Institute of Informatics and Mechatronics

Bachelor's Thesis

in the field of study of Computer Engineering and Mechatronics

Cloud Managed Unmanned Aerial System

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This work is dedicated to my loving and very supportive parents ...

Acknowledgements

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Cloud Managed Unmanned Aerial System

Abstract. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

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Keywords: AWS, UAV, UAS

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Nomenclature

Acronyms / Abbreviations

AWS	Amazon Web Services
DJI	Da-Jiang Innovations
GCS	Ground Control Station
LTE	Long Term Evoluton (Telecommunication)
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle

Chapter 1

Introduction

Unmanned Aerial Vehicles also known as UAVs or Drones, although hardly a new technology, with the first used UAV recorded in history dating back to 1849 [1], have recently gained a lot of attention from various sectors ranging from entertainment to military. This is going to have an impact that cannot be overseen over the coming years as more and more people find uses of UAVs in various applications. UAVs were initially developed to be used for military operations, mainly surveillance, but they were later armed to also enable them to perform long-distance military operations without putting humans at risk. The United States of America has used these types of UAVs mainly in the wars in the Middle East, where UAVs like the General Atomics MQ-9 Reaper also known as Predator B and Northrop Grumman RQ-4 Global Hawk have been widely deployed [2].

Despite their use in the military sector, UAVs have also been employed in other sectors such as commercial and entertainment sectors, where UAVs are being used in things like land geography mapping, industrial surveillance, photography and many more. Companies like SZ DJI Technology Co., Ltd. or Shenzhen DJI Sciences and Technologies Ltd. in full, more popularly known as its trade name DJI have had a lot of success in this area, where as of March 2021 DJI was coveringitself covers (research on the percentage of drones that DJI makes and are on the market). UAVs have also seen great use in the healthcare sector, where companies like Zipline [3] are implementing an end-to-end supply chain system that employs UAVs to supply and deliver medical supplies to hospitals in rural areas in Rwanda that are hard to reach or inefficient to reach by any other means of delivery. Rwanda has also seen great use of UAVs during the COVID-19 pandemic where UAVs were widely used by the Rwanda's Ministry of Health and the Rwanda National Police to spread COVID-19 awareness in Kigali communities [4].

As UAVs gain the market, the need to have robust UAV systems also known as UASs becomes eminent. Therefore, in this thesis, focus was put in designing and building a robust, scalable, highly available cloud deployed Unmanned Aerial System, that can easily be integrated with cloud services like Amazon Web Services also known as AWS to provide a solution where UAV pilots can control UAVs from virtually anywhere in

the world. The proposed system comprises of a UAV flying with onboard compute that has an LTE datalink to a ground control system also known as GCS, dashboards and a command-and-control center application running in a highly available and fault tolerant AWS cloud infrastructure. The focus of this thesis is to therefore assess the possibilities of implementing such a solution in an efficient, resilient, reliable, and highly available manner and discuss on the pros and cons of the solution.

The proposed solution, as seen in the high high level design in figure 1.0.1, was developed following the best industry standards in software development and architecture as is going to be described in detail in the next chapters. This thesis is also going to discuss the developments that have already been made in this area as well as areas that need further research and development.

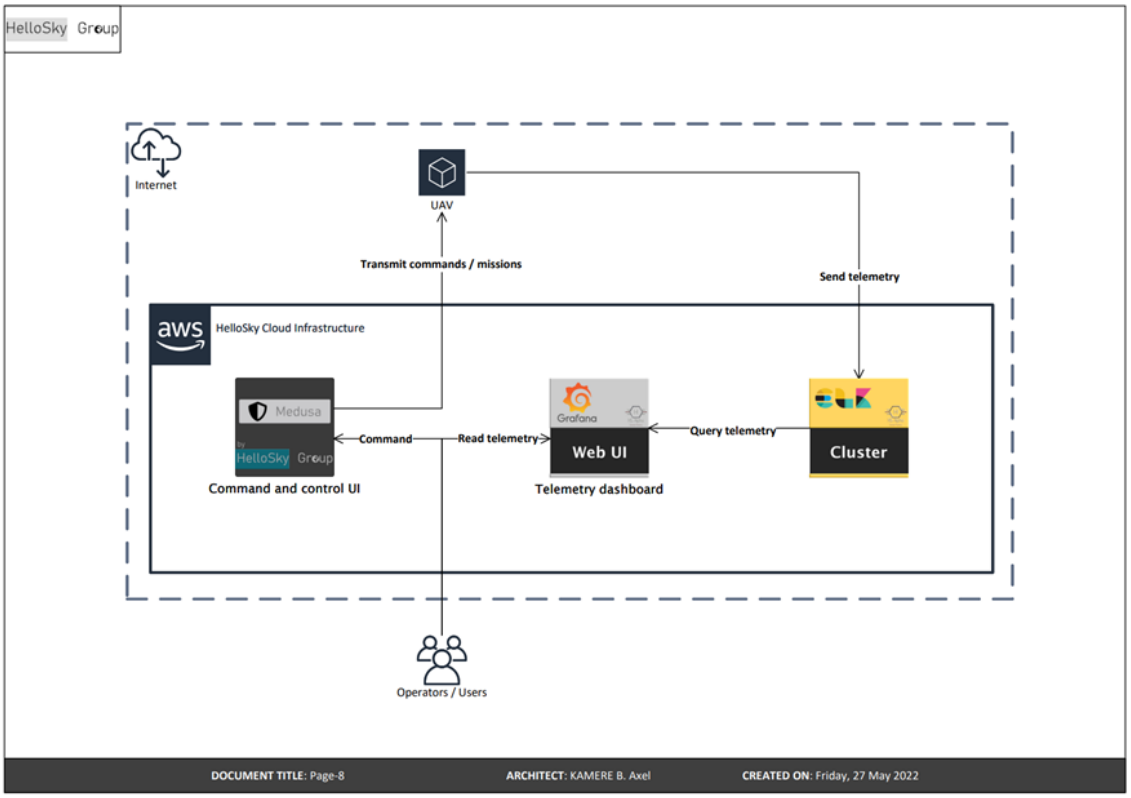

Figure 1.0.1. System High High Level Design.

Source: Own creation. Designed with Microsoft Visio. Refer to 2.4.6.

1.1 Related work

bla bla

1.2 Use case

As UAVs emerge, there will be a need to be able to centrally manage a fleet of UAVs. Depending on the UAV use case, operators might need to also control them at a long distance beyond eyesight. A UAV operates as part of a system comprised of multiple other components that support the operation of a UAV. The main components are a Ground Control System, (Research on the main components of a UAV). UAVs can either be Fully autonomous, fully manual, or semi-autonomous. UAVs can also be employed in various use cases, below are various scenarios in which UAVs can be used

- Terrain mapping.
- Shipping and delivery.
- Search and rescue.
- Law enforcement.
- Military reconnaissance / Surveillance.

For a UAV to perform any of the above, it needs to meet certain criteria, a UAV should:

- Have onboard computer to process mission commands on the fly.
- Have onboard key components like,
  - Sensors, depending on the mission.
  - Cameras.
  - Battery.
  - LTE modules or Satnav modules to allow communication with ground control.
- Have LTE or Satellite communication to enable the UAV to set up a datalink with the ground control. The UAV would have to send data such as
  - Ground speed.
  - Altitude.
  - Battery levels.
  - Yaw.
  - Location.
  - Direction.
  - Sensor data.
  - Send the data frequently for real-time or near real-time communication.
  - Be able to react and if necessary, take evasive maneuvers when:

* On collision course.
* The batteries are low on power.
* Out of connectivity range.

1.3 Problem definition

1.4 About HelloSky group

Across this thesis, there will be mentions of the name "HelloSky group". Several designs built for the project as well as source codes all have mentions of HelloSky group or hsg in abbreviations.

HelloSky group is a company name that I came up with to brand my work done and future developments that will be made on this project and many other related projects that will be built in the future. HelloSky group in itself was though as a group company that will have multiple child companies, and in the scope of this project, it will be used to represent the part of the company that is envisioned to deal with aerial monility, hence being the scope of the thesis. Figure 1.4.1 shows the HelloSky group logos used throughout the thesis project.

(a) Colored 500 x 200.

(b) Black and white 500 x 200.

Figure 1.4.1. HelloSky group logos.

Source: Own creation. Designed with Affinity Designer. Refer to 2.4.4.

Chapter 2

Theory

In this chapter, key background concepts and methodologies used in the thesis are going to be discussed. The chapter is going to discuss explain what is meant by unmanned aerial system and its components.

The chapter is also going to discuss on the cloud provider, Amazon Web Services (AWS), used to host various components of developed system, simulation and software development tools used, as well as laws and regulations around unmanned aerial systems.

2.1 Unmanned Aerial System

bla bla

2.1.1 Unmanned Aerial Vehicle

bla bla

Classification of Unmanned Aerial Vehicles

bla bla

2.2 Amazon Web Services

bla bla

2.2.1 Infrastructure as code

bla bla

2.3 Simulation

bla bla

2.3.1 Webots or Ardupilot?

bla bla

2.4 Graphics and software development

bla bla

2.4.1 Microsoft Visual studio code

bla bla

2.4.2 PyCharm by JetBrains

bla bla

2.4.3 PhpStorm by JetBrains

bla bla

2.4.4 Affinity Designer

bla bla

2.4.5 GitHub

bla bla

2.4.6 Microsoft Visio

bla bla

2.5 Law and regulation

bla bla

Chapter 3

Methodology

3.1 Approach

3.2 Solution description

Describe the solution on a higher level. Discuss HLDs.

Chapter 4

Setup

4.1 Software

4.1.1 Command and Control Center

4.1.2 Telemetry dashboard

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