Requirements Specification

Joel Fåk, Viktor Eriksson, Per Boström, Eric Gratorp,
Astrid de Laval, Sven Ahlberg

Version 1.1

Status

Reviewed		
Approved		

PROJECT IDENTITY

CDIO, Group 2, Identification of LCD monitors
Linköping University

Name	Responsibility	Telephone	E-mail
Joel Fåk	Project manager	073-425 86 68	joeka281@student.liu.se
Viktor Eriksson	Document manager	070-468 07 15	viker942@student.liu.se
Eric Gratorp	Test manager	070-899 25 42	erigr222@student.liu.se
Sven Ahlberg	Design manager	076-127 06 78	sveah621@student.liu.se
Per Boström	Quality manager	073-248 58 59	perbo612@student.liu.se
Astrid de Laval	Scrum master	070-119 21 69	astde117@student.liu.se

Group mail: cdioproject3@googlegroups.com

Customer: IEI, Linköping University, 581 00 LINKÖPING,
Contact person: Kristofer Elo, kristofer.elo@liu.se

Table of Contents

- Table of Contents
- Document History
- Introduction
  - Parts
  - Aims and Goals
  - Application
- System Overview
  - Components
  - Boundaries
- Definitions
- Design Requirements
- Functional Requirements
- Performance Requirements
- User Interface
- Economy
- Safety Requirements
- Deliveries
- User training
- Documentation
- Maintainability

Document History

Version	Date	Performed changes	Performed by	Reviewed
v0.1	2012-09-13	First draft	PB, AdL, JF	
v0.2	2012-09-18	Second draft. Revision after input from supervisor	AdL, JF	EG, PB
v1.0	2012-09-20	Revision after feedback from client. Clarification of some of the requirements.	AdL, PB, JF	JF
v1.1	2012-10-04	Revision after feedback from examiner. Requirement 5 and 7 fused. Requirement 22 removed. Other requirements clarified. Definition list added.	JF	

Introduction

2 million LCD monitors & TVs are sold each year in Sweden. As a monitor contains both environmentally harmful substances and valuable materials, the interest in an automated recycling process is large. This project is a part of the research project HÅPLA which investigates the possibility for such processes and is performed as a part of the course TSBB11 Images and Graphics at Linköping University.

Parts

Customer: Kristofer Elo, kristofer.elo@liu.se, IEI, Linköping University
Examiner: Vasileios Zografos, zografos@isy.liu.se, ISY, Linköping University
Supervisor: Marcus Wallenberg, marcus.wallenberg@liu.se, ISY, Linköping University
Project team: Joel Fåk, Astrid de Laval, Per Boström, Eric Gratorp, Sven Ahlberg, Viktor Eriksson, cdioproject3@googlegroups.com

Aims and Goals

The objective of the project is to detect and locate LCD monitors in a pallet using a Microsoft Kinect sensor, then use a Yaskawa SDA10 industrial robot to pick up the monitors and place them by the side of the box. The project shall investigate the degree to which the sensor can be used to detect the LCD monitors as well as how much information that can be obtained about the monitors.

Application

A monitor contains both environmentally harmful substances and valuable materials and components. The system will be used as the first step of a recycling process of LCD monitors. As the monitors arrive in the recycling process, they will be lying unsorted in pallet boxes. The system will then locate the monitors, pick them up and place them with the right side up by the side of the box. After the identification and sorting processes are performed by the system, the monitors will proceed in the recycling process and the harmful substances will be disposed.

System Overview

The system shall detect and locate LCD monitors in a pallet. An industrial robot will then be used to pick up the monitors, one by one, and place them by the side of the box.

Components

The components included in the system is the Yaskawa SDA10 industrial robot, the Yaskawa NX100 control system, a Microsoft Kinect sensor and an image processing unit to compute suitable grasping points and angles for the robot to pick up monitors. Also included is a technical documentation and an user manual.

Boundaries

The program will be used in a Microsoft Windows environment and the control system (Yaskawa NX100) used by the available Yaskawa robot.

Definitions

Successful pickup	Grasping and lifting the monitor without dropping it.
Monitor goal position	A specified, pre-programmed position and orientation.

Design Requirements

The following tables sets out the requirements of the system. Each requirement has its own row in the table. The first column holds the identification number of the requirement which has nothing to do with the priority of the requirement. The second column states if the requirement has been renegotiated since the first version of this document. The meaning of the requirement is defined in the third column and its priority is found in the fourth column. All requirements with priority 1 need to be fulfilled at final delivery. If there is time left when all requirements with high priority are fulfilled, the project group will continue with the lower-priority requirements. The table below sets out the design requirements of the system.

Table 1. Design requirements

Requirement	Version	Description	Priority
1	0.1	The system shall use a Yaskawa SDA10 robot with a Yaskawa NX100 Controller.	1
2	0.1	The system shall use a Microsoft Kinect sensor.	1
3	0.1	The system shall be used in Windows environment.	1

Functional Requirements

The table below sets out the functional requirements of the system.

Table 2. Functional requirements

Requirement	Version	Description	Priority
4	0.3	The system shall be able to segment the scene into objects and determine which of the objects are monitors.	1
5	0.2	The system shall be able to estimate the shape and pose of at least one monitor when requirement 4 is fulfilled. Minimum requirements: ● Determine the long and short side of the monitor. ● Determine the plane normal of the monitor, with accuracy according to requirement 14. ● Determine if the monitor is partially occluded.	1
6	0.2	The system shall be able estimate the optimal grasping point of a monitor when requirements 4-5 are fulfilled, according to requirement 14.	1
~~8~~	~~0.2~~	~~The system shall be able to estimate the chance of a *successful pickup* (see definitions) of a monitor, with pose, occlusions and possible grasping point~~	=
9	0.1	The system shall be able to pick up a free monitor with a vacuum gripper when the screen is graspable and requirements 4-8 are fulfilled.	1
10	0.2	The system shall be able to pick up a free monitor with a gripping tool when the screen is ungraspable and requirements 4-8 are fulfilled.	2
11	0.1	The system shall be able to place the monitor in a *monitor goal position* (see definitions).	1
12	0.1	The system shall include a calibration procedure for determining the mapping between Kinect coordinates and robot coordinates.	1

Performance Requirements

The table below sets out the performance requirements of the system.

Table 3. Performance requirements.

Requirement	Version	Description	Priority
13	0.2	The project group shall conduct an analysis of where the Kinect sensor should be placed relative the objects of interest to obtain reliable measurements.	1
14	0.2	The project group shall evaluate which parts of a monitor screen that are appropriate to use as a grasping point for a vacuum gripper in order to achieve a *successful pickup*.	1
15	0.3	The system shall be optimized to perform each grasping task cycle in under 30 seconds.	2

User Interface

The table below shows how the user can communicate with the system.

Table 4. User interface requirements.

Requirement	Version	Description	Priority
16	0.3	The system shall include a user interface where the process could be monitored and controlled according to requirement 17-21. The user interface should consist of a regular computer screen, mouse and keyboard.	1
17	0.2	The user shall be able to initiate a calibration of the Kinect sensor.	1
18	0.2	The user shall be able to start the grasping cycle.	1
19	0.2	The user shall be notified in case there is some abnormality or if the process can not be continued at any stage in the grabbing task cycle.	1
20	0.3	The system shall be able to get input from an operator if the process can not continue autonomously at any stage in the process.	2
21	0.1	The system shall be able to instruct an operator to manually move a monitor or otherwise solve a problem if needed to continue.	2

Economy

The table below sets out the requirements for the economy of the project.

Table 6. Economy requirements.

Requirement	Version	Description	Priority
23	0.2	No more than 1440 hours of work shall be used to complete the project, which means 240 hours for each member in the team.	1

Safety Requirements

The table below sets out the requirements for security around the system.

Table 7. Security Requirements

Requirement	Version	Description	Priority
24	0.1	The system shall stop if there is too much uncertainty about the planned procedure or if there is no free monitor.	1

Deliveries

The table below sets out the important dates of the project's deliveries.

Table 8. Deliveries

Requirement	Version	Date	Description	Priority
25	0.1	Sept. 20	The requirement specification shall be delivered to the customer.	1
26	0.1	Oct. 4	Test plan should be delivered to the customer	1
27	0.1	Oct. 18, Nov. 1, Nov. 15, Nov. 30	Prototypes of the system should be demonstrated to the customer after each sprint, at the dates specified.	1
28	0.1	Dec. 14	Demonstration of the finished product	1
29	0.1	Dec. 14	Test protocol should be delivered to the customer	1
30	0.1	Dec. 14	User manual should be delivered to the customer	1
31	0.2	Dec. 14	Technical documentation should be delivered to the customer	1

User training

The following training is needed in order to be able to use the system.

Table 10. Required education

Requirement	Version	Description	Priority
32	0.1	User manual will contain the information needed to use all the features of the system.	1

Documentation

The following documents will be included in the final delivery.

Table 9. Documentation

Document	Language	Object	Target group	Format
Technical report	English	Defines all the demands on the system.	Technical manager	Electronic
User manual	English	Introductory description of the system.	User	Electronic

Maintainability

The table below sets out the maintainability requirements of the system.

Table 11. Maintainability

Requirement	Version	Description	Priority
33	0.1	The software shall be released with a open source licence.	1