Project Report*

*As a fulfilment to the course: ”Project course name”, D7039E & E7032E. Lecturer: Jan van Deventer.

Martin Blaszczyk, Edward Cedegård, Niklas Dahlquist, Edward Källstedt, Albin Martinsson, Måns Norell
Computer Science, Electrical and Space Engineering Dept.
Luleå University of Technology
Luleå, Sweden
{marbla-6, edwced-4, nikdah-6, edwkll-7, mnsnor-5, albmar-6}@student.ltu.se

***Abstract*—**

I. Introduction

Background and motivation

Self explanatory.

Contributions

How does this report contribute. Are there any novel solutions?

Structure

The overall structure of the report [1]

II. Arrowhead

Arrowhead

What is it?

Extras

More in depth about the strucutre of the Arrowhead implementation. Flow diagrams etc.

III. Concept Design

Mechanical structure

The final design of the robot. Include CAD renderings etc.

Electrical components

Electrical components such as motors, MCUs etc. Why were they chosen

Requirements

IV. Communication

Communication

TTL, ROS, Arrow-¿Robot

V. Modeling

Robotic arm

Forward kinematics

Inverse kinematics

Base

Camera vision and calibration

In this section it is outlined the theory behind the camera vision system. How points in a 3D-space are projected on a 2D-plane, calibration and distortion correction.

Camera model

Distortion

VI. Machine Vision

Line following

QR-codes reading

Deep learning?

VII. Motion

Robot Arm Path Planning

If a robot manipulator is required to visit specific discrete points, waypoints, path planning is the problem of deciding how to move between these points. Planning the path is also important to ensure the movements are smooth, meaning that, since we ”control” the speed of each joint, the desired positions and velocities should be continuous.

Interpolation

One method of interpolating between points is to use cubic spline interpolation. A spline [2] is a piecewise polynomial function and consequently a cubic spline is a function consisting of piecewise cubic polynomials. A cubic polynomial will ensure a smooth movement since its first derivative, the velocity, will be continuous. To ensure that each required point is visited the bounding values for each cubic function are set to zero [3].

Joint Space interpolation or Cartesian Motion

The interpolation can take place in joint space or in cartesian space. Joint space interpolation means that the waypoints are expressed as joint values and that the interpolation is calculated between these joint values. Cartesian motion means that the waypoint are expressed as cartesian coordinates and that the interpolation takes place in cartesian space.

Implementation

The robotic manipulator, shown in figure **??**, has a number of waypoints that it is required to visit. The desired waypoints are expressed in joint values, and a cubic spline interpolation is used to interpolate between these joint space waypoints. The path for picking up and placing the object can be seen in figure 1 and 2 respectively.

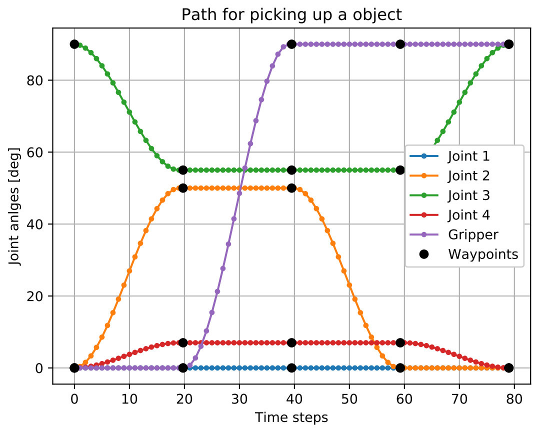

Fig. 1. Path showing the joint values required for picking up the object.

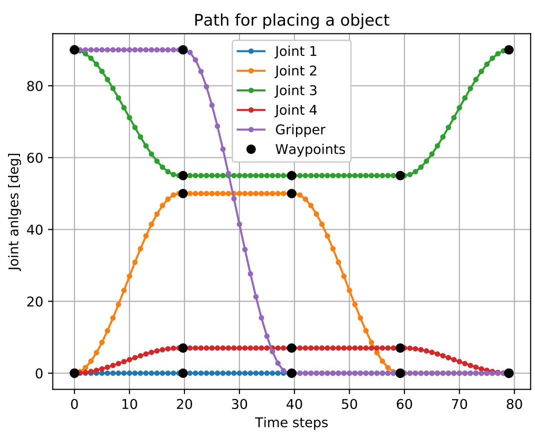

Fig. 2. Path showing the joint values required for placing the object.

Base

VIII. Experiment

Prototype components

Overview of what is being used in the evaluation

Movable base evauation

Arm evaluation

Gripping evaluation

Sensor evaluation

Arrowhead evaluation

IX. Conclusions

Conclusions of the robot and the course (?) Is our design good? Is Arrowhead good?

Conceptual design

Appendix

Martin Blaszczyk

Martin is a 5th year Y-student with interest in Control och Mechatronics. In this course he'll take the role of the Project Leader where the main objectives are to keep focus on the goal, hold meetings and an overall oversight of the project. As for the technical part the main interest will be in machine vision together with Edward K. to use cameras or other sensors to localize external objects for the robot to grip, avoid or approach.

Edward Cedgård

Master in electronic systems and control engineering. Edward's main task is to design the robotic arm and gripper mechanism together with Niklas. Tasks as deriving the kinematic equations, and implementation using forward and inverse kinematics. Choise of motors, armdesign, communication with motors using serial communication.

Niklas Dahlquist

Niklas is studying his fifth year at the Engineering physics and electrical engineering student program.

His main focus will be to work with Edward Cedgård to evaluate the gripping mechanism and if necessary design new components and model the corresponding control system to be able to lift up and hold the target object.

Edward Källstedt

Currently studying his fourth year in the Master Programme in Computer Science and Engineering. A fan of making things secure, fast, scalable, and well-documented. Primarily interested in low level software development. Will initially work on the machine vision implementation together with Martin. In addition to machine vision specifically this work will also consist of robot localization and collision avoidance. As the project progresses he will take on more general software problems that might arise. The first week will be spent researching different computer vision technologies.

Albin Martinsson

Albin is a 5th year computer science student specializing in industrial computersystem. In this project he will be focusing on the arrowhead integration and bein charge of the Github repository. This will entail connecting all the services toeach other and making sure they are authenticated and secure. Being in chargeof the git repository will entail merging pull requests and sorting out conflicts, making sure that the version control part of this project runs smoothly.

Måns Norell

Studying for a master in electronic systems and control engineering. Måns main task is to design the base and line-following controller for moving the robot along a line. Tasks include designing the base, printing the specialized parts, simulating and testing the base. Communication between controller, motor and camera will be worked on in collaboration with those in charge of these tasks.

Project structure

To keep the project going and have an organized structure the project is divided in different parts, or subprojects. Each group member is either alone or in group responsible for each part of the project which coincides with their interests.

- Arrowhead
- Machine vision and localization of external objects
- Gripping tool
- Movable base

Meetings

Every week the group will be meeting on Mondays and Tuesdays to catch up and support each other. This scheme may change in the future if needed. The Monday meetings will have the following agenda where the goal is to catch up with the whole project group and discuss the project

- Status of work done the previous week by each member
- Preparation for the seminar
  - Discussion of the previous seminar meeting
  - How the weeks work has been coinciding with the seminar feedback
  - Questions to ask the teachers
  - Questions to ask the other group
  - Who does what during the Tuesday seminar
- Other

The Tuesday meeting will be after the seminar to collect and reflect over the feedback from the teachers and the other group. Also a status on the work planned to be done the coming week will be discussed so that each member has an overview of what the other members are doing. The meetings will have the following agenda

- What feedback did the teachers give
- What feedback did he other group give
- Feedback to each other withing the group
- Work to be done the following week
- Other

As mentioned, this meeting structure may be subject to changes if needed and of course if any member of the group wants to work from home a video call will be organized.

References

[1] Stanford Artificial Intelligence Laboratory et al., “Robotic operating system.” [Online]. Available: https://www.ros.org

[2] E. W. Weisstein. ”spline.” from mathworld–a wolfram web resource. [Online]. Available: https://mathworld.wolfram.com/Spline.html

[3] ——. ”cubic spline.” from mathworld–a wolfram web resource. [Online]. Available: https://mathworld.wolfram.com/CubicSpline.html