

HAN Master Major Project

# Major Project

## Using FANUC R-2000iC/210F (6-axis robot) for improved efficiency in FRC parts formation

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Figure 0.1: FANUC R-2000iC/210F 6-axis industrial robot arm

# Contents

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1	Abstract	1
2	Preface	1
3	Summary	1
4	Acronyms	1
5	Problem Definition	2
	Appendices	3
A	Appendix 1	4
B	Appendix 2	4

# Abstract

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This work aims to integrate a FANUC 210F 6 axis industrial robot arm into an experimental production line. As this production line is set in a research environment, gaining a deeper understanding of all involved systems is desired.

The dynamic behaviour of a physical system is best expressed with an analytical model. In order to control a robot arm, a kinematic model needs to be created. With this model, a control algorithm can be derived.

The objective of this thesis is to derive the complete inverse kinematic model of a 6 degrees of freedom (DOF) robotic arm analytically. For an exact numerical simulation of the device most steps are laid out theoretically and difficulties in the practical implementation are described. Additionally for follow up projects this work also contains a quick start guide and a safety manual for the robot in this setting. Finally to contribute to current research, twinning specifications will be defined.

# Preface

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Robots can be defined as programmable movement automatons that can perform tasks without human supervision and can be taught at least repetitive tasks. Increasingly, also ways to sense their surroundings are added and improve their movements according to their surroundings. These additionally to the sensors like pulse encoders at their axes to feedback control their endpoint position accuracy.

I have started working with robots and robotic systems in my bachelor studies. As a starting engineer, I was exploring the possibilities of automated manufacturing with CNC mills and 3D printers. These were very simplistic robotic systems based on a feedforward control with stepper motors for position accuracy. For starting a production process, these devices had to be half automatically calibrated and the position and orientation needed to be taught automatically by pointing the drill/printing head to the markerpoints.

# Summary

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# Acronyms

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**HAN** Hogeschool van Arnhem en Nijmegen

**SPC** Smart Production Centell

**DOF** degrees of freedom

# Problem Definition

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For FRC part production, a robot arm can be used to load the press with raw material, as it allows for more flexibility in the production line. As the robot arm has many degrees of freedom, there are different strategies for a control cycle. Main constraint is to achieve this movement of materials as fast as possible to minimize the cool-down of the molten FRC. Additionally, the accelerations and forces on the material should be minimized while transferring, to make sure no material is lost in the process. This makes it hard to find an ideal, fast control strategy to place the raw material into the press.

## References

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# Appendices

## **Appendix 1**

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## **Appendix 2**

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