# Requirements Specification

Group 3

October 2, 2012

# Project Identity

Group 3, 2012/HT, "The Robot Dog"

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# Contents

# Document history

| Version | Date | Changes | Made by | Reviewed |
|---|---|---|---|---|
| 0.1 | 2012-09-06 | First version | Johannes Markström | 2012-09-07 |
| 0.2 | 2012-09-10 | Second version | Johannes Markström | 2012-09-11 |
| 0.3 | 2012-09-17 | Third version | Johannes Markström | 2012-09-25 |
| 1.0 | 2012-10-02 | Accepted version | Johannes Markström | - |

# 1 Project aim

The project aims to develop a system that allows for a visually guided mobile robot to follow a person. This requires (1) the detection/tracking of the person, and (2) mapping the position and scale of the person to the robot control signals. The accuracy/precision of the tracking/detection and control algorithms will be evaluated. An optional extra is for the robot to go to where the person is pointing, requiring recognition and identification of the pointing gesture and keeping track of the approx. position in the world.


Figure 1: The robot tracking a person.

## 2 Organization

The project model SCRUM will be used for organizing the development. The project leader will act as SCRUM-master and have continuous contact with the client.

## 3 Resources available from client

This section describes resources given from the client.

- CVL's mobile robot:
  RC car with mounted laptop and camera
  4 core Intel Core i7 CPU + Nvidia 480M GPU
  Point Grey USB camera
- 24 hours of supervisor aid

## 4 Economy

This section describes the economy for the project.

- All project members are given 240 hours each.
- Access to workspace and workstations at the university.

## 5 Deliveries

This section describes what should be delivered and when.
BP2, 20 September

- Requirement specification

BP4, 12 November

- A first prototype of the system
- First version of the web-page online

BP5, 10 December

- All prio 1 functionalities described in requirement specification
- Web-page

BP6, 14 December

- Technical report
- Poststudy
- Test protocols
- User manual

BP7, 18 December

- Presentation
- Poster
- Video

# 6 Requirements

The requirements are ordered with numbers where 1 is defined as hard requirements that need to be fulfilled in order to have a successful delivery. When all requirements labeled as 1 are solved, the ones with 2 may be solved. If all number 1 and number 2 are solved, the ones with number 3 can be solved.

| Nr | Description | Prio |
|---|---|---|
| 1 | Prio 1 functionality should work in a large empty rectangular room. | 1 |
| 2 | Prio 1 functionality should work in an empty indoor environment. | 2 |

## 6.1 Documentation requirements

These requirements describe how the different parts of the project should be documented.

| Nr | Description | Prio |
|---|---|---|
| 3 | The main functionality in the robot should be completely documented. | 1 |
| 4 | All of the documentation should be delivered in .pdf format. | 1 |
| 5 | All of the documentation should be written in LaTeX | 2 |
| 6 | All functionality in the robot should be completely documented. | 2 |

## 6.2 Implementation requirements

These requirements describe how the source code should be structured and other implementation requirements. The client requires future development of the robot therefore the source code should be modular and well documented. The different modules will run in separate threads for easier change of modules.

| Nr | Description | Prio |
|---|---|---|
| 7 | The source code should be well documented using the tool Doxygen. | 1 |
| 8 | The source code should be written in C++ in Visual Studio IDE. | 1 |
| 9 | The source code should be continuously submitted to the SVN. | 1 |
| 10 | The basic source code should be modular. | 1 |
| 11 | The robot should work on the system given by the client, see section 4. | 1 |
| 12 | All source code should be modular. | 3 |

## 6.3 System behaviour requirements

These requirements describe what functionalities the robot should have, they should also fulfil the Robustness and Performance requirements.

| Nr | Description | Prio |
|---|---|---|
| 13 | The robot should be able to autonomously follow an operator moving away from the robot. | 1 |
| 14 | The robot should be able to handle the operator walking towards the robot. | 1 |
| 15 | The robot should have the ability to identify the operator by a predefined gesture. | 2 |
| 16 | The robot should have the ability to stop following the operator by a predefined gesture. | 2 |
| 17 | The robot should be able to go to the operator position by a predefined gesture. | 2 |
| 18 | The robot should be able to pause its following of the operator by a predefined gesture. | 2 |
| 19 | The operator should be able to give directives for a position to where the robot should go to. | 3 |
| 20 | The robot should be able to receive an image and find the object depicted in the 3D world. The image must comply with requirements in given documentation. | 3 |

## 6.4 Robustness requirements

These requirements describe situations the robot should be able to handle.

| Nr | Description | Prio |
|---|---|---|
| 21 | The robot should be able to follow a person walking at top velocity of 1m/s. | 1 |
| 22 | The robot should not loose track of its operator more than one time per minute in average. | 1 |
| 23 | The robot should not crash into static walls. | 1 |
| 24 | The robot should not crash into static obstacles. | 2 |
| 25 | The robot should be robust to moderate changes of the lightning conditions in the environment. | 2 |
| 26 | The robot should handle multiple persons present in the environment. | 3 |
| 27 | The robot should be able to follow a person running at top velocity of 3m/s. | 3 |

## 6.5 Performance requirements

These requirements describe what performance the robot should achieve.

| Nr | Description | Prio |
|---|---|---|
| 28 | The robot should be within a distance from the operator where the distance is documented in the technical report. | 1 |
| 29 | The mean time of identifying an operator should be below 25 seconds. | 1 |
| 30 | The robot should be within a user-specified distance from the operator with a documented error margin. | 2 |
| 31 | The time to respond to gestures should at most be 5 seconds. | 2 |
| 32 | The fail rate of recognizing gestures should not be more than 10%. | 3 |

## 6.6 Evaluation requirements

These requirements describe what evaluation that should be performed.

| Nr | Description | Prio |
|---|---|---|
| 33 | Evaluations which prove that the hard requirements are fulfilled should be done. | 1 |
| 34 | Evaluate the accuracy of the operator detector module by measuring the number of false/true hits. | 2 |
| 35 | Evaluate the accuracy of the operator descriptor module by measuring the number of false/true matches. | 2 |
| 36 | Evaluate the time the robot is outside the user-specified distance interval per minute in average. | 2 |
| 37 | Evaluate the accuracy of gesture detection. | 2 |

# 7 Limitations

The robot will not work in all situations and therefore some limitations known are described below.

## 7.1 Deployment limitations

The environments do not contain transparent areas such as windows or similiar and the ground is horizontal and dry. Furthermore the lighting in the environments is strong enough so that the robot can distinguish the structure of the surroundings as well as all present persons in the robots visual field. The lightning condition must not dramatically change while the robot is operating, for example the light being turned off. It's assumed that the operator at all times is visible and maintains a distance to the robot making tracking and identification possible. The operator can not change clothes during operation.