Fly-Crash-Recover: A Sensor-based Reactive Framework for Online Collision Recovery of UAVs

(Technical Paper)

An Analysis and Recommendation of the Implementation of Automated Cheat Detection Systems on Honor-Based Academic Societies

(STS Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Introduction

As unmanned aerial vehicles continue to grow in use both for commercial and personal use in our society, the potential issues with loss of control due to damage or collision require new strategies to prevent or successfully recover from an incident if one occurs. The technical portion of this Capstone project is focused on Fly, Crash Recover: Safe Recovery of Faulty Unmanned Aerial Vehicles, focusing specifically on quadrotors. The technical project can be broken down into two main components: first, the creation and analysis of crash data to learn what happens to the quadrotor, and second, the implementation of recovery strategies based on analytical and experimental recovery theory and cash data on two platforms.

In a largely unrelated field from a technical and societal standpoint, the STS thesis presented here focuses on the implementation, consequences, and best practice recommendations for automated cheat detection systems in honor based academic societies. As many readers of this Prospectus are aware, the University of Virginia is only one of many educational institutions in the US and around the world that rely on an honor policy or honor culture to instill academic and institutional values in its students while fostering high academic standards and achievements. What remains largely unanalysed is the effect that automated cheat detection systems have on students and their academic performance, impressions of the honor system, and interactions with fellow students while working on assignments that are automatically checked for honor infractions. This STS thesis intends to examine the changes in these relationships from the standpoint of students and educators to provide insight into how these systems effect societies of this type and to provide a basis for best practice in the implementation of such systems.

Technical Topic

The developments of unmanned aerial vehicles (UAVs) in recent years has introduced a new set of problems related to the operation and flight of these vehicles. This Capstone project focuses on how to create strategies to recognize an issue with a flight, such as hitting a wall, pole, or other object, or damage to the propeller blades and allow the UAV to recover itself before fully losing control or crashing. These recoveries are dependent on the type of issue present, as a collision would require course adjustment away from the wall and actions to return to a balanced state while damage to part of the vehicle would require an ongoing adjustment to the power sent to other motors during flight.

Existing research in this field has provided several starting points, examining multiple types of failures. Work done by Gareth Dicker, Fiona Chui and Inna Scharf examines quadrotor response to wall impacts and proposes a successful controller design for recovery of quadrotor systems (Dicker, Chui, Scharf 2017). This research provides a good baseline for direct impacts, and research from Teodor Tomić and Sama Haddadin considers the effects of external torque on quadrotors, with the external torque provided in this case by obstacle impacts (Tomić, Haddadin 2014). Both of these researches examine a different part of collision, but neither fully implements a control scheme to recover both from the issue presented in their respective research as well as that of the other paper. Further impact and recovery considerations are provided by Mark Mueller and Raffaello D'Andrea through their analysis and implementation of quadrotor systems with the loss of one to 3 motors (Mueller, D'Andrea, 2012). This research into maintaining stability despite the loss of a critical system is an important consideration as the

quadrotors in this project may or may not lose some control over subsystems like motors after impacting an obstacle.

Two platforms are used to analyze collisions and design recovery strategies, a DJI Tello quadrotor and a Crazieflie. Working with Nicholas Anselmo, Garret Miller, Ryan Remias, Matthew Trivett and Shirley Wang, the project begins with the creation and analysis of crash data using a VICON vision system and obstacles including a wall, pole, tree and others. This first part of the project draws on the previously mentioned research to create and design collision classifications in order to determine which recovery strategy is best suited for the collision experienced. By determining the correct recovery type, these recovery strategies can be implemented on the two platforms of the Tello and Crazieflie, but will likely focus on the Crazieflie due to the better access to low level controllers as compared to the Tello. This implementation and it's testing form the second part of this technical project. Once complete, it is expected that we will have successful identification of impacts and their types as matching our recovery strategies, and implementations of recovery strategies to cover a range of impacts between the quadrotors and obstacles.

STS Topic

The research focus of the STS thesis is on how automated cheat detection systems impact honor based academic societies, examining inter-student impacts, student-institution impacts, and providing insight into how systems that have a justifiable existence can be best implemented from a technical and social standpoint to minimize the impact they have on honor based academic societies. In order to understand the different interaction impacts, two main approaches

will be used. First, a review of applicable literature on both how honor is perceived at various institutions and why, when, and how dishonorable actions are made, and second, interviews of current students, teaching assistants, and faculty at the University of Virginia who have either been subject to such systems in their academic careers or have implemented them for their courses. These methods will provide a foundation background and context to the information gathered in the interviews, and through the interviews a closer look at specific impressions and the reasons or thoughts behind the opinions had or actions taken with regards to automated cheat detection systems.

There is a measure of interest in why and how students cheat, a analysis of which from Vanderbilt University presents a student view on what is considered unethical from students (Bruff 2011). Other student oriented information and perspective is more technically analysed in form, timing, and correlations of student work and activity in an online platform (Palazzo, Lee, Warnakulasooriya and Pritchard, 2010). This data will form a background and case study for analysis of current situations and implementations.

I intend to use primarily actor network theory to analyze this issue. While actor network theory may be a more complicated approach than several other theories, the nature of honor based academic societies fits well. Actor network theory does not consider pre-existing structures and instead focuses on how relationships between actors (including people) are affected by power and the circumstances (Cressman 2009). Given that the student bodies are constantly in flux and the societal definitions of honor are, at many institutions including UVA, upheld by the same student body, actor network theory provides a flexible and proper framework in which to analyze honor based academic societies (UVA Honor).

Honor systems are different for each university that chooses to implement one, and the relationship that students have is unique to the experiences both previously and during study for each student. These systems provide then a set of ideals that are enforced via community or administrative action, such as the student Honor Committee at the University of Virginia (UVA Honor). Individual student relationships are also an important consideration, and part of the justification of the usage of actor network theory in order to analyze multiple types of relationships, where each type is defined by the relations of the comprising individuals. Academic institutions that have honor systems are another key stakeholder, and the relationship between the institution, the responsible enforcement group whether student or institutional, and the students themselves therefor form the major relationships of the system, and the usage of technical systems needs to be properly integrated into all of these relationships to disturb the existing system minimally and remain a fair system to use. According to an article from the Chronicle in which professor David Pritchard of the Massahcusetts Institute of Technology, changes in lecture style and engagement can be used, but the same article acknowledges that copying answers or other cheating methods is not seen as students as wrong (Young, 2010). This attitude from students is an important consideration for developing and implementing anti cheat systems; if students do not see their actions as wrong, is a purely technical solution the correct solution?

In order to determine how best to support academic societies with technical systems, it becomes important to understand how the system currently exists, as well as the opinions and underlying decisions of students and faculty in that system. Some systems, such a a proposed online biometric identification system, ensure that the assignment is only submitted by one

student, but this system may fall short of changing opinions and encouraging proper academic engagement (Nakkabi, Saad, Ardigo, Quinan 2017).

Research Question and Methods

How do automated cheat detection systems affect honor based academic societies, and how can they be best implemented? With the rise of digital education and larger course sizes, it has become at once easier than ever for students to act against the requirements of honor policies, and more difficult for those teaching to uncover such actions (Marshall, Varnon 2017). In order to understand the system more broadly and to encompass a variety of viewpoints, two main approaches will be used. In depth research across a variety of approaches, both technical and societal will be conducted. The changes in education structures and how students approach cheating and integrity have changed much in the last few decades, and according to Zorana Ercegovac and John Richardson in their article on the topic, there are still research and topics that have not been fully considered (Ercegovac, Richardson 2004).

I believe that the information and policies that students are presented with as they enter university, particularly those that are based on an honor system, form a critical part of the relationship between those students and other students, as well as with the university faculty and environment. To better understand how honor impacts incoming students and how larger course sizes affect honor relations between students, students, and faculty, Professor Ann Reimers provides a good perspective through an interview (A. Reimers, personal interview, 2019). Additionally, as most students perform their entire undergraduate work at one institution according to the National Student Clearinghouse Research Center, the changes in student and academic honor relationships are of interest (NSC Research Center, 2016). Professor Brynn

Seabrook of the Science, Technology and Society department at the University of Virginia has worked both as a faculty member for first year students, as well as with students on the completion of their fourth year graduation requirements and thus provides another suitable interviewee (B Seabrook, personal interview, 2019).

Conclusion

The technical portion of this thesis focuses on the analysis of quadrotor impacts and propulsion damage and focuses on designing recovery strategies for several general classes of the aforementioned issues. The implementation of these strategies focuses on two hardware platforms, the DJI Tello and a Crazieflie quadrotor. These recovery strategies will allow quadrotors to recover form in flight collisions or issues successfully, creating a more resilient and robust UAV.

The STS thesis will analyze the impacts of automated cheat detection systems on honor based societies both in the way they affect student-student and student-institution relationships. Once these relationships are better understood and examined in the context of the trends of student actions and habits a foundation for best practice for the implementation of such systems when they are justifiably needed will be proposed.

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