**Autonomous Drone Police Aid and Assailant Deterrent (DPAAD)**

Project Report

by

CMPE 195A

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**ABSTRACT**

**Autonomous Drone Police Aid and Assailant Deterrent**

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College campuses have always dealt with criminal offenses and are always attempting to make these campuses safer for students. Most of the crimes that take place are burglaries, sex offenses, and theft. The police’s only response to this situation is to send out officers to the scene of the crime in hopes of catching the assailant in the act. With police forces struggling to catch the assailants, this can lead to a general feeling of unsafety. This feeling can lead to a less engaged campus which may result in fewer attendance rates. Additionally, the only deterrents the police have for this type of behavior is the use of security cameras which can be ineffective for the job required of them. Many of the assailants are able to escape and remain uncaught while relying solely on the victim’s description of the assailant in hopes of finding them. The use of a device which can respond to the situation in time faster than the response speed of police on the ground as well as aid the individual being attacked would serve as both an aid to the police and a deterrent to the attacker.

The current problem faced by police forces in attending to the aid of individuals is their slow response speed. If they are lucky, there will already be a unit on campus, however, if not, a unit will have to be deployed from their headquarters which would cause an even greater delay. This slow response time often results in the escape of the attacker where they can’t possibly identify him or her. The use of cameras can help to solve them but it’s possible that these cameras either aren’t sensitive enough, lack a proper field of view, or simply aren’t in that location. Additionally, the cameras can’t aid the victim while they are being attacked which does not help in hindering the assailant. When cameras aren’t present, there is no way to identify the attacker besides witness descriptions. These descriptions can be faulty or lacking in detail and ultimately don’t often result in apprehending the attacker.

The drone will act as a first responder to a potential crime happening on campus. The drone will be able to reach the destination of where an attack is taking place faster than the police can respond. When the buttons pressed to signal the police to an emergency, the drone will be signalled to attend to that location When the drone responds, it will capture images of the attack location in the form of video or still images, as well as emitting a sound and/or lights to deter an attacker. This will allow the drone to both deter attacks and aid in identifying and apprehending the aggressor through image capturing. The use of an autonomous drone will allow the police to mobilize without the need of a “pilot” as well as allowing the drone to fly according to its program avoiding possible human error. This drone will serve as an invaluable police aid and also a criminal activity deterrent.

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**Chapter 1. Introduction**

* 1. **Project Goals and Objectives**

The autonomous drone has several goals in mind. The ultimate goal is to provide a safer college campus by deterring criminal activity as well as apprehending the criminals that commit these offences. In order to achieve this, the drone will have to operate autonomously by receiving a signal and properly flying to the location where the distress signal was triggered. From that point, the drone will need to begin recording images of the attacker whether in still frames or video. This process will also occur while the drone is flashing lights or providing a spotlight to illuminate the scene in order to hinder the assailant. After the police arrive on the scene, they will send a signal to the drone indicating for its return to base. The drone will then return to base where it will go into a standby mode awaiting another distress signal.

This drone aims to aid in the prevention of criminal activity on college campuses. Many of the activities that take place on college campuses can be prevented or prevented from escalating with the use of a fast response device aimed at alerting nearby individuals and alarming the attacker. With the increase in drone popularity and the advances in the field of automation, this project is a foreseeable step forward in the advances of security and automation.

* 1. **Problem and Motivation**

San Jose State University is at the heart of downtown San Jose which is notorious for homeless and criminal activity. Often this sort of activity can drift onto San Jose State’s campus and lead to crime that impacts students. While San Jose campus police have attempted to become more transparent and active with the criminal activity happening through SJSU alerts, this often leads to a greater feeling of unsafety and lack of police power. To deal with this, some changes must be made in how the police go about apprehending criminals and preventing any sort of criminal activity.

To properly act as a deterrent and aid for police, the drone must cause the assailant a sense of panic resulting in them fleeing the scene and additionally must be able to assist the police in identifying the suspect. The drone will cause this sense of alarm and panic through the use of lights and sounds that will have the capability of alerting bystanders and additionally assisting the police in quickly acquiring the location of where the distress signal was sounded. The drone will come to the aid of the victim and scare away the attacker’s while also providing crucial evidence to the police.

* 1. **Project Application and Impact**

The results of this project will develop a safer college campus where these drones are implemented. This will have a societal impact in creating a more enticing college experience where individuals don’t fear for their safety. With individuals not worrying about their safety, they will be able to focus properly on their academics resulting in more successful students and graduates. The use of these drones will also impact industry resulting in drones being utilized in more aspects of society. Drones may see use throughout cities in the delivering of goods or even see expanded use of their current application in police forces in urban areas.

The use of these drones may also have adverse effects on society. The use of drones may call into question the possible infringement on people’s fourth amendment rights. People may feel that they did not actively consent to the use of these drones for their surveillance purposes. This may result in possible legislation being passed either in favor or opposition to the use of drones and will have many implications on the future of drones.

* 1. **Project Results and Deliverables**

The expected results of this project is a system in which to call a drone to a location in order to provide assistance to someone being attacked as well as provide valuable information to whoever owns the drones, ideally the police. This system will be a composition of hardware tools such as the drone itself, microcontroller, IR sensors, as well as the adaptation of open source code responsible for autonomous flight. The edits to the code will allow for the drone to fly to a desired location as well as take certain routes according to our preferences written into the code. These preferences will help to avoid collisions and allow the drone to take a more streamlined and optimal course to the location.

The deliverable for this project will be a prototype of the drone outlined in this report. The prototype will be designed to implement the features outlined, however, it may not be executed in the most desirable fashion. This means that the design could be improved upon to make it faster and more efficient. Both of these features will make the drone more desirable and additionally reliable. The prototype will act as a barebones model in which possible upgrades could be implemented based on the consumer’s needs. Upgrades may include a sturdier frame for durability, more powerful motors for increased speed and acceleration, or other peripheral upgrades such as motion detector. The drone will ultimately have the ability to autonomously fly to a location, perform reconnaissance, aid the victim, and return to its original location. **Chapter 2. Background and Related Work**

* 1. **Background and Technologies**

Drones have been used by the military for decades and up until quite recently they haven’t been readily accessible to the public. Within the past decade we have seen a lot of innovation in the drone industry. We are beginning to see the various applications of drones not only for military use but for things such as agriculture, exploration of areas and to help the community in ways that don’t endanger other lives; a search and rescue team could send an autonomous drone into a fire versus them risking their life to do the same job.

Drones are either controlled by a remote controller or some type of pre-programmed response which is why they are commonly used by military or hobbyist.

With all the drones having surveillance capabilities we have to have some way to control it and that’s where the software portion comes in. We have a mounted camera on the drone that records what is going on in the surroundings and that it being controlled by some type of software. The Viewpoint software is a good platform to control the mounted camera and gives the user the flexibility to point the camera wherever they want. This obviously comes into the category of surveillance which is why for certain drones it is required to register them with the FAA(Federal Aviation Agency) and in some cases you have to obtain certain certifications from them to operate the drones.

Drones and the software that has been uploaded to the hardware can serve different purposes. DroneDeploy is a popular software that allows people to process maps, interpret data and 3D modeling. With the amount of sensors that are available we can use the drone for many different purposes and have it gather and analyze different types of data.

The coding can get really complicated when dealing with the drone and the camera interacting together. There are currently multiple autopilot softwares that take care of that and allow us to make our own edits to it. The one that we are currently playing around with is called Paparazzi UAV(Unmanned Air Vehicle) and it provides us with a bunch of libraries that have different functionalities. The code is mostly written in Python and there is a lot of Matlab involved as well for the processing of the maps that the camera is capturing.

* 1. **State-of-the-art**

The drone market is flooded with drones specific to the the individual needs of the person purchasing the drone. The drone is growing at an exponential rate, according to an article on recode global sales grew about 60 percent in the last year, with the hobbyist market almost doubling. The leading company in the hobbyist community is definitely DJI which make drones with excellent video and photo functionalities. The current drone they offer which is considered the best in the field is the DJI Mavic Pro which can go up to 65 mph and has 27 minutes of fly time. It has a range of about 7 km and has a 3-axis gimbal attached to the camera. Currently we are looking into editing and making changes to their drones if possible. In terms of having stable drone that we can use to perform the functionality we need it would be better to try and “hack” their software and make the modifications we need.

There is also a growing market for drone racing, it’s to the point where people are talking about drone racing being an actual sport. Most of all drones not just racing drones are using LiPo(Lithium Polymer) batteries because if offers the overall best option for batteries. A pretty good racing drone that we examined was the KingKong 210GT, the components used on this drome were something that we considered but later decided not to get since the controller software is not the one we wanted. The 210GT runs the F3 flight controller, which is good but we wanted something that would be more open source and developer friendly where we could make some modifications. **Chapter 3. System Design**

* 1. **3.1 Architecture Design**

[Describe a general architectural solution for your system. This section must include textual description accompanied with diagrams.]

DPAAD is designed around the concepts of stability, simple assembly, and modularity simple maintenance. The chassis is a *XIRO drone* frame which features a quad motor configuration with blade style propellers, and retractive quad leg landing gear system. The chassis is able to house the several primary components: system control board (SCB), electronic speed controller (ESC), and the situational record unit (SRU). The overall chassis is made of formed plastic, and houses several built in components: 4 DC brushless motors, LED’s, and system wiring for easy integration.

The core of DPAAD is the SCB, which is a **[ENTER RASPBERRY PIE MODEL HERE]**, which communicates with a *Q Brain 4 x 25A Brushless Quadcopter ESC* via PWM hub. **[Explain more about the PIE here]**

**[Discuss peripherals here. (Magnetometer & GPS, RF module(taking remote interrupt), and RF distance detection, WiFi maybe??, dont think we totally need IR right now actually,)]**

The ESC is a 4-channel DC-AC controller. It takes in 4 separate PWM signals from the SCB (one for each motor), and distributes the signals to their addressed motor. It utilizes a 12V DC power from a 5200mAh Li-Po battery that is rated at 20C. The ESC can handle a distribution of up to 25A across all four AC Brushless motors.

The motors are each rated for 100W, and take in 3-phase AC. They are axial-flux motors which means their outer housing rotates as the electromagnetic force is applied to it. This means the motors are relatively very efficient compared to DC brushless.

All electronics with the exception of the high powered components (motors and servos), will be powered by a filtered and regulated 5V DC delivered by a DC-DC buck converter / regulator board. This will allow the engineers to power any onboard device via their respective power port (e.g. USB port, through-hole header, screw terminal fastener, etc). The board offers simplicity in terms of power management and application to ensure long lasting life.

For the user interface, there will simply be a hand held push button keychain fob that contains an RF beacon which transmits an interrupt frequency to the DPAAD. It maintains a constant broadcast for the drone to map its way to the user in distress. Once the range has been minimized, the drone will then know the location of the user, as be able to capture the on scene information.

* 1. **Design Constraints, Problems, Trade-offs, and Solutions**

Throughout the process of planning and development, engineers must foresee the possible setbacks in order to mitigate risk, and have a chance to design around the issues that can arise from unforeseen failures. Certain parameters play a key role in creating the proper design plan going forward, and here are the factors that were considered during the planning and design process.

* 1. **3.2.1 Design Constraints and Challenges**

[Present your design constraints in different perspectives, such as economic, resources, society and environment, hardware/software, mathematical/scientific theories and safety and reliability.]

The primary design constraint is of course time. We need to be sure that our design fits our capability to deliver a working product on time including testing, regression, and possible changes that may occur. Similarly, we are limited on financial contribution which means we need to not only build a reliable product, but a cost effective one too. Individual mistakes turn into sunk costs, so it is a goal to minimize the reality of these risks.

**3.2.2 Design Solutions and Trade-offs**

[Document your approaches to cope with the given constraints. Present your design trade-off decisions and solution selections to deal with these constraints and problems and challenges.]

**References**

[List most influential documents (articles, books, web pages, white papers, etc.) related to the project. List them in IEEE reference format. Publications are judged by the quality of their references and some reader review the references before even reading the paper. The high quality references are those from peer reviewed journal and conference papers. Papers with little research might just include URLs. At the bottom are references to news articles.]

**Appendices (Optional)**

**Appendix A – Appendix Title**

[Typical example: you can include a specific standard here.]

**Appendix B – Appendix Title**

[Typical example: you can include a specific interface details here.]