Koç University
College of Engineering
ELEC 491 - Design Project Proposal

Spring 2022

Aerial Robot for Package Transmission

Participant Info:

Name	ID	Email	Phone
1. Çağla TÜRKOĞLU	64842	cturkoglu17@ku.edu.tr	0531 011 00 93
2. Alp Doğukan Halitoğulları	64679	ahalitogullari17@ku.edu.tr	0532 722 26 57

Project Advisor:

Name	Signature
Ozan Özhan	

Abstract

Nowadays, by the developments in logistics, package transmission in an efficient manner become one of the most prominent topics both in our daily life and also in the business life. Package delivery can be done for different missions in different ways. By the usage of technology, new tools for delivery such as unmanned aerial vehicles (UAVs), have been emerged and became the central for different applications of different businesses and also for governmental entities [1]. Some common transmission vehicles can be stated as drones, cars, motorcycles, electrical scooters etc. Among the latter, aerial transportation vehicles are preferred since they are faster than other tools by avoiding traffic and having a wider view providing mapping options. One of the most common UAV is drones, which are accessible by everyone with the usage in a restricted area, and used in different applications such as aerial imaging, agriculture, monitoring, mining, rescuing etc. [3]. Some advantages of drones can be stated as augmenting work efficiency and productivity by lowering manufacturing costs, provide accurate outcomes, enhancing customer relationship and other services, dealing with security problems etc. [1]. At the times where there is traffic or for analyzing an unreachable territory for military aims, drones become beneficial [1]. Leading companies in the delivery industry in the world such as Amazon, UPS and DHL started to use drones in their business processes due to its lowering manpower attributes and avoiding undesired traffic to the sky [2]. In our project, we also choose to use UAV, namely drone, due to their advantages mentioned previously for making a delivery in the most efficient way using decision analysis. We aim to deliver small rescuing packages (closest one to the destination) with a certain weight located in various, distinct package centers to the people who calls for a package from their mobile phone application. By delivering the required relief supply kits to the people who are unable to reach, we believe that we can save a life or at least help a person.

Table Of Contents

INTRODUCTION **4**

CONCEPT 4
OBJECTIVES 5
BACKGROUND 6

S/T METHODOLOGY AND ASSOCIATED WORK PLAN **8**

1. METHODOLOGY 8
   a) Background Information Analysis *8*
   b) Mobile Application Implementation *8*
   c) Drone Implementation *9*
   d) Algorithm Evaluations and Prototype Design *9*
2. WORK PACKAGE DESCRIPTIONS 10
3. DEMONSTRATION 15
4. IMPACT 15
5. RISK ANALYSIS 16
6. GANTT CHART 16

ETHICAL ISSUES **16**

REFERENCES **17**

Introduction

1. Concept

Unmanned Aerial Vehicles (UAVs) are used in many different areas from military missions to package transmission having different sizes [4]. Even though they are firstly designed for the military and aerospace purposes, they became very common during past years due to their increased safety level and efficiency that they provide [4]. They have different coverage range from 30 miles to 3000 feet in the air according to their properties and design aims [4]. Some industries that they are used can be mentioned as imaging, monitoring, entertainment, logistics, filming, inspection etc. In our project, we will focus on the aerial product delivery and shipping which is one of the most popular field that drones are used since they lower man power and delivery tines significantly. Some big companies that use drones in their operations can be stated as Amazon, Dominos, FedEx, DHL etc. Also, another prominent application area that drones are used is rescuing operations. They are used for detecting disasters and provide monitoring to the rescuing teams to find the easiest paths. In our project, we will merge package delivery and rescuing operations of drones and come up with a mission such that our aerial robot will load relief supply kit from a source point determined by the location obtained from the mobile application, then reach to the destination point which is a hard place to go by manpower.

Figure 1 Drone used by Amazon for package delivery

In order to achieve our proposed objective, we will first design the mobile application with the required parameters: location and colour of the package chosen. Colour of the package will determine the content of the packet and can be seen on the application. Once the application is prepared, the data collected from the application will be processed according to our decision analysis algorithms in our aerial robot's controller as inputs:

- location information will be used to detect which package centre containing the required packet in its inventory is the closest to the destination point and assign as the source point for aerial robot's trip
- colour information will be used to detect which packet to be loaded to the aerial robot using a camera located in the aerial robot.

In the demo day, our mission of transmitting the required relief supply kit to the user located in a current location will be presented and experienced by our friends who have already installed the mobile application. Even though there won't be a real disaster in the demo day, hopefully, our aerial robot will be working for delivering the required package to the destination by avoiding collisions and unwanted traffic on its path. By accomplishing our mission, we aim to help people who feel desperate in a place that they are stuck in and may save a life. In further applications, this project can be used for rescuing teams by integrating several package centers with various package contents identified by image processing algorithms and by including more stops in the drone's path, such as closest pharmacies and supermarkets, for including more specific products according to the use case.

2. Objectives

In our project, our goal is to deliver a relief supply kit containing different items such as surgical band, dried fruits, burn cream etc. to the person who is located in a place where it is difficult to reach him/her by using manned vehicles. We will first design the mobile application for people containing a button where the live location of the people will be sent when the user taps on one of the package options. The location and chosen package information will be sent to our database system and then sent to the main control station on the computer, which is designed for the drone using Raspberry Pi. By implementing a decision analysis process including the choice of source package centre and the user that will be served first, the package will be collected from the nearest package centre from the user's location then delivered to the destination point. In order to realize this process, we will analyse the articles and experimental methods provided by different sources. Since there exist several challenges in our project such as acquiring the live location of the user, loading a package to the drone and avoiding collisions on the trip of the drone, examples and background information is very critical.

We will start by first implementing the algorithm for our mobile application. The application will be written using the language SWIFT and the data will be stored in Firestore, which is a database provided by Google. In the application part, we will start by designing the interface by putting two different package options including their content and colour. When the user presses one of them, a verification question will be posed and with the Accept button, the location information and the package chosen information (colour) will be sent to our database. Then, this data will be sent to the main controller for the drone and will be used for the processes realized by the drone.

Secondly, we will design our drone algorithm and start to collect the required equipment for the drone. For monitoring the graphics related to the flight of the drone, we will use *MATLAB* codes with the appropriate toolbox. To avoid collisions, during the trip and take-off/landing, we would use several LIDARs. For better analyzing destinations (for package collection from the package centers and package delivery to the destination), we would use colors which will be identified by the camera located on the aerial robot (drone).

After collecting the data from the database, drone's algorithm will process it according to the decision tree that we made. First user that will press will be given priority and the delivery will be made from the nearest package center according to the color of the package chosen and the current location of the individual. According to the obstacles' position, our LIDARs will be informed and make sure that they don't hit them. By implementing such an algorithm, we will be able to deliver the packet to the destination without any ruin and as fast as possible.

Finally, our consequent demo will achieve a mission in an area where there is a parking center of the drone, different package centers and several destination points (location of mobile phones). In the demo day, our friends can download our mobile application and press to the desired packages in different locations and wait for our drone to reach their location at a minimum time.

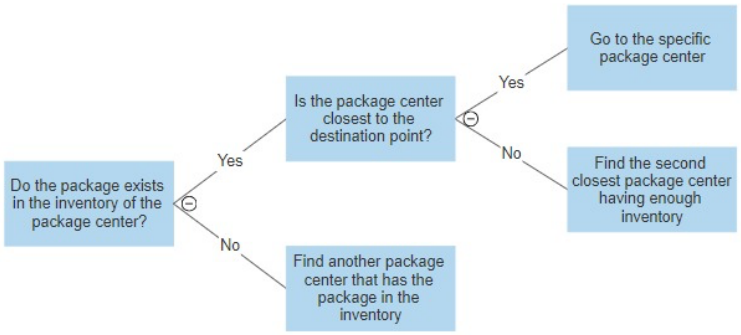

Figure 2 Decision Tree

3. Background

There are many examples of drones carrying packages around the world. Most recently, Amazon has designed and uses package-carrying drones for the delivery of cargo [5]. These robots have many benefits to both the environment and people. Since drones work without human power, they move very quickly. In this way, cargo delivery times are considerably shortened. In addition, since no cars are used for cargo deliveries, carbon dioxide emissions to the environment have decreased considerably. In Figure 1 shows a drone designed to carry packages.

Figure 3 Example of Package Transform with Aerial Drone [6].

Drone technology is a fairly new technology and is developing quite rapidly. About 10 years ago, helicopters were used for TV series and movies, and there was a cameraman on the helicopter. However, drones, which are quite small compared to helicopters, are used today and the same quality is achieved. In this way, the costs in many films and other project have decreased considerably. These drones consist of very simple components. They are mostly 4 motors and can be controlled by easily accessible devices such as mobile phones.

While designing this project, we started from this example and decided to design an aerial drone that could help humanity. With this drone we will design, we will carry food and first aid packages. To illustrate, when a mountaineer is stuck on a mountain, he will be able to ask for food packages thanks to this drone. The package will be able to arrive in a much shorter time than the arrival time of search and rescue teams.

In addition, this drone will be able to work in cold weather. The other example is the case of staying in the snow, which seems to be quite a lot in our country this year. As a result of heavy snowfall, many vehicles were left on the road and people were left without water and food in their cars for up to 1 day. Therefore, in a situation like this, food and first aid packages can be carried easily. Our first goal was for people to have easy access to this opportunity. Therefore, we decided to design a phone application within it. Thanks to this phone

application, even if the needy person has moved after requesting help, the drone and the product will be directed to the last point of change thanks to the smart software. Thanks to the radar, LIDAR and camera on it, it will be able to reach its target easily without being hit by trees, lampposts or even flying birds. In Figure 2, the combined result of these equipment is given.

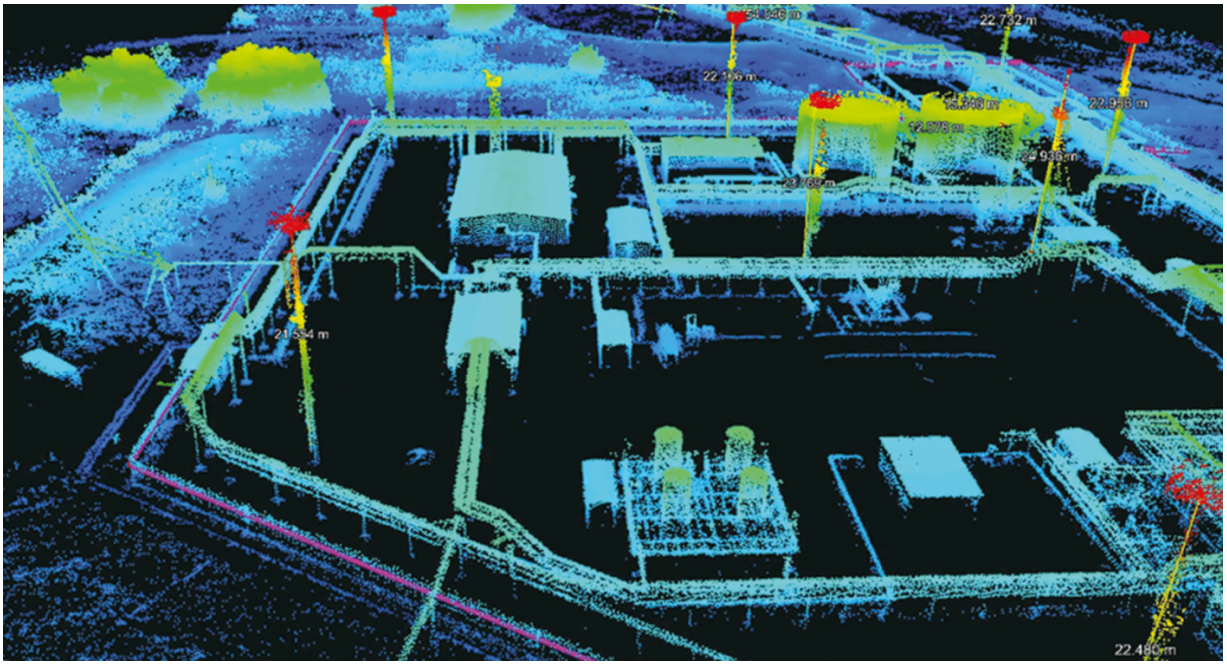

Figure 4 Example of LIDAR Sensor [7]

This aerial drone we designed in the future is a project open to development. For example, these robots can also be used to extinguish fires in hard-to-reach areas such as forest fires. Another example would be flying cars. The working principle of this project can be used for the safe flight of flying vehicles.

S/T methodology and associated work plan

1. Methodology

a) Background Information Analysis

Since drones are used in a wide area both for personal and business purposes, we need to first analyse how they differentiate in between, then understand the basics of them such as the main parts constructing its body part and widely used software languages for controlling. Also, the main parts used in a drone such as motor, propellers, flight controller, GPS module, battery, Raspberry Pi etc. should be understood with our technical knowledge and a meeting can be requested from a professor in Mechanical Engineering department in Koç University to deal with the assembling and loading part of the drone requiring high level of electronics and mechanical design. For the controller part, a meeting can also be arranged with a professor in Computer Engineering department in Koç University. After realizing the meetings and having a general idea of drones, we would observe the operations of DHL, Amazon and UPS which use drones for their business operations. Also, since we will integrate a mission of rescuing in our project, we will have dialogs with the rescuing teams or companies using drones for their rescuing operations and understand in what extent they are using them, and for what purposes. By having different ideas from the real-world users, we would understand the needs of the people better and then design the algorithms and use cases according to them. In terms of technical parts, our knowledge from ELEC 202 and ELEC 310 will help us to design the electronics parts of the drone and implement filters. In addition, for the development of the mobile application we would use our skills gained from COMP 319B. In addition, we will use our knowledge from COMP 202 for algorithm implementation for overall project.

b) Mobile Application Implementation

One of the most prominent elements of our project is our mobile application since we will use the data obtained from the mobile application in drone's controller for its mission. Our mission starts by user's call from the mobile application by tapping on the corresponding packet. In our mobile application, two package types will be listed containing their names, content and colour. According to user's need, he/she will tap on the packet option that he/she needs and will be asked for verification. After verifying his/her choice, his/her current location information will be obtained by user's mobile phone's GPS. All the algorithms on the mobile application will be implemented using the software language SWIFT, and all the data obtained from the mobile application will be sent to the database of Google, namely Firestore. After, these data will be sent to the main controller of the drone to be processed.

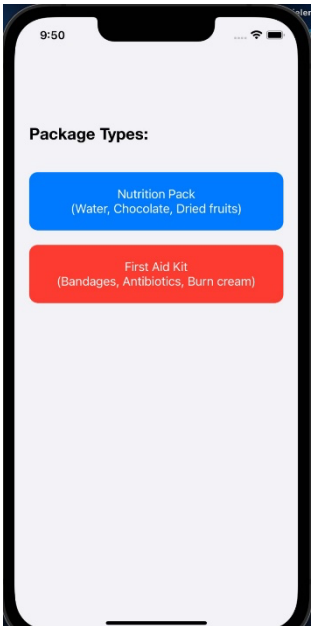

Figure 5 Mobile Application

c) Drone Implementation

For the drone body, we will use a body made of carbon fiber with landing pallets. We will integrate 4 brushless motors of approximately 2400 KV on drone and we will support these motors with 12-inch carbon fiber propellers. Brushless motor driver will be used to control the motors and drive them with PWM. These brushless motor drivers will be separate for each motor and will be supported by the flight control board. We will integrate the Raspberry pi version 4 board to manage the drone. This control board will be programmed with PYTHON and MATLAB languages. We will use the raspberry pi card again as a manager control system to pull the drone's take off command and location information from the database and transmit it to the drone. The drone will take its energy from the lithium battery and the main operating system will work with mains electricity. Obstacles will be recognized by LIDAR sensors and distances will be measured by these sensors. We will prefer a colour and ultra-fast camera so that it can recognize the boxes it will carry and the landing place. We will design a robot arm or choose electromagnet method to hold the box. In addition, we will utilize a GPS to send the current location of the drone to the main operating system.

d) Algorithm Evaluations and Prototype Design

Before the demo day, we will have several experiments consisting of different package centres, colours, source and destination points and user numbers. By the feedbacks we will have after PDR and CDR, we will design our aerial robot according to them and try to improve its accuracy and efficiency at each point. In order to make our aerial robot not to collide on its path we need to configure our LIDARs and cameras such that they detect all the obstacles and can move according to them. Also, our camera will understand the RGB values of the packet and choose the right one for the correct package delivery. After making our aerial robot and mobile application integration we will have some evaluation criteria for accomplishing the mission by overcoming our project's challenges:

- Is the location information of the user is collected correctly from the mobile application?
- Do the colour chosen for the package is correctly sent to the database?
- Do drone's main controller and mobile application is communicating instantly?
- Can drone choose the nearest package centre to the user?
- Can drone see the inventory of the package centres?
- Can drone differentiate packages with different colours and choose the right one?
- Can drone successfully take-off and land?
- Do we get a feedback message when the drone is achieving its missions such as taking-off, loading, landing?
- Can our aerial robot finish its trip without any collisions?

In the demo day, we expect to satisfy all our evaluation criteria and have the mission done in our campus. We will set package centres at different locations containing different amount of supply relief kits. We will have several friends who installed our mobile application in their cell phones and make them press to desired packages in different locations. Then, our aerial robot will choose to go to the destination by starting from the nearest package centre containing the desired package (identify by camera), then load the package, then take-off and have a trip by not hitting to any obstacle (using LIDARs), then it will land to the destination point and complete its mission.

2. *Work Package Descriptions*

Work package number	**1**	Start date or starting event:		**Week 3 (28 February 2022)**	
Work package title	**Literature Review about aerial drones**				
Participant number	1	2			
Participant name	Çağla	Doğukan			
Weeks per participant	1	1			

Objectives

- Review of sample projects and articles on aerial drones.

Description of work

T1.1 (Week 3 – Week 4)

- Researching mathematical operations and experimental details related to drone flight (e.g. calculations of weight and engine powers)

T1.2 (Week 3 – Week 4)

- Researching technical details for camera, LIDAR, other sensors and PID codes

Deliverables

D1.1 (Week 4)

- A document about the research topic

D1.2. (Week 4)

- A document about the research topic

Milestones

M1.1

- Compare the methods proposed for configuring the drone with LIDARs and cameras and analyse the algorithms used in different languages.

Work package number	**2**	Start date or starting event:		**Week 4 (7 March 2022)**	
Work package title	**Budget & Component List**				
Participant number	1	2			
Participant name	Çağla	Doğukan			
Weeks per participant	1	1			

Objectives

- Material research for drones and required equipment for the whole project

Description of work

T1.1 (Week 4 – Week 5)

- Conducting market research and creating a budget list

T1.2 (Week 4 – Week 5)

- Research and comparison of necessary materials

Deliverables

D1.1 (Week 5)

- A document about the budget list

D1.2. (Week 5)

- A document about the component types and properties

Milestones

M1.1

- Creating a budget list for aerial robot and buy the required components

Work package number	**3**	Start date or starting event:		**Week 5 (14 March 2022)**	
Work package title	**SOS Aplication**				
Participant number	1	2			
Participant name	Çağla	Doğukan			
Weeks per participant	1	1			

Objectives

- Development of SOS application and configuration of database.

Description of work

T1.1 (Week 5 – Week 6)

- Firestore database configuration and collection creation

T1.2 (Week 5 – Week 6)

- Writing a phone application in SWIFT language and sending location information from the mobile application to Firestore

Deliverables

D1.1 (Week 6)

- A screenshot of Firestore database output

D1.2. (Week 6)

- A simulation of mobile application

Milestones

M1.1

- Design the mobile application with integrating it to Firestore

Work package number	**4**	Start date or starting event:		**Week 6 (21 March 2022)**	
Work package title	**Extra components code**				
Participant number	1	2			
Participant name	Çağla	Doğukan			
Weeks per participant	1	1			

Objectives

- Development of LIDAR sensor and camera software

Description of work

T1.1 (Week 6 – Week 7)

- Writing and developing LIDAR sensor software

T1.2 (Week 6 – Week 7)

- Writing and developing camera sensor software

Deliverables

D1.1 (Week 7)

- Improved code and output

D1.2. (Week 7)

- Improved code and output

Milestones

M1.1

- Developed and consolidated code for LIDAR and camera integration

Work package number	5	Start date or starting event:		Week 7 (28 March 2022)	
Work package title	**PDR and Assembling**				
Participant number	1	2			
Participant name	Çağla	Doğukan			
Weeks per participant	1	1			

Objectives

- Preliminary Design Review and Prototype Design

Description of work

T1.1 (Week 7 – Week 8)

- Assembling the main parts of the drone

T1.2 (Week 7 – Week 8)

- Assembling the main parts of the drone

Deliverables

D1.1 (Week 8)

- Assembled drone

D1.2. (Week 8)

- Assembled drone

Milestones

M1.1

- Assemble main parts of the drone such as motor, propellers, flight controller, GPS module, battery, Raspberry Pi etc

Work package number	6	Start date or starting event:		Week 8 (4 April 2022)	
Work package title	**Main Software**				
Participant number	1	2			
Participant name	Çağla	Doğukan			
Weeks per participant	1	1			

Objectives

- Writing the software for landing, flying etc. and designing main controller of the drone

Description of work

T1.1 (Week 8 – Week 9)

- Writing software for special commands such as drone flying and automatic landing

T1.2 (Week 8 – Week 9)

- Writing a computer application for drone control and data extraction from the database

Deliverables

D1.1 (Week 9)

- Compiled code

D1.2. (Week 9)

- A simulation about computer app

Milestones

M1.1

- Implement algorithms for the drone to accomplish basic operations such as take-off, landing, flying etc

Work package number	7	Start date or starting event:		Week 9 (18 April 2022)	
Work package title	**Box holding**				
Participant number	1	2			
Participant name	Çağla	Doğukan			
Weeks per participant	1	1			

Objectives

- Development and manufacturing of the equipment needed to hold boxes

Description of work

T1.1 (Week 9 – Week 10)

- Writing the software of the box holding equipment

T1.2 (Week 9 – Week 10)

- Development of the box holding equipment

Deliverables

D1.1 (Week 10)

- Compiled code for box holding equipment

D1.2. (Week 10)

- An equipment for box holding

Milestones

M1.1

- Development of equipment for holding and dropping boxes to be transported

Work package number	8	Start date or starting event:		Week 10 (25 April 2022)	
Work package title	**CDR and Final Integration**				
Participant number	1	2			
Participant name	Çağla	Doğukan			
Weeks per participant	1	1			

Objectives

- Critical Design Review and Final Version of Aerial Robot for Package Transmission

Description of work

T1.1 (Week 10 – Week 13)

- Combining and compiling the software of the main code and the code of the extra equipment

T1.2 (Week 10 – Week 13)

- Installation, integration and testing of required extra components of the drone. (e.g. Camera, LIDAR and box holding equipment)

Deliverables

D1.1 (Week 13)

- Final code

D1.2. (Week 13)

- Final Version of Aerial Robot for Package Transmission

Milestones

M1.1

- Integrating camera and LIDARs to the drone and implement a computer application for main operations including mapping, controlling, decision analysis etc.
- Make improvements according to the feedbacks obtained in CDR and deficiencies observed during the test fly.

Work package number	9	Start date or starting event:		Week 13 (16 May 2022)	
Work package title	**Final Demo and Project Video**				
Participant number	1	2			
Participant name	Çağla	Doğukan			
Weeks per participant	1	1			

Objectives

- Preparation of presentation and demo video

Description of work

T1.1 (Week 13 – Week 14)

- Preparation of presentation

T1.2 (Week 13 – Week 14)

- Preparation of demo video

Deliverables

D1.1 (Week 14)

- A document for presentation

D1.2. (Week 14)

- Demo video

Milestones

M1.1

- Preparing the demo video with the stated mission (package transmission by the aerial robot) accomplished
- Get final feedbacks from the supervisors and submit project report including demo video
- Finalizing the project

3. Demonstration

The performance of our project can be evaluated by several parameters such as: instant communication between drone and mobile application, correct colour detection, database management, decision analysis, inventory management, operations of drone (take-off, landing, loading), avoiding collisions. By looking at these criteria, we can evaluate our drone's performance as successful or not.

Instant communication: It evaluates if our drone's main controller and RaspberryPi can communicate with the mobile application instantly. If we have an instant communication, we can conclude that our drone can lower delivery times significantly compared to manpower.

Colour detection: It evaluates our aerial robot's performance in terms of its image processing skills. Since we will use colours to identify different packages, it is a critical operation for delivering the correct package to the user according to his/her choice in the mobile application.

Database management: It measures how accurately the database is getting information from our mobile application. It is a critical operation for our mission since we will get the location information from the mobile application and send it to the database, then send it to the main controller of the drone.

Decision analysis: It evaluates how efficiently our aerial robot accomplish its mission being in line with our decision analysis algorithm. It should consider the location information and colour information in its decision processes.

Inventory management: Since we are delivering packages from different package centres, inventory management is a key concept for our project. We will look at the inventory list of each package centre and make sure that our aerial robot doesn't chose the package centre without the required package even though it's the closest one from the user.

Operations of drone: It evaluates the main operations of the aerial robot such as taking-off, landing, loading and also making sure that we can get information about the drone's situation instantly on the controller.

Collisions: It evaluates the performance of our aerial robot in terms of its avoidance of collisions and having a round trip efficiently.

Our final demonstration will consist of a mission designed specially for our aerial robot. We will use the data collected from mobile application in drone's main controller to accomplish its tasks. At the end, we will deliver the desired supply relief kit to the user without any loss or collision on the path. The performance of our final demonstration can be measured using the evaluation parameters listed above.

4. Impact

Our project, aerial robot for package transmission, is designed to be used in both package delivery and rescuing applications. By detecting the correct packages according to colours, it can be useful for the package delivery purposes for the companies in the logistics industry. In addition, our main motivation is to use this package delivery operations for transmitting supply relief kits to the people who are in unreachable locations. When there is a disaster or someone is stuck in a place, our aerial robot would detect the person when he/she taps on the package desired on the application and will receive it at the least amount of time. We believe that we can touch into someone's life and help them or even save a life.

5. Risk analysis

The first risk in our project is that they are some limitations for drone operations such as flying latitude, location and drone license. For instance, according to FAA (Federal Aviation Administration), drones should operate in low attitude [8]. So, we need to take consider these perspectives while implementing operations. If one of the restrictions are not obeyed, we could have serious outcomes such as invasion of privacy, not obeying to law etc.

The second risk in our project can be stated as having several challenges including knowledge of different software languages, integration of camera and LIDARs, loading properly, landing without collision etc. We need to take consider several parameters in every step of our project. For instance, loading and dropping the package operation needs to be designed by considering weight of the package, surrounding of the destination point and obstacles in the path.

Our last risk can be stated as the security of the communication between the computer and the drone. Since their communication will be wireless, it will be open to other people if we don't use our skills in cybersecurity. In our project, we also need to give attention to this point since the drone has the power to travel and also has a camera which can be a real problem if it gets into control by other people.

6. Gantt Chart

Aerial Robot for Package Transmission — Çağla Türkoğlu / Alp Doğukan Halitoğulları

Task ID	Task Name	Start Date	End Date	Duration (In Weeks)	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13
T01	Literature Review about aerial drones	28 February 2022	7 March 2022	1											
T02	Budget & Component List	7 March 2022	14 March 2022	1											
T03	SOS Aplication	14 March 2022	21 March 2022	1											
T04	Extra components code	21 March 2022	28 March 2022	1											
T05	PDR and Assembling	28 March 2022	4 April 2022	1											
T06	Main Software	4 April 2022	18 April 2022	1											
T07	Box holding	18 April 2022	25 April 2022	1											
T08	CDR and Final Integration	25 April 2022	16 May 2022	3											
T09	Final Demo and Project Video	16 May 2022	23 May 2022	1											

Ethical Issues

Our project will mainly agree with IEEE Code of Ethics and limitations of FAA (Federal Aviation Administration). If there are licenses or extra products required for the software tools, we will obtain them and use the programs accordingly. In addition, there are privacy concerns since we integrate a camera on the drone. We won't have any recordings with the camera for not invading privacy of any people.

References

[1] Business Insider. 2022. Drone technology uses and applications for commercial, industrial and military drones in 2021 and the future. [online] Available at: <https://www.businessinsider.com/drone-technology-uses-applications> [Accessed 28 February 2022].

[2] Allerin.com. 2022. [online] Available at: <https://www.allerin.com/blog/10-stunning-applications-of-drone-technology> [Accessed 28 February 2022].

[3] Drones, A., Us, A. and Uses, U., 2022. Applications and Uses for UAV Multirotor Drones. [online] Rise Above Custom Drones & Robotics Pty Limited. Available at: <https://www.riseabove.com.au/drone-services/uav-applications-and-uses/> [Accessed 28 February 2022].

[4] Builtin.com. 2022. What Is A Drone? What Are Uses For Drones? | Built In. [online] Available at: <https://builtin.com/drones> [Accessed 28 February 2022].

[5] Campaignlive.co.uk. 2022. FAA grounds Amazon drone delivery. [online] Available at: <https://www.campaignlive.co.uk/article/faa-grounds-amazon-drone-delivery/1334152> [Accessed 28 February 2022].

[6] Campaignlive.co.uk. 2022. FAA grounds Amazon drone delivery. [online] Available at: <https://www.campaignlive.co.uk/article/faa-grounds-amazon-drone-delivery/1334152> [Accessed 28 February 2022].

[7] page, H. and (LIDAR), A., 2022. Aerial laser scanning (LIDAR) with UAV. [online] zala-aero.com. Available at: <https://zala-aero.com/en/services/aerial-laser-scanning-lidar/> [Accessed 28 February 2022].

[8] Ukessays.com. 2022. Ethical Issues of the Use of Drones. [online] Available at: <https://www.ukessays.com/essays/military/ethical-issues-of-the-use-of-drones.php#:~:text=The%20third%20ethical%20concern%20of,many%20national%20parks%2C%20and%20marine> [Accessed 28 February 2022].