Assignment 3a
Onboard Data Handling

Autonomous Landing and Berthing

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Thesis Title

Thesis Subtitle

Author Name

Abstract

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Acknowledgements

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1 Introduction

1.1 Purpose

This is the System Requirements Document (SRD) for the Real Time System Project within the course Onboard Data Handling. It concerns the software for a rover, which shall be controlled by commands and send telemetry. The overall purpose of this system is, to give students training in various aspects of software engineering for systems including low level hardware interfaces.

This document is prepared to define the requirements of the software and will be used as a reference for the design.

1.2 Scope

This document is redacted as part of the development of the software for a rover that will receive and execute commands as well as send telemetry containing the battery status. The actions of the rover which shall be controlled are the movements, the grip arm and the camera.

Therefore it is applicable to the entire onboard software of the rover.

1.3 Definitions, acronyms, abbreviations

ADC	Analog to Digital Converter
ASW	Application Software
ESA	European Space Agency
GS	Ground Station
HOOD	Hierarchic Object-Oriented Design
I	Motor Current (given in Ampere)
IEEE	Institute of Electrical and Electronics Engineers
OS	Operating System
SRD	System Requirements Document
SW	Software
TBD	To Be Decided
TC	Telecommand
TM	Telemetry
U	Battery Voltage (given in Volt)

1.4 References

Reference	Code	Title
[1]	ESA BSSC (96)	Guide to applying the ESA software engineering standards to small software projects
[2]	ESA PSS-05-03	Guide to the software requirements definition phase
[3]	IEEE Std 830-1998	IEEE Recommended Practice for Software Requirements Specifcations
[4]	OBDH_A1	C-Standard for Balloon Project

1.5 Overview

This document consists of

- a short introduction (Chapter 1) stating the purpose of the document, references and used abbreviations
- an overview of the system (Chapter 2) as a simplified logical model showing its basic functions
- the requirements for the software (Chapter 3) to fulfil the aforementioned purposes

2 General Description

2.1 System Overview

Coordinated Universal Time (UTC)
The processes of the system are shown in Figure (**??**). The ASW shall communicate with the GS, exchanging telecommands and telemetry. The ASW will handle the commands in two different ways. Concerning the movements of the rover itself, the commands will be executed by the ASW, while all commands for the grip arm and the camera are relayed to a different controller system, which is already implemented. Additionally, the voltage of the battery and the current of the motor are measured via an ADC.

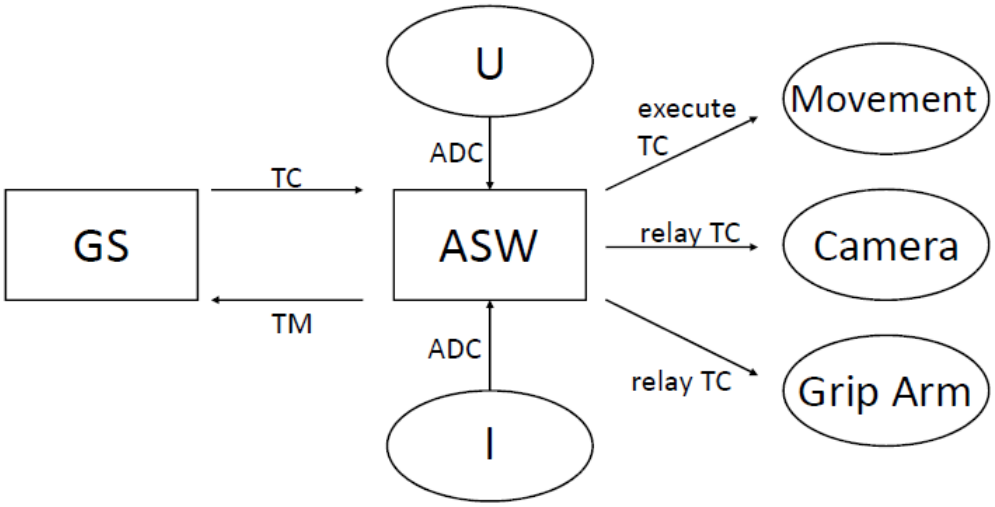

Figure 2.1: Functionality of the system.

The requirements for the ASW are grouped according to its main functions. Four parts have been identified:

- Modes
- Initialization
- Commands
- Telemetry

Modes is responsible for controlling the transitions between the different modes that the ASW has. The initialization sets up the system after its start. Commands includes receiving and executing/relaying of the received commands from the ground station. Telemetry is responsible for monitoring the system and sending a telemetry message.

2.2 Function and Purpose

The ASW shall be able to receive commands from the ground station. Those commands have to be split in the parts concerning the movement, the grip arm and the camera. Commands for the movement shall be executed, while commands for the other two devices are passed on to separate controllers. Additionally, the ASW shall monitor the voltage of the battery and the current taken by the motor. The battery voltage shall be included in a telemetry set, sent back to the ground station.

2.3 Constraints

The development of the ASW is mainly constrained by the fact, that the entire hardware interacting with the SW is already chosen and present. Additionally, the other software parts controlling the rover movements, the grip arm and the camera are already implemented as well as the ground station. For that reason, the developed ASW has to be highly orientated towards those existing parts as no changes are possible in the surrounding systems anymore.

3 Specific Requirements

3.1 General

The requirements will be presented categorized in sections depending on the functionality or the ASW part that shall apply them. Under each section all the requirements are listed, and for a better understanding of the system and better reference to the requirement a global numbering system has been prepared.

Each requirement number has the numbering form of "RXX-XX": "R" for requirement followed by four numbers separated by a dash. The first two numbers refer to the group/section each requirement belongs, while the two other numbers are the number of the requirement in the group.

Section/group list with the corresponding numbering:

00 Modes

01 Initialization

02 Commands

03 Telemetry

04 Performance

05 Interface

06 Operation

07 Resource

08 Verification

09 Acceptance testing

10 Documentation

11 Security

12 Portability

13 Quality

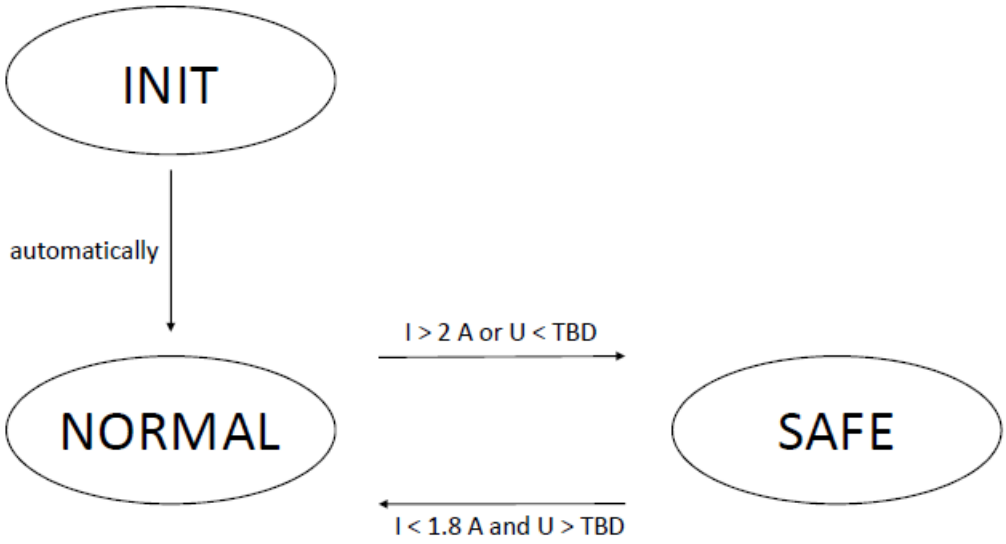

Figure 3.1: Transitions between modes.

14 Reliability

15 Maintainability

16 Safety

17 SW Design and Programming

As the developed ASW is highly constrained by the interacting systems, all following requirements are ranked as essential.

3.2 Functional requirements

3.2.1 Modes

The ASW shall have three different modes. Those modes are INIT, NORMAL and SAFE. The transitions between the modes are shown in Figure (**??**).

R00-01
The software shall have three modes: INIT, NORMAL, SAFE.

R00-02
The software shall start in INIT mode.

R00-03
The NORMAL mode shall be reached automatically after INIT mode has finished, that means all necessary initializations are completed.

R00-04
During NORMAL mode telecommands are processed, telemetry is sent and the power status is monitored.

R00-05
If the battery voltage is lower than TBD or the current of the motor is higher than 2 A, the system shall change to SAFE mode. (TBD will be solved by the customer during SRR)

R00-06
In SAFE mode, all movements are stopped. The only action by the system in this case, is monitoring the power status.

R00-07
The system changes from SAFE to NORMAL mode, if the current of the motor is smaller than 1.8 A and the battery voltage is higher than TBD. (TBD will be solved by the customer during SRR)

3.2.2 Initialization

R01-01
The initialization of the software shall be done first after the start.

R01-02
The initialization sets up the interfaces according to the used communication busses.

R01-03
The initialization sets up the used hardware.

3.2.3 Commands

Specific requirements regarding the commands the ASW will receive from the ground station or equivalent controlling software.

R02-01
The ASW shall be able to process commands arriving at a minimum interval of 0.5 s.

R02-02
The TC that the ASW can process shall always have the same structure as a NULL-terminated string in the format of:

$ROVER,<RA>,<RD>,<RS>,<CH>,<CV>,<GAC<,<GAH>,<GAV>*<CHK><NULL>

R02-03
All numbers but Rover direction (<RD>) shall be ASCII-coded integer in the interval 0-100.

Detailed description of the command:

<*RA*>, *Rover Angle*. Shall have a value between 0-100, being 0 the leftmost angle, 50 the 'center' angle and 100 the rightmost angle.

<*RD*>, *Rover Direction*. Shall have a value of 0 or 1. 0 is forward movement and 1 is backward movement.

<*RS*>, *Rover Speed*. Shall have a value between 0-100, being 0 no speed and 100 the fastest speed.

<*CH*>, *Camera Horizontal*. Shall be the relay value through the I2C-bus.

<*CV*>, *Camera Vertical*. Shall be the relay value through the I2C-bus.

<*GAC*>, *Griparm Claw*. Shall be the relay value through the I2C-bus.

<*GAH*>, *Griparm Horizontal*. Shall be the relay value through the I2C-bus.

<*GAV*>, *Griparm Vertical*. Shall be the relay value through the I2C-bus.

<*CHK*>, *Checksum*. Shall be an ASCII-coded hexadecimal number with byte wise XOR on preceding bytes.

R02-04
All commands which are not following the specified format will be ignored by the ASW.

R02-05
All received commands are checked for correctness by the ASW using the checksum.

3.2.4 Telemetry

The telemetry section includes all monitoring tasks as well as the information sent to the ground station.

R03-01
The ASW shall be able to monitor the battery voltage every 0.25 s via the ADC.

R03-02
The ASW shall be able to monitor the current of the motor every 0.25 s via the ADC.

R03-03
The ASW shall send telemetry every 0.5 s.

R03-04
The sent TM shall always have the same structure as a NULL-terminated string in the format of:

$ROVERGS,<Battery Voltage>*<CHK><NULL>

Detailed description of the telemetry values:

<*Battery Voltage*>. Shall be a float value with one decimal number.

<*CHK*>, *Checksum*. Shall be an ASCII-coded hexadecimal number with byte wise XOR on preceding bytes.

3.3 Performance requirements

R04-01
Every command shall be executed before the next one arrives setting the deadline to the minimum interval of arriving commands (see R02-01 for the value).

3.4 Interface requirements

R05-01
Communication between the terminal and the rover shall be done via UART protocol.

R05-02
Communication between the ASW and the steering units of the camera and the grip arm shall be made via I2C protocol.

3.5 Operational requirements

None.

3.6 Resource requirements

None.

3.7 Verification requirements

None.

3.8 Acceptance testing requirements

None.

3.9 Documentation requirements

None.

3.10 Security requirements

None.

3.11 Portability requirements

None.

3.12 Quality requirements

None.

3.13 Reliability requirements

None.

3.14 Maintainability requirements

None.

3.15 Safety requirements

None.

3.16 SW Design and Programming Requirements

R17-01
The ASW shall be written in C language.

R17-02
The code shall follow the rules dictated by the standard designed for a small software project "C-standard for Balloon Project", by Benedikt Reihs and Roger Gutierrez [4].

R17-03
FreeRTOS shall be used as an operating system.

R17-04
The ASW shall be designed according to the ESA HOOD method.