of college students cannot devote that much of their income to what is essentially a hobby (since commercial use is still illegal in most cases), but MUST allows those students to plan, build, configure, test, and operate these systems at no cost to the student.

What has been accomplished on your project goals?

Our goals can be summarized into four parts:

- Create and establish the Mizzou Unmanned Systems Team (MUST) as an interdisciplinary student organization devoted to the research and development of small unmanned aerial systems (SUAS)
- Facilitate an environment that supports the research and development (R&D) of: unmanned systems; software that supports the autonomous nature of SUAS; and applications for the use of unmanned systems
- Publish unmanned systems-related research as performed by one or more of our team members
- Compete in various national and international competitions in order to win prize money and become a self-sustaining organization

Additionally, we created a goal of community outreach and education.

We have accomplished three of these four goals. First, we created and established MUST, which is now a recognized student organization at the University of Missouri. The organization is open to all who wish to join, regardless of experience or academic path. To date, we have members from the Colleges of Engineering, Arts & Science, and Biology, as well as the School of Law. Though our community outreach events both on and off campus, we have become well-known for our collective regarding the safe and effective use of SUAS.

In order to facilitate the R&D of unmanned systems, the software that runs on them and their various potential uses, we have purchased a number of commercial off-the-shelf (COTS) unmanned systems components as well as fully-assembled SUAS in order to provide team members with the necessary hardware to do their work. This hardware has been supplemented with a wide array of specialty tools that aid in the R&D process.

Additionally, we have purchased a pair of laptops with true-to-life physics simulators in order to safely test SUAS without incurring any potential losses in the event of an incident. As a result, we have seen the beginnings of a number of research projects, although none of yet to see full fruition. We continue to work with external collaborators, for example we have been asked to design a system to work with Missouri State Parks for deer population studies from the air – this is a great example of some interdisciplinary work because we need to understand the project from biological and engineering perspectives.

Finally, MUST has entered and competed in its first international competition (2015), the Student Unmanned Aerial Systems competition. Although we did not place very high in the competition this year, our team members learned a lot about how the competition works and, despite our low ranking, we did come home with a small amount of prize money to help recuperate our cost of entry.

In 2016, the team decided to take a year break from entering the competition. It was deemed that the amount of changes necessary to the airframe and systems would place an unduly high burden on the students involved, and possibly "rush" to get the competition and reflect badly upon the team. As such, a strategic decision was made to provide a stronger entry for 2017.

Some of our members have also engaged in unmanned systems research, focusing primarily on how 360* cameras can be integrated with the system and what applications such cameras would be suitable for. We refer to one obvious application that we have identified as "eISR", or Enhanced Intelligence, Surveillance and Reconnaissance: there is no shortage of information regarding the use of unmanned systems as tools to facilitate ISR, but we posit that the additional field of view offered by 360* video will provide a more whole picture of the system's surroundings to the pilot without requiring the pilot to maneuver the system in order to obtain that picture. This should also allow for longer mission times by virtue of not needing to use the system's limited battery power for movement in order to know what is around the system; of course, the additional weight of the 360* camera (compared to a traditional one, such as a GoPro) will have a negative impact on mission time, but whether or not it will outweigh the power savings from reduced movement will have to be determined. The systems to be used for this experiment are still being designed.

FAA and University Policies

Dickinson is involved with the policy making process at MU with regard to the ability to use drones for University activities. Additionally, the IT program and MUST are working towards obtaining a "Section 333" exemption from the FAA to allow parties to operate UAS legally in accordance with federal rules and regulations. This in essence legitimizes the MU business need to fly UAS as part of university activities.

Recently, the FAA released an “interpretation” which makes it legal for students to fly UAS as part of their course work. This is of tremendous importance, as students are now able to fly UAS as part of courses and team development work.

Community Outreach and education

We have made arrangements with a hobbyist R/C community in Columbia, the Mid-Missouri Radio Control Association (MMRCA), to allow our members to fly unmanned aerial systems (UAVs) on their property at no cost to the student. MUST members must be accompanied by a trained MMRCA pilot; this decision was made to reduce the risk of an accident due to inexperienced pilot error, as well as to encourage relationships between members of MUST and MMRCA. Although MMRCA is exclusively a UAV flying club, the knowledge that their members have regarding design methodologies, configuration of components, and troubleshooting can be (and have been) applied to unmanned systems in general.

While we have been working hard to educate our fellow interested Mizzou students about the joys of unmanned systems, we have also engaged in various community outreach events to bring our message of safe and responsible applications of unmanned systems to students in the Columbia, Missouri area; most notably, our local Cub Scout troop, as well as students at Oakland Middle School. During these events, we cover the various parts of an unmanned system, how they interact with one another, how they are controlled, and what applications a particular unmanned system might have in the real world. This is followed up with a live demonstration. To date, the requests we have received from the community regarding our expertise in unmanned systems has been focused on the aerial aspect; for better or for worse, everyone conjures up some image (usually negative) in their mind when they hear the term “drone”, but we are happy to report that we change the minds of nearly all those to whom we speak. While the younger students we are actually providing the lesson for are usually just left with a reaffirmed belief that UAVs are “really cool”, the parents that accompany these young students will often talk to us afterward to learn more. A number of MUST members have actually taken to focusing on the community outreach aspect; while this was not the intention when we created MUST, it is without a doubt a welcome addition to the scope of the Team.

What remains to be accomplished?

What remains to be done is to publish the research done by our team members. One of our team members is working on a research project related to disaster recovery efforts within the Department of Computer Science and is looking to incorporate unmanned systems into the project. Due to working with multiple disparate groups on this research, this has been a slow-going process. We hope to have more work done on this research project within the year.

Evaluation Criteria

We established the following evaluation criteria in our proposal:

- The creation of working prototypes designed for a specific application
- Proof-of-concept tests
- Developing quality use cases and documenting efficient and practical workflows
- The solving of a real-world problem using information obtained and/or carried out by unmanned systems
- The entry into a national student student competition regarding unmanned systems

The first and last pieces of criteria have been met and explained on the previous page. Our proof-of-concept tests have not been recorded due to having spent our time thus far familiarizing ourselves with the copious amount of software that continues to be developed for use with UAS. While we have had some ideas for novel solutions to real-world problems using UAS, we have thus far been unable to test these systems due to FAA regulations on where we are able to fly. Finally, we have begun the process of solidifying and documenting our workflow on how to determine the right UAS for a given task; we hope to publish this are part of ongoing work.

Current Expenditures

There are many small expenditures that go into the creation of multiple drones and accessories. These accessories include microcontrollers, batteries, spare parts, gimbals, motors, props, balancers, antennae, GPS receivers and many other things. Additionally, we purchased computer hardware necessary to drive the real-world simulation software and work on research projects. Also, MUST had travel expenses to travel to the competition. Here is a summary of our expenses.

Category	**Cost**
Field Computer Equipment	5235.27
Drone equipment/Cameras	6639.35
Travel Expenses	1855.01
Supplies and parts for Drones	2144.7
Total	**15874.33**

The remaining funds have been returned.