



**YAŞAR UNIVERSITY  
FACULTY OF ENGINEERING  
DEPARTMENT OF COMPUTER ENGINEERING**

**COMP4910 Senior Design Project 1, Fall 2020  
Supervisor: MUTLU BEYAZIT**

**Project Code Name: CYBER DRONE  
Final Report**

**23.05.2021**

**By:  
Bora GÜZEL, 17070001010  
Ege Erberk USLU, 16070001007  
Simge Binnaz ÖZDEMİR ,17070001001**

## PLAGIARISM STATEMENT

This report was written by the group members and in our own words, except for quotations from published and unpublished sources which are clearly indicated and acknowledged as such. We are conscious that the incorporation of material from other works or a paraphrase of such material without acknowledgement will be treated as plagiarism according to the University Regulations. The source of any picture, graph, map or other illustration is also indicated, as is the source, published or unpublished, of any material not resulting from our own experimentation, observation or specimen collecting.

### Project Group Members:

Name, Lastname	Student Number	Signature	Date
Simge Binnaz ÖZDEMİR	17070001001	S.B.Ö.	23.05.2021
Ege Erberk USLU	16070001007	E.E.Uslu	23.05.2021
Bora Güzel	17070001010	B.Güzel	23.05.2021

### Project Supervisors:

Name, Lastname	Department	Signature	Date
Mutlu BEYAZIT	Computer Engineering		

## ACKNOWLEDGEMENTS

We would like to express our gratitude to Mr. (Assist. Prof.) Mutlu Beyazıt, who supported us with his knowledge and experience at every stage of our graduation project called Cyber Drone, who supported us with his sincerity and gave direction to our work. On the other hand, we would like to express our gratitude to all our professors who have brought us to this day, who have conveyed their knowledge to us, who have made us move on the right path in terms of education throughout our university life, who teach engineering ethics and most importantly, who have reinforced our human values and we would also like to express our gratitude to our families who have always supported us unconditionally in our lives.

## **KEYWORDS**

Simulation

Drone

Game Engine

Customization

Multiplayer

## **ABSTRACT**

In our daily life, drones can easily reach areas that people cannot reach. With this feature, drones are a very important tool for today. While reaching these challenging areas, financial losses may be experienced during drone use due to external factors or user errors. In order to fix or minimize these material damages, it is aimed to teach people how to use drones and to show the behavior of drones. For this, possible external factors have been transferred to a simulation environment. Thanks to the use of this simulation environment and the reports of the events occurring during the simulation, it is aimed that people can see their mistakes and learn from these mistakes. Therefore, users will gain experience and their ability to use drones will improve. Thus, this project will contribute to the minimization of material damage that may occur due to human error or external factors to the drones.

## **ABSTRACT(TÜRKÇE)**

Günlük hayatımızda insanların ulaşamadığı alanlara dronlar rahat bir şekilde ulaşabilmektedirler. Bu özelliği ile dronlar günümüz için çok önemli birer araç olmaktadır. Bu zorlu alanlara ulaşırken dış etkenlere ya da kullanıcı hatalarına bağlı olarak dron kullanımı sırasında maddi kayıplar yaşanabilmektedir. Bu maddi hasarları giderebilmek ya da minimize etmek amacı ile kişilere dron kullanımı öğretmek ve dronların davranışlarını göstermek amaçlanmıştır. Bunun için olası dış etkenler bir simülasyon ortamına aktarılmıştır. Bu simülasyon ortamının kullanımı ve simülasyon sırasında meydana gelen olayların kullanıcılar tarafından gözlemlenmesi amaçlanmaktadır. Dolayısı ile kullanıcılar deneyim kazanacaklar ve dron kullanabilme yetenekleri gelişecektir. Böylelikle dronların insan hatası veya dış etkenlere bağlı olarak ortaya çıkabilecek maddi hasarların en aza indirilmesine katkıda bulunacaktır.

## ÖZET

Cyber Drone projesi, dron kullanımını öğretmek ve dronların gerçek hayattaki davranışlarını bir simülasyon ortamına aktararak meydana gelebilecek maddi hasarın azaltılmasını hedefleyen bir projedir. Cyber Drone projesi, gerçek hayatta dron uçurma deneyimi olmayan bireylere bu yeteneği sanal ortamda verip bu sanal deneyimi daha verimli hale getirmek adına çok sayıda harita ve farklı çevre koşullarına ilişkin ortamları barındıran bir simülasyondur.

Projemiz istemci-sunucu ilkesine dayalı olarak çalışmaktadır. Sistem yöneticileri simülasyon uygulaması üzerindeki bütün sistemlerden sorumludur. Sistem yöneticileri tarafından erişim izni verilen kullanıcılar masaüstü uygulaması üzerinden sisteme dâhil olabileceklerdir. Sistem yöneticileri kullanıcılar verdiği yetkiler doğrultusunda sistem yönetimi gerçekleştirir. Buna ek olarak sistem yöneticileri web uygulaması üzerinden kullanıcıları gözlemleyebilirler.

Simülasyon, dronların gerçek hayattaki hareket kabiliyetini, kullanıcılara en gerçekçi şekilde aktarmayı hedeflemektedir. Bunlara örnek olarak dronların 360 derece etrafı görme kabiliyeti, kalkışı ve inişi verilebilir. Simülasyona erişim sağlayan kullanıcılar uygulama içerisinde farklı dronları deneyimleme şansına sahip olur. Simülasyona başlarken kullanıcılar deneyimlemek istediği harita ve dış etmenleri seçebilirler. Buna ek çoklu oyunculu seçeneği bulunan simülasyonda, kullanıcıların birden fazla dronla aynı ortamı paylaşımları koşullarında hareketlerini gözlemleme şansına da sahip olacaktır. Bu seçimler dronların davranışlarına yansıtacağından kullanıcılara gerçekçi bir ortam sağlayacaktır.

Bu özellikler doğrultusunda gerçekçi bir deneyim sağlayarak kullanıcıların dron kullanmayı öğrenmesi, dış etkenlerden dronların nasıl etkileneceğini gözlemlemesi ve bu etkiler sonucunda kullanıcıların kendilerini gözlemleyebilmeleri amaçlayarak yanlış kullanım ve dış faktörlerden oluşacak maddi hasarı azaltmayı amaçlar.

## **TABLE OF CONTENTS**

PLAGIARISM STATEMENT	2
ACKNOWLEDGEMENTS	2
KEYWORDS	3
ABSTRACT	4
ABSTRACT(TÜRKÇE)	4
ÖZET	5
TABLE OF CONTENTS	6
LIST OF TABLES	7
LIST OF ACRONYMS/ABBREVIATIONS	8
1. INTRODUCTION	9
1.1. Description of the Problem	9
1.2. Project Goal(s)	9
1.3. Project Output(s)	9
1.4. Project Activities and Schedule	10
2. DESIGN	11
2.1. High Level Design	11
2.2. Detailed Design	11
2.3. Realistic Restrictions and Conditions in the Design	12
3. IMPLEMENTATION, TESTS and TEST DISCUSSIONS	12
3.1. Implementation of the Product	12
3.2. Tests and Results of Tests	12
4. CONCLUSIONS	13
4.1. Summary	13
4.2. Cost Analysis	13
4.3. Benefits of the Project	14
4.4. Future Work	14
References	15
APPENDICES	15
APPENDIX A: REQUIREMENTS SPECIFICATION DOCUMENT	15
APPENDIX B: DESIGN SPECIFICATION DOCUMENT	15
APPENDIX C: PRODUCT MANUAL DOCUMENT	16

## **LIST OF TABLES**

<b>Table 1:Project Activities &amp;Schedule.....</b>	<b>10</b>
<b>Table 2:Human power table.....</b>	<b>13</b>
<b>Table 3:Cost of the cyber drone project.....</b>	<b>14</b>

## **LIST OF ACRONYMS/ABBREVIATIONS**

UML	Unified Modeling Language
DSD	Design Specification Document
RSD	Requirement Specifications Document



# **1. INTRODUCTION**

## **1.1. Description of the Problem**

It is quite difficult for users to use a drone at first. Because getting used to the ergonomic structure of the drone and using its maneuverability effectively requires a certain experience. Therefore, crashes caused by the user may occur in the beginning. The consequences of these crashes often cause great costs. In addition, the inability to prepare in advance for environmental influences significantly increases the damage to the drones and the costs caused by the damage. [1]

Since drone users cannot experience the pitch where they will operate, they may encounter problems related to the operation field. When the drones are on the pitch, structural damage may occur in the drones as a result of being exposed to external factors. When the resulting damages are irreversible, it causes substantial financial losses.

Details of the problem states that Appendix A: Requirement Specifications Document.

## **1.2. Project Goal(s)**

Based on the problem we mentioned in Section 1.1, the aim of the Cyber Drone project is to realize a simulation environment which is realistic and gives more freedom to the user. Thus, the simulation will teach our users how to use drones without using them in real life. In addition, the project aims to create a simulation where users can observe the different effects of the environmental conditions and multiplayer conditions to the drones before they are on the field. [2]

## **1.3. Project Output(s)**

During Comp 4910 & Comp 4920:

- Project Proposal
- Requirements Specification Document v1.0
- Requirements Specification Document v2.0 (in Unified Modeling Language)
- Design Specification Documentv1.0 (High level in Unified Modeling Language)
- Final Report & Web Poster
- Requirements Specification Document v2.1
- Design Specification Documentv1.1 (High level)
- Design Specification Documentv2.0 (Detailed)
- Product Manual & Product

#### 1.4. Project Activities and Schedule

In this section, the process from the idea stage of the project to the product is shown in the **table 1**. The process that starts with the set-up phase of the team continues with a wide preparation phase. After the preparation phase, the requirements of the project were determined. Designs were shaped according to the determined ones. Launch and execution part started after design. After the code and environment is completed, the generated parts are combined each other. The whole system has been tested and monitored in project performance and monitoring section.

**Table 1:Project Activities &Schedule.**

<b>Project Title: Cyber Drone</b>				
<b>WBS NUMBER</b>	<b>TASK TITLE</b>	<b>START DATE</b>	<b>DUE DATE</b>	<b>DURATION</b>
#1.0	Project Initiation			
#1.1	Group determination	10.06.2020	10.07.2020	30
#1.2	General Research	8.07.2020	27.08.2020	49
#1.3	Project selection	3.09.2020	12.09.2020	9
#1.4	Research about project	12.09.2020	3.10.2020	21
#1.5	Project Assignment	10.11.2020	27.11.2020	17
#2.0	Project Planning & Documentation			
#2.1	Requirement Specification document (RSD v1.0)	30.11.2020	15.12.2020	15
#2.2	Requirement Specification document (RSD v2.0 in UML)	7.01.2021	24.01.2021	17
#2.3	Design Specification Document (DSD v1.0 in UML)	7.01.2021	24.01.2021	17
#2.4	Final report v1.0 & web poster	7.01.2021	24.01.2021	17
#2.5	Requirement Specification document (RSD v2.1)	22.02.2021	30.02.2021	8
#2.6	Design Specification Document (DSD v1.1 High level)	30.02.2021	2.03.2021	28
#2.7	Design Specification Document (DSD v2.0 Detailed)	20.02.2021	26.03.2021	36
#2.8	Product Manual v1.0	22.03.2021	2.04.2021	10
#2.9	Final version of DSD, RSD & Product manual	25.04.2021	1.06.2021	36
#2.10	Project web Site	25.04.2021	1.06.2021	36
#2.11	Project Summary in Turkish	25.04.2021	1.06.2021	36
#2.12	Poster	25.04.2021	1.06.2021	36
#2.13	PowerPoint Slide Presentation	25.04.2021	1.06.2021	36
#2.14	Project demonstration Video recording	25.04.2021	1.06.2021	36
#2.15	Product	25.04.2021	1.06.2021	36

#3.0	Project Launch & Execution			
#3.1	Generating drone movement code	22.02.2021	1.03.2021	9
#3.2	Map design & generating air condition code	27.02.2021	5.04.2021	38
#3.3	Integration of Map and movement code	1.04.2021	20.04.2021	19
#3.4	Web system creation	22.02.2021	20.04.2021	58
#3.5	Creation of database system	22.02.2021	20.04.2021	58
#3.6	Integration of database to Web environment	16.04.2021	22.04.2021	6
#3.7	Implementation of User interface of Unity & air condition part	27.02.2021	5.04.2021	38
#3.8	Combining of Unity user interface and game part	1.04.2021	20.04.2021	19
#3.9	Creating Multiplayer game	1.04.2021	20.04.2021	19
#3.10	Integration of web system and unity game system	20.04.2021	10.05.2021	20
#4.0	Project Performance/Monitoring			
#4.1	Holistic Monitoring of System	10.05.2021	18.05.2021	8
#4.1	Web system testing	20.04.2021	10.05.2021	20
#4.3	Testing all integrated system	10.05.2021	20.05.2021	10

## 2. DESIGN

### 2.1. High Level Design

In our High-Level Design Specification Document (DSD final version), information was given about the simulation that we will generate. After the introduction, explanations were made regarding the system design of the simulation and the architecture, structure and environment of the system, which are sub-parts of the system design. Detailed classifications regarding the system design were made. In addition, information about test design was given simply. Our high-level design is provided in Appendix B: Design Specifications Document by referring to its relevant sections. [3]

### 2.2. Detailed Design

Cyber drone project is a unity game engine product consisting of two main parts. These main parts are Unity and Web side.

Unity section includes user interface and simulation environment. Registered members can create their own world by choosing different maps and different environmental conditions. Or, with the multiplayer option, they can use the simulation by sharing the same environment with more than one person. In the system built with Unity, there are scripts for the movements of drone and camera objects and other components that these scripts interact with. Thanks to the prepared canvas interfaces, these interactions are easily transferred to the user.

The web part is another part that is mostly used for the management of the Unity system. General data management for users is provided over the web. System administrators register users on the system themselves. Registered users can update their profile with their login information on the web. In addition, the user records at any time during the simulation and has the opportunity to watch the recorded recording with a web. Login information and activity status for users are managed by system administrators over the web.

The detailed design and operation of the system part is given in the Design Specification Document. [3]

### **2.3. Realistic Restrictions and Conditions in the Design**

- The product to be delivered can serve more than one user at the same time.
- Drones and map types may be below the targeted number because of financial reasons and limited time.
- In order to ensure security in the first version of the project, passwords can be provided by the system, thus this will minimize security problems in the system.
- In the first version of the project, RSA was used as the encryption technique while sending the username and password required to enter the simulation or web system.
- Keeping game records and logs unencrypted in the server.
- Keeping records on a single server instead of distributed servers.
- Video Recording part is run only in Windows Environment due to FFMPEG and screen recording system.

## **3. IMPLEMENTATION, TESTS and TEST DISCUSSIONS**

### **3.1. Implementation of the Product**

The project will be implemented with the help of Unity Game Engine. C# will be preferred as the coding language due to the use of Unity Game Engine. Unity's physics engine and libraries will be used while building the simulation environment. It is planned to store the data obtained from the simulation in SQL-based databases. For the reporting system, it is planned to choose a C# based backend framework called ASP.NET Core. At the same time for the front-end part, it is planned to use a JavaScript framework named Vue.js and bootstrap included in Cascading Style Sheets (CSS). Photon Network system is used for multiplayer part implementation. In addition, node.js server is used to manage online user server. [4]

### **3.2. Tests and Results of Tests**

During the construction and testing of the project, all APIs were tested using Postman. Because Postman is a very useful rest client for testing backend APIs [5]. All remaining tests for the web were tested manually. For the Unity section, the interactions of movements and objects have been manually set up on different computers. The determined features have been tested by individuals. Details regarding the mentioned test are given in the product manual. [6]

## 4. CONCLUSIONS

### 4.1. Summary

The Cyber Drone project aims to teach the use of drones and to reduce the material damage that may occur while using drones by transferring the real-life behavior of drones to a simulation environment. Cyber drone project is a simulation that provides this flight ability to individuals who do not have experience of flying drones in real life in a virtual environment and includes many maps and different weather conditions. It also enables individuals to experience multiplayer conditions by sharing the same environment with more than one person.

Our project works based on the client-server principle. System administrators are responsible for managing all systems. Users who are granted access by the admins will be able to join the system via the desktop application. Admins are able to create, update, read, delete and give permissions to their users. In addition to that, Admins may see the other logs of their user with web application. In addition, the user can watch her/his own recordings and manage her own profile.

The simulation aims to convey the real-life mobility of drones to the users in the most realistic way. Examples of these are the 360-degree perspective of drones, take-off and landing. Users can customize their drones. Also, they can select the map and different air conditions while during the simulation. These choices will be reflected in the behavior of the drones, and this will provide a realistic environment for the users. In addition to this situation, the user can share the same environment with more than one user in the multiplayer mode, thus finding the opportunity to observe their movements in a multi-player environment.

In line with these features, it aims to enable users to learn to operate drones in different situations, to observe how drones will be affected by external factors, to see where they made mistakes. So that simulation aims to reduce material damage caused by misuse and external factors.

### 4.2. Cost Analysis

In this section, the manpower table and cost analysis required during the project are made. The amount of workforce required for the project to achieve the desired goal is shown in Table 2. The weekly working time of each team member has been processed. In addition, information about the assets to be used on Unity during the implementation of the project is given in Table 3. Table 3 has been prepared using the following references. [7] [8] [9]

**Table 2: Human power table.**

<b>Human Power / Date</b>		<b>Simge Binnaz Özdemir</b>	<b>Ege Erberk Uslu</b>	<b>Bora Güzel</b>
February	Week 1	24 hours	24 hours	24 hours
March	Week 2	24 hours	24 hours	24 hours
	Week 3	24 hours	24 hours	24 hours
	Week 4	24 hours	24 hours	24 hours
	Week 5	24 hours	24 hours	24 hours
April	Week 6	24 hours	24 hours	24 hours

	Week 7	24 hours	24 hours	24 hours
	Week 8	24 hours	24 hours	24 hours
	Week 9	24 hours	24 hours	24 hours
May	Week 10	24 hours	24 hours	24 hours
	Week 11	24 hours	24 hours	24 hours
	Week 12	24 hours	24 hours	24 hours
	Week 13	32 hours	32 hours	32 hours
June	Week 14	32 hours	32 hours	32 hours

**Table 3:Cost of the cyber drone project.**

Software	Cost
Drone assets	30
City builder Map asset	33.9
Mountain trees map asset	20
Total	50 \$

#### **4.3. Benefits of the Project**

- Our users can learn and practice using drones without using them in real life thanks to the simulation.
- To be able to experience the drone's reactions under different air conditions.
- To give experience of using different drone types.
- Learning to use drones without worrying about financial risks.
- Observing and learning from the mistakes made by the users thanks to the web system.
- To have experience in a multiplayer environment.
- To save the simulation moment, download and watch it later.

#### **4.4. Future Work**

More maps, drone types and weather conditions can be added depending on the progress of the project. In the future, a compiler can be developed and integrated into the system. Thus, the desired movements in real life can be compiled and become a code simulator. Also, Physic engine in project can be improved by adding more realistic movement. Users can make the movements they want to the objects with the compiler. By improving the existing multiplayer side, features such as lobby system and adding friends can be added. In addition, as the multiplayer side is developed, it can be used for simulation of swarm drones in the future. In addition, all restrictions that mentioned in section 2.3 will be implemented such as adding recording system for all operating systems.

## References

- [1] j. feist, "First time flying a drone? Don't make these mistakes," droneRush, 26 04 2021. [Online]. Available: <https://dronerush.com/top-drone-flying-mistake-5564/>. [Accessed 18 05 2021].
- [2] D. D. Y. Servisi, "Drone simülasyon uygulamaları," DJI Drone Yetkili Servisi, 18 feb 2019. [Online]. Available: <https://djidroneservisi.com/drone-simulasyon-uygulamalari/>. [Accessed 18 05 2021].
- [3] D. Team, "Design specification document (Dsd final)," İzmir, 2021.
- [4] wikipedia, "Unit game engine," wikipedia, 17 may 2021. [Online]. Available: [https://en.wikipedia.org/wiki/Unity\\_\(game\\_engine\)#:~:text=Unity%20is%20a%20cross%2Dplatform,support%20more%20than%205%20platforms](https://en.wikipedia.org/wiki/Unity_(game_engine)#:~:text=Unity%20is%20a%20cross%2Dplatform,support%20more%20than%205%20platforms.). [Accessed 18 05 2021].
- [5] D. demirbaş, "Postman Nedir?," Kodcular, 21 nov 2020. [Online]. Available: <https://medium.com/kodcular/postman-nedir-ce39bef14db7#:~:text=Postman%20backend%20apilerini%20test%20emek%20i%C3%A7in%20olduk%C3%A7a%20kullan%C4%B1%C5%9Fl%C4%B1%20bir%20rest,export%20edip%20arkada%C5%9Flar%C4%B1n%C4%B1zla%20da%20payla%C5%9Fabiliyorsunuz..> [Accessed 18 05 2021].
- [6] D. Team, "Product Manual final version," izmir, 2021.
- [7] "City builder:urban," unity asset store, 12 april 2021. [Online]. Available: <https://assetstore.unity.com/packages/3d/environments/urban/city-builder-urban-180722>. [Accessed 18 05 2021].
- [8] "Drone tau," unity asset store, 1 april 2020. [Online]. Available: <https://assetstore.unity.com/packages/3d/vehicles/air/drone-tau-165900#content>. [Accessed 18 05 2021].
- [9] "Mountain trees dynamic nature," unity asset store, 31 march 2021. [Online]. Available: <https://assetstore.unity.com/packages/3d/vegetation/trees/mountain-trees-dynamic-nature-107004>. [Accessed 18 05 2021].

## APPENDICES

## APPENDIX A: REQUIREMENTS SPECIFICATION DOCUMENT



CyberDroneRSDFinal.docx

## APPENDIX B: DESIGN SPECIFICATION DOCUMENT



CyberDroneDSDFinal.docx

## **APPENDIX C: PRODUCT MANUAL DOCUMENT**



CyberDrone\_PMfinal.docx