

# Project Plan: Autonomous Rescue System with UAV and Tracked Vehicle

Version 0.3

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## Status

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Course name:	Reglerteknisk projektkurs, CDIO	E-mail (@googlegroups.com):	rescuerangers
Project group:	Rescue Rangers	Document responsible:	David Ryberg
Course code:	TSRT10	Author's student ID:	Davry764
Project:	FiRe System	Document name:	Project Plan

## Project Identity

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## Document History

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# 1 Customer

The customer is Torbjörn Crona from Saab Dynamics. The client is Martin Lindfors from the department of Electrical Engineering at Linköping University.

## 2 Overview of the project

In this chapter the purpose and the goal with the project will be presented. All deliveries in the project will be presented in table 1.

This project is a continuation on an ongoing project that has been carried out during several years. Previously the long-term goal has been to create a minesweeper that autonomously finds landmines in an area and clears said area of the landmines. This was done with a tracked vehicle. Last year, an UAV was added to the project, intended to co-operate with the tracked vehicle in the minesweeping mission.

This year, the long-term goal has changed from minesweeping to autonomous rescuing using the same tracked vehicle and UAV from previous year. The long-term goal is to create a system that tracks down missing and/or injured people using the UAV, and to aid them using the tracked vehicle.

### 2.1 Purpose and goal

The purpose of this project is to deliver an autonomous rescue system consisting of a quadcopter and a tracked vehicle. The quadcopter should identify all objects of interest within a desired area and communicate their position to the vehicle on the ground and the user, autonomously, through a wireless link. Given the positional data, the tracked vehicle should autonomously move to the provided positions of interest and return to its origin after doing so. The process should be continuously streamed to a laptop which provides the user with information about the ongoing operation. In this project, the group members will also gain experience of working on a project and in a group.

### 2.2 Deliveries

In the table 1 below all deliveries included in the project are mentioned. The date of each delivery as well as the tollgate (see 11.2) the delivery belongs to are also listed in the table.

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Table 1: List of the projects deliveries

<b>Deliveries</b>	<b>Tollgate</b>	<b>Date and time</b>
Time report	-	Weekly
Status report	-	Weekly
Requirements specification, complete version	2	24/9 2018
Project plan	2	24/9 2018
Time plan	2	24/9 2018
Design specification, first draft	2	24/9 2018
Design specification, complete version	3	8/10 2018
Test plan	3	8/10 2018
Verification of parts of functionality	4	7/11 2018
Test protocol of parts of functionality	4	7/11 2018
Finished product	5	30/11 2018
Test protocol of all functionality	5	30/11 2018
User manual of the system	5	30/11 2018
Technical documentation	6	13/12 2018
Project evaluation	6	13/12 2018
Poster presentation	6	13/12 2018
Web page	6	13/12 2018
Demo film	6	13/12 2018
Installation guide	6	13/12 2018



### 3 Phase Plan

The project is going to be divided in three phases according to the LIPS-model, before, during and after. To every phase there are documents and information from the LIPS-book on how the different phases should look and be structured, see ref to LIPS.

#### 3.1 Before the Start of the Project

A group of people with different qualifications were put together to create a project group to match the customer's project directives, see project directives ref. The members of the group were assigned different responsibilities and a requirements specification was written in dialogue with the customer to make sure that it followed the given project directive.

A project plan and time plan was created to ease the work flow in the project.

#### 3.2 During the Project

The time plan will be revised continuously throughout the project and therefore the project plan may need to be revised.

All tests need to be documented during this phase and will be used to develop the product.

#### 3.3 After the Project

Once the finished product is delivered to the customer the project is finished and a project evaluation is written by all project members.

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## 4 Organization Plan of the Project

In this chapter the structure of the organization both within the project group and between the project group and outsider parties is described.

### 4.1 Organization Structure with Customer

The organization includes several important key members, see Figure 1 for a graphical overview of the structure. External personnel are represented with green boxes and the members of the project group are represented with blue boxes. All members of the project group have been assigned a specific role. The roles are assigned in order to make sure certain areas and activities will be managed properly.

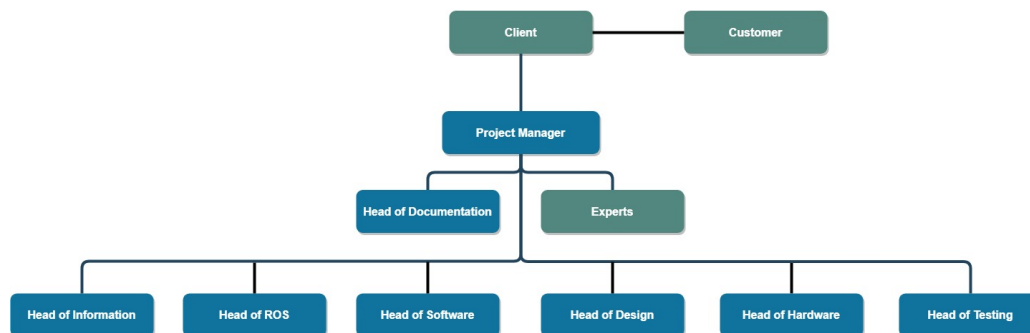


Figure 1: Organization of the project.

### 4.2 Conditions for Collaboration within the Project Group

In this section the different posts of responsibility that exist in the project group are explained.

#### 4.2.1 Project Manager (PM)

The PM's responsibilities include:

- Handling the communication between the group and the customer and the client.
- Planning the ongoing work.
- Following up and ensuring that the goals of the project are achieved.
- Encouraging the group to work efficiently together.
- Assisting in solving internal conflicts of the group, if necessary.
- Following up to ensure that the workload is distributed equally over the group.
- Sending status reports of the conducted work to the client and the customer, weekly.
- Sending time reports to the client, weekly.
- Setting up and planning meetings with the group.
- Updating the time plan in accordance of the group's decision.



#### 4.2.2 Head of Documentation (DOC)

The DOC's responsibilities include:

- Planning the writing and the verification of the documents.
- Ensuring that the required documents are written and finished in time.
- Ensuring that there are document templates to all required documents.
- Ensuring that the document revision control is executed in a correct manner.
- Ensuring that the documents are proof-read before they are handed in.

#### 4.2.3 Head of Testing (TST)

The TST's responsibilities include:

- Ensuring the writing of a test plan, test specifications and test protocols.
- Planning and coordinating the testing of the system.
- Planning full scale tests.
- Following up on the requirements specification to ensure that the testing shows that the requirements regarding the functionality are met.

#### 4.2.4 Head of Design (DES)

The DES's responsibilities include:

- Ensuring the planning and the development coordination of the design.
- Cooperating with the SOF and the HRD to oversee the design of the system.
- Ensuring that the different parts of the system work together.

#### 4.2.5 Head of Software (SOF)

The SOF's responsibilities include:

- Informing the group of the coding standard and the revision control of the code.
- Ensuring that the code follows the coding standard and that it is well commented.
- Cooperating with the DES and the HRD to oversee the design of the system.
- Cooperating with the ROS to oversee the software design.



#### 4.2.6 Head of Hardware (HRD)

The HRD's responsibilities include:

- Looking after the hardware to ensure that it is properly maintained.
- Receive reports of possible malfunctions of the hardware from the group and ensure that they are resolved.
- Cooperating with the DES and the SOF to oversee the design of the system.
- Ensuring that a risk analysis is conducted regarding the UAV.

#### 4.2.7 Head of Information (INF)

The INF's responsibilities include:

- Ensuring that a web page is created and updated.
- Ensuring that a demonstration film is shot and edited.
- Ensuring that a poster presentation is created.
- Ensuring the preparation of an oral presentation.

#### 4.2.8 Head of ROS (ROS)

The ROS's responsibilities include:

- Reading up on Robot Operating System and presenting the information to the rest of the group.
- Overseeing the software design together with the SOF.
- Receiving questions regarding Robot Operating System from the rest of the group and ensuring that they are answered.



## 5 Documentation Plan

The documents that are to be delivered during the course of the project are presented below.

Document	Description	Date
Requirement specification	A document that describes that requirements that the project group and the customer undertake to fulfill.	24/9 2018
Project plan	A plan of how the project will be executed, inclusive a time plan.	24/9 2018
Design specification	A technical specification of the design of the system.	8/10 2018
Test plan	A specification of which system tests are to be done and how they will be conducted.	8/10 2018
Test protocol, part of functionality	Test protocols of part of the functionality	7/11 2018
Test protocol	Test protocol of the functionality of the entire system	30/11 2018
User manual	Manual that describes how to use the product.	30/11 2018
Technical report	A report that describes the system on a technical level.	13/12 2018
Project evaluation	An evaluation of the project in its entirety	13/12 2018
Poster	A poster presentation of the system at a general level.	13/12 2018
Web page	A web page that describes the project.	13/12 2018
Film	A demonstration film to promote the product.	13/12 2018
Installation guide	A guide of how to perform the installation.	13/12 2018



## 6 Development Methodology

The group will be divided into smaller subgroups with 2-3 people each. These subgroups will work in parallel with each other on separate requirements. Each subgroup is responsible for the documentation regarding the implementation of the requirement. If the requirement is software based, the subgroup should also cooperate with the Head of Design, and keep him updated on the overall implementation. The Head of Design should have a larger knowledge about the overall system and is responsible for the information exchange between subgroups, to be able to combine subsystems later on in the project.

A group meeting is to be held every week. This meeting should be used to update all the project members on the current progress of the project. It should also be used to solve disagreements within the group and to schedule for the future of the project, mainly the following week.

Documentation should be done continuously throughout the project. The Head of Documentation is responsible for storing the documents and that the documents maintains a high quality. All the code created throughout the project will be stored at a GITLAB repository. The code should keep an high standard according to the Google code standard guidelines. The Head of Software is the one who is responsible for ensuring that the code is of high quality and follows the code standard mentioned earlier.

A signal protocol will be created and updated during the project. This protocol should contain all the created signals between the different components present in the system. Old signals used in previous projects, which are of interest in this project, should also be added to this protocol if possible. These signals have been documented previously and will thus be transferred to the signal protocol of this project. The signal protocol should be used to give an overview of the system and to simplify the creation of the technical documentation.

Old functionality will be tested before implementing the new functionality. New functionality should also be based on old functionality if possible, to increase the effectiveness of available resources in the group.

A test plan for the project will be created before the 24/9 2018 (tollgate 2, see table 1). The test plan will contain tests on all the requirements listed in the requirement specification for the project, see [1]. Each test has to be written in a consistent way that makes it easy to execute the test repeatedly in the same environment and with the same conditions.

Test will be carried out continuously throughout the project. A test protocol will be written for each test run, with information about the test run, such as if the test run passed or failed. All single test protocols will be merged into a large, single test protocol document at the end of the project.

As mentioned earlier in this document, the Head of Testing is responsible for product testing. He is therefore responsible for the creation of the test plan and the test protocol(s), and that these are of high quality, i.e. that the requirements are tested thoroughly and that the tests are easy to follow. The Head of Testing does not need to be present at each test run, but is responsible for that the test run is documented by the people who carried out the test. Furthermore, at least one person from the subgroup which implemented the requirement that is to be tested has to be present during the test run.

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## 7 Qualification Plan

To be able to deliver a final product according to the requirement specification the members of the project group need to be educated in relevant areas.

To ensure that the product and the project at large satisfy the required quality certain quality checks will be carried out during the course of the project, see below.

### 7.1 Documentation

The DOC is responsible for the quality of the documents that are to be handed in. All documentation is to be proofread by more than one person in the group before it is handed in, and all documents are to follow the same format.

### 7.2 Code

The SOF is responsible for ensuring that all code is well commented and documented, and that all code follows the given coding standard. The code is to be reviewed continuously throughout the course of the project.

### 7.3 Functionality

The TST is responsible for ensuring that the functionality of the system is up to standard. This is to be done by carrying out specific tests, described in a test plan.

### 7.4 The Project Group's Education

It rests upon the project group to obtain any knowledge needed to fulfill the project and deliver a product in accordance with the Requirement specification. Some assistance in acquiring additional knowledge is provided in the form of technical advisors and experts.

## 8 Reporting Plan

The PM is responsible for updating the client and the customer of the continuation of the project. This is done with time reports and status reports.

### 8.1 Time report

A time report is to be sent to the client each Sunday evening. The time report includes the hours spent by each group member as well as the total number of hours spent by the group. The time report also includes the time plan, which will be updated continuously throughout the project.

### 8.2 Status report

A status report is to be sent to both the client and to the customer each week before the beginning of the upcoming week. The status report is a brief description of the work and progresses that have been done during that week.

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### 8.3 Meetings with the client and the customer

The PM will meet with the client approximately once a week. During this meeting the client will be able to get a short update on the project. Other meetings between the group and the client and/or the customer can be held upon the request of either party.

## 9 Meeting Plan

The project group in its entirety will meet once a week on Mondays 13:15-14:00, unless otherwise agreed. During these meetings all members will be updated on the progress of the different parts of the project. Any concerns will be discussed and a brief plan of the upcoming week will be summed up.

## 10 Resource Plan

The resources that are at disposal during the project are presented below.

### 10.1 People

The project group is composed of eight students from the Applied physics and Electrical Engineering program at Linköping University.

Other than the project group there are three advisors assigned to the project; one advisor from the Department of Electrical Engineering (ISY) at Linköping University and two advisors from Saab Dynamics.

### 10.2 Material

The necessary equipment is provided by Saab Dynamics. The current equipment consists of one tracked vehicle (Balrog) and one UAV (Sauron). Balrog is equipped with GPS, IMU, odometers, camera, laser scanner, WiFi and Bluetooth. The software from previous years are also at the group's disposal. Any further material that is needed might be purchased by Saab Dynamics.

### 10.3 Facilities

The project group have at their disposal a project room and shared access to *Visionen*, a test site located in the B-house at the university.

### 10.4 Economy

The time budget for each member of the group is 240 hours in total. For the group as a whole that is 1920 hours.

The time budget for the advisor from Linköping University is 40 hours and the time budget for the advisors from Saab Dynamics is 40 hours combined.

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## 11 Milestones & Tollgates

The project contains various check points at which the project group - independently or together with the customer - assesses the progress so far. There are the Tollgates and Milestones, each of which are specified and listed in their own subsection below.

### 11.1 Milestones

On top of the more formal tollgates, the project group internally have agreed upon certain milestones related to significant points of technological progress in the project. Milestones are related to testing of technical aspects of the product and its subsystems and are used to provide continuous feedback to the project group regarding the progress of the project. The milestones are listed in the table below.

No	Milestone	Date
1	Design specification final version	1/10 2018
2	Detection of person in distress	12/10 2018
3	Autonomous driving on operation area w/o obstacles	12/10 2018
4	Functioning scanning system	19/10 2018
5	Communication between Sauron and Balrog	9/11 2018
6	Functioning GUI	14/11 2018
7	Sauron & Balrog can carry out a mission successfully	23/11 2018

### 11.2 Tollgates

Tollgates are meetings separating phases of the project where the customer and the project group agrees upon whether the project should progress into the next phase, or be discontinued. The preliminary dates for these meetings are listed in the table below.

No	Tollgate	Date
2	Delivery of verbal presentation of the project, requirement specification, project plan, time plan and rough draft of design specification.	24/9 2018
3	Delivery of design specification and test plan.	8/10 2018
4	Delivery of the following sub functionality; scanning system and detection system, as well as test protocols of this functionalities.	7/11 2018
5	Delivery of the system functionality, test protocols, user manual, and a presentation of the system functionality in line with the requirement specification.	30/11 2018
6	Delivery of technical documentation, project evaluation, poster, web-page, film and installation guide.	13/12 2018





## 12 Activities

In this section the activities of the project is listed. The time plan is based off of these activities. Each activity is described with a number, a name, a description, dependencies of other activities, if any, and estimated time requirement.

### 12.1 General

General activities that are not specific to any other subsection are listed in this section.

No	Activity	Description	Dependency	Time[H]
1	Meetings	Group meetings 1 hour per week and person, sometimes more.	-	155
2	Time reporting and Status reporting	Fill in time report and write status report, 0.25 hours per week and person	-	30
3	Review code	Review the code and ensure that it follows the code standard. This is done by the SOF.	-	10
4	Project managing time	Meeting between PM and client etc.	-	7.5
5	System test	Testing the system according to the test plan and fill out test protocols.	-	62
6	Full scale test	Test the entire system and fill out test protocols	12	80
7	Presentation Tollgate 5	Presenting the full functionality of the system to the customer	-	32
8	Project conference	Attending the project conference at the end of the course	-	24
9	Lectures	Lectures included in the project course that are not part of the entrepreneurship part.	-	16
10	Structuralize previous code	Look over code from previous year, "clean up" and transfer relevant code to project.	-	40
11	Study previous documentation	Gain insight into the system from previous year.	-	20
12	Cooperation between the systems	Getting Balrog and Sauron to cooperate on the mission, e.g. Sauron autonomously sends position data to Balrog once it has found a person in distress etc.	36, 42	60



## 12.2 Documentation

Activities that relate to the writing of documents and presentations are listed in this section.

No	Activity	Description	Dependency	Time[H]
13	Requirement specification	Write the requirement specification	-	94
14	Design specification	Write design specification	-	100
15	Project plan + Time plan	Write project plan including time plan	-	77
16	Test plan	Write test plan and create test protocols.	-	40
17	User manual	Write user manual.	-	30
18	Installation guide	Write installation guide	-	15
19	Technical documentation	Write technical documentation	-	100
20	Project evaluation	Write project evaluation	-	30
21	Poster	Create a poster presentation	-	20
22	Web page	Create web page.	-	40
23	Film	Shoot and edit film presenting the product.	-	25
24	Preparation project conference	Create an oral presentation	-	20



## 12.3 Sauron

Activities that are specific to the functionality of Sauron are listed in this section.

No	Activity	Description	Dependency	Time[H]
25	Research and establish connection	Establish a Wi-Fi connection between the base station and Sauron, and a connection between the RC-controller and Sauron.	-	4
26	Enable Sauron to take off and land	Take off and landing with Sauron.	25	6
27	Flight regulation of hovering height	Implementation regulator for constant hovering height.	26	6
28	Flight regulation of flying speed	Implementation of regulator for constant flying speed.	26	6
29	Detection of AprilTag	Implementation of AprilTag detection with the onboard camera.	-	20
30	Data transmitting	Transmittig data through Wi-Fi to the base station.	25	15
31	Data receiving	Recieving data from the base station.	25	15
32	GPS location	Locating Sauron's position using GPS.	-	15
33	Route planning	Planning of route to search the whole test area.	-	30
34	Route following	Following of a chosen route.	33	80
35	Tracking of Sauron	Continous tracking of Sauron when moving.	27,28	30
36	Scanning of area	Combining route planning, route following and detection of April-Tag to search an area for persons in distress.	29, 33, 34	40



## 12.4 Balrog

Activities that are specific to the functionality of Balrog are listed in this section.

No	Activity	Description	Dependency	Time[H]
37	Research and establish connection	Establish a Wi-Fi connection between the base station and Balrog, and a connection between the RC-controller and Balrog.	-	4
38	Install and integrate LIDAR	Installation of the new LiDAR sensor.	-	30
39	Regulation study	Study route planning and following.	-	20
40	Route planning	Planning of route from Balrog's current location to target location.	45	30
41	Route following	Following determined route.	-	40
42	Drive to a specific coordinate autonomously	Combining route planning and route following so Balrog can get to a chosen destination autonomously.	40, 41	40
43	Task planning	The plan for which Balrog should execute the task, in which order Balrog shall prioritize people in distress and such.	42	30

## 12.5 Communication

Activities that relate to the communication between Sauron and Balrog are listed in this section.

No	Activity	Description	Dependency	Time[H]
44	Communication between Sauron and Balrog	Establishing communication between Sauron and Balrog.	25, 37	30
45	Joint coordinate system	Joining Sauron's and Balrog's coordinate system together to one.	-	50



## 12.6 GUI

Activities that are related to the GUI are listed in this section.

No	Activity	Description	Dependency	Time[H]
46	Draw Balrog and Sauron	Mark Balrog and Sauron on a map in the GUI.	-	15
47	Draw people in distress	Mark people in distress on a map in the GUI.	-	5
48	Parameter design	Create an interface to insert parameters in the GUI, such as dimensions of the search area and the number of people in distress.	-	10
49	Troubleshooting tab	Create a trouble shooting interface in the GUI.	-	20

## 13 Time Plan

See the document Time plan.

## 14 Alteration Plan

The requirement specification might be renegotiated in accordance with the client.

The time plan will be updated and revised continuously throughout the course of the project.

### 14.1 Inspections

Every document that will be handed in shall be inspected by at least one project member and the Head of Documentation, to ensure that the document follow the standard that has been set. The code will be inspected by one or more project members in addition to the code author(s) to ensure that it follows the given structure.

### 14.2 Test plan

See the document Test plan.



## 15 Risk Analysis

For each activity, a risk analysis will be performed. These analyses might not be documented. The larger risks that might jeopardize the project are presented below.

### 15.1 General

- **Data loss:** The SOF is responsible for ensuring that the code is backed up and stored properly. The documents are written in Overleaf, and the DOC is responsible for ensuring that the different revisions of the documents are stored properly.
- **Hardware malfunction:** The HRD is responsible for ensuring that any hardware malfunctions are taken care of. Saab Dynamics is responsible for replacing malfunctioning hardware. If the malfunction is such that the project is severely delayed or impossible to complete, the requirement specification will have to be renegotiated.
- **Changes in project group:** If there are any changes in the project group, that is if a group member leaves the group or is unable to complete the budgeted hours, the requirement specification will have to be renegotiated.

### 15.2 Flying the UAV

Flying the UAV risks damaging surrounding property and hardware, as well as hurting the project members and other people close to the UAV. Therefore, it is of utmost importance that the flying is done in the safest way possible. The HRD is responsible for ensuring that a safety plan is created. The safety plan should be checked each time before flying the UAV.

## 16 Priorities

The requirements plan is divided in three different priorities; 1, 2 and 3. Priorities 1 are requirements that have to be fulfilled in order for the project to be approved. Priorities 2 are requirements that may be carried out if there is time left. Priorities 3 are requirements that are nice to have but only will be carried out if requirements of priority 1 and 2 are completed.

## 17 Project Closure

When the project is completed, all documents will be available to all parties involved. The keys for the project room and the equipment will be handed in. A project evaluation will be written by the project members.

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Course name:	Reglerteknisk projektkurs, CDIO	E-mail (@googlegroups.com):	rescuerangers
Project group:	Rescue Rangers	Document responsible:	David Ryberg
Course code:	TSRT10	Author's student ID:	Davry764
Project:	FiRe System	Document name:	Project Plan



## REFERENCES

### Written Sources

- [1] Rescue Rangers CDIO 2018. Requirement Specification: Autonomous Rescue System with UAV and Tracked Vehicle, 2018.