INGENIA SE | YEAR 2022-2023

System Requirements Specifications

Grupo Hell-ix

25 November 2022

Contents

1. Preface

The System Specifications Document is addressed to project stockholders, as well as the Hell-ix Group. The following table displays information about the different issues of the document during the development of the project.

Table 1.1: Version Control

Issue	Date of Issue	Reason for Issue
1.0	25/11/2022	Initial Issue

2. Introduction

The system proposed consists of an autonomous racing drone to compete against another similar system in various tasks. The system is composed of a small UAV, a vision system to detect the environment of the drone, and a central computer to process data from the vision system and direct the UAV.

3. Glossary

UAV Unmanned Aerial Vehicle, a flying robot which does not require a human to operate.

4. User Requirements Definition

Here, you describe the services provided for the user. The nonfunctional system requirements should also be described in this section. This description may use natural language, diagrams, or other notations that are understandable to customers. Product and process standards that must be followed should be specified.

Competition/Deadline/URS/ST-001

Function The system shall be functional before may 2023

Description

According to the project management, the drone shall be able to perform both race phases by May 2023. This will be the end of the INGENIA SE Project and the competition will take place.

Competition/Budget/URS/ST-002

Function The budget available is 2000€

Description

The total budget for the project is 2000€. This means that the drone shall meet all the stated requirements spending less than this amount of money, including hardware and accessories.

Competition/Environment/URS/ST-003

Function The drone will fly in an enclosed space inside the university

Description

In order to meet the legal constraints, the drone shall fly inside the university area and below a specific height. Also, the space shall be enclosed to ensure the drone stability and avoid severe atmospheric disturbances that could damage the drone because of its light weight.

5. System Requirements Specification

Drone/Flight/SyRS/SY-001

Function The drone shall be able to fly in a controlled manner

Description

Prior to complete the two different race phases, the drone should be able to perfectly fly in a controlled manner. This is mandatory so that the drone can be able to precisely avoid obstacles.

Drone/Motors/SyRS/SY-001.1

Function The drone shall be able to lift its own weight plus the components mounted

Description

To participate in the different races the drone shall fly on its own. In order to achieve this, it has to self-propel, so the motors shall provide with the necessary power to lift its own weight and the components mounted.

Drone/Networking/SyRS/SY-001.2

Function A remote control system shall be able to manipulate the drone manually

Description

The drone shall respond to a manual remote control system to ensure security. If the automatic control system does not behave as expected, the drone shall be controlled in a manual way.

Drone/Networking/SyRS/SY-001.3

Function A remote control system shall be able to control the movement of the drone automatically

Description

During the second phase of the race, the drone shall avoid certain obstacles. To do this, it shall have to be controlled automatically by a remote system.

Drone/Onboard Computer/SyRS/SY-001.4

Function A control algorithm shall run onboard the drone

Description

Although the computing and control of the drone shall be done from a remote control unit, there shall exist a control algorithm to be run onboard the drone to ensure short time response in basic tasks.

Drone/Flight/SyRS/SY-002

Function The drone shall be able to traverse the race track autonomously as fast as possible

Description

The drone shall be able to

- Fly autonomously
- Follow a predefined path
- Detect and avoid hazardous objects
- Detect obstacles
- Make decisions autonomously based on obstacles
- Do this in a fast manner

Drone/Battery/SyRS/SY-002.1

Function The battery installed shall be large enough to ensure the competition is completed

Description

The battery system equipped on the drone shall be sufficient to complete each tasks with no need for a recharge. Therefore, the battery capacity shall be sufficiently large and the team shall purchase an extra battery to enable tests on the drone while the battery gets recharged.

Drone/Central Computer/SyRS/SY-002.2

Function A central computer shall perform the bulk of the processing

Description

A small control algorithm shall be installed on board to perform basic tasks of the drone, but there shall be a remote central unit with which the drone shall be controlled and the calculations necessary to detect and avoid obstacles made.

Drone/Vision System/SyRS/SY-003

Function The drone shall detect and avoid obstacles

Description

In the second stage of the competition, the drone will need to be able to avoid obstacles of the following categories:

- Hoops
- Poles
- Doors
- Split Rectangles

Therefore, the drone shall be able to distinguish between obstacle types and decide its trajectory based on this information.

Drone/Networking/SyRS/SY-003.1

Function The images captured by the drone shall be sent to a central computer for processing

Description

The information captured by the camera shall be sent to a central computing unit for processing, detection of substantial information, and decision based on the images captured. This shall be done wirelessly.

Drone/Flight/SyRS/SY-003.2

Function The drone must react in time to obstacles in its way

Description

The complete process of capturing, sending, processing, receiving and reacting shall be performed sufficiently fast so that the drone shall not collide with obstacles in its way.

6. Software Requirements Specification

Software/Source Code/SRS/SO-001

Function The source code must be traceable

Description

The source code shall be located in a repository so that changes can be tracked and previous versions are accessible.

Networking/Communications/SRS/SO-002

Function The software shall be able to communicate the drone and the central computer

Description

A communications software shall be designed so that the drone can communicate with the central computer wirelessly in order to transfer the collected data by the sensors in the drone and receive the instructions from the computer.

Central Computer/Vision/SRS/SO-003

Function The software shall be able to process images

Description

A processing pipeline shall be created which takes images as inputs and produce obstacle detections as outputs. The detections shall then be processed into instructions for the drone to execute.

Software/Programming Language/SRS/SO-004

Function The programming language shall be of the compiled type

Description

The programming language shall be compiled in order to minimize the latency between a detection and the consequent instruction.

7. System Architecture

There are three main factors affecting the system:

1. **University:** Professors of the subject set requirements and limits to the system. The main two factors are a deadline for the project and a maximum budget.
2. **Competition:** The competition is the main event of the project, it must be developed alongside the drone by both teams. It is affected by the budget and the deadline, and produces rules, obstacles and the race time of the different stages of the competition.
3. **Drone:** The drone will participate in the competition. It is affected by all the mentioned signals.

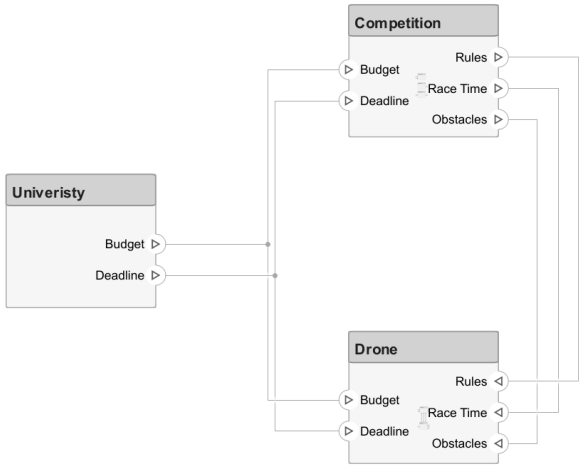

Figure 7.1: Diagram of the relations between the objects present for the project

7.1 Competition

The competition is composed of three mayor elements:

1. **Environment:** The physical environment where the competition is performed, including the race track and obstacles. The environment must be built before the deadline and within the given budget.
2. **First Race:** The first race will be centered around time, hence the race time is the signal.
3. **Second Race:** The second race will be centered around interacting with

obstacles, the main signal are these obstacles, and it is affected by the budget needed to build them.

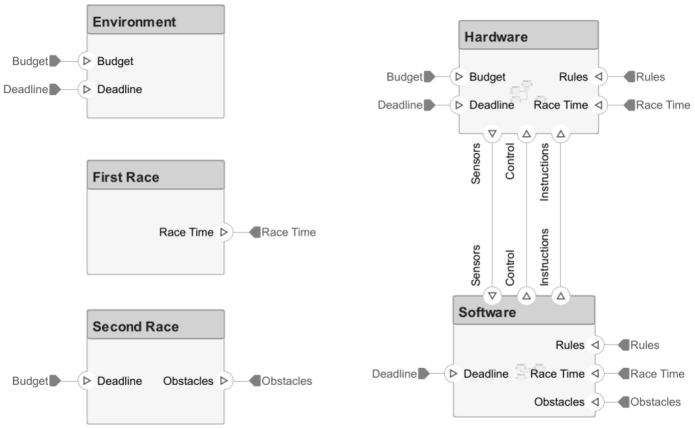

Figure 7.2: Diagram of the relations between the elements of the competition and the drone

7.2 Drone

The drone can be subdivided into the hardware and the software. Hardware encompasses all the physical elements and is affected by the budget. Software encompasses the programs that will run on the hardware and, as programmers do not receive remuneration for their work, it is not affected by the deadline, rules and results from the competition. Sensor data is sent from hardware to software, which in return emits instructions and a control signal for the movement of the drone.

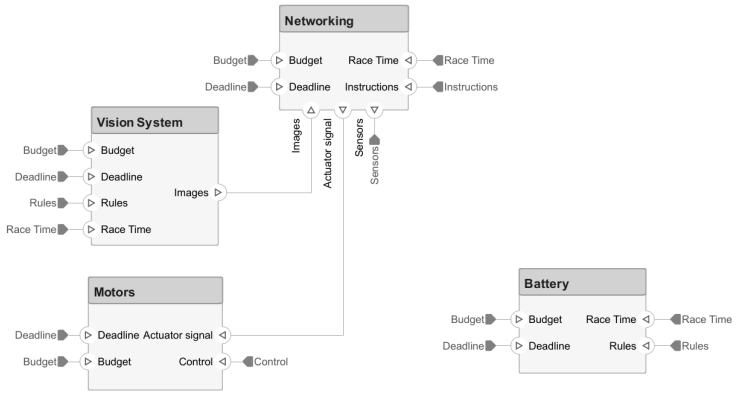

Figure 7.3: Diagram of the relations between hardware components

7.2.1 Hardware

There are four hardware components in the system:

1. **Motors:** Motors enable the drone to move, they receive an actuator signal from networking but also an inner control signal from the mounted computer.
2. **Vision System:** With the objective of sensing the environment, it is affected by obstacles present in the competition and produces images that are sent to networking.
3. **Networking:** Hardware required to handle communications between the central computer and the drone. Most signals pass through networking.
4. **Battery:** The battery is essential to ensure the autonomy of the drone, and is affected by signals such as race time to ensure the drone is able to participate in the entire event.

7.2.2 Software

Regarding software, there are three main frames:

1. **Onboard:** Refers to the mounted computer in the drone. This computer is assumed to be under-powered, hence it will be limited to basic tasks such as producing the control signal for the motors from instructions.
2. **Communications:** Equivalent to networking in hardware, it handles information transfer between different elements of the system.
3. **Central Computer:** Software centered around processing data received from the vision system and producing instructions.

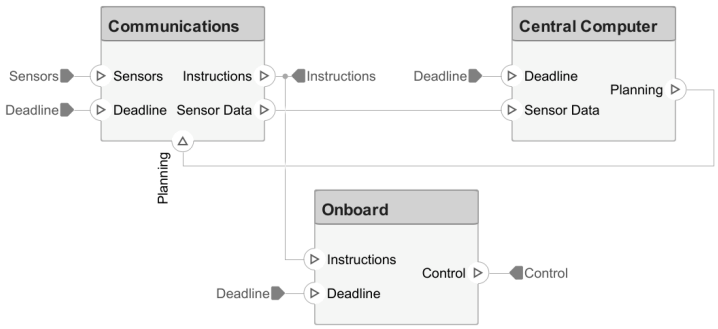

Figure 7.4: Diagram of the relations between software elements

8. System Evolution

There are many assumptions about the system at the current stage of the project. The competition is not fully defined and its rules may change. It is also assumed that a central computer can be used and that there is a possible communication channel. The location of the vision system has not been designed, it may be mounted on the drone or fixated around the environment.