



## The four Ws'

Please make a new document for each topic, so it will be easy to edit if there is a mistake.

- Who are you addressing:

scientists who are specialists in your field of research, a wider group of scientists, fellow students, or public audiences?

- Why is your message important?

Why are you communicating it? Presumably you are not doing it just for credits, but to add to the pool of knowledge

- What are your main findings or “take-home” messages? ’

What are you going to present - new research results or a review of a topic? What prior knowledge, expectations and questions might your audience have? What technical language do they understand?

- How can you best deliver your message and satisfy the audience’s need?

How will the audience use its new knowledge?

## **Test template**

Use this template when you need to make a test of something

**Purpose:**

**Test equipment:**

**Procedure:**

**Measuring data:**

**Results:**

**Uncertainties of measurement:**

**Conclusion:**

# Contents

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<b>1 System overview</b>	<b>3</b>
1.1 Geomagic touch . . . . .	3
1.2 Communication computer . . . . .	4
1.3 Test setup . . . . .	4
1.4 Da vinci robot . . . . .	4
1.5 Endowrist . . . . .	4
1.6 Robot operating system . . . . .	4
<b>2 Kinematics</b>	<b>5</b>
2.1 Kinematics for the Geomagic touch . . . . .	5
2.2 Kinematics for the Endowrist . . . . .	6
2.3 Kinematics for the Da vinci robot . . . . .	6
<b>Bibliography</b>	<b>7</b>

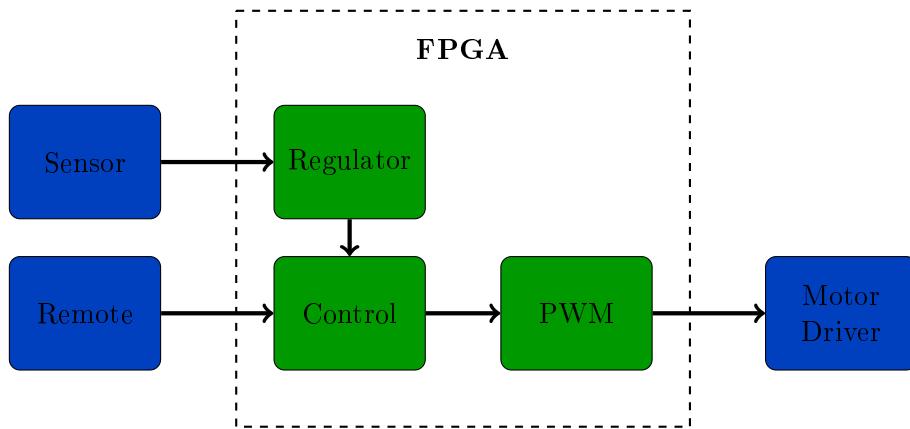


Figure 0.1: simpel Tikz figure

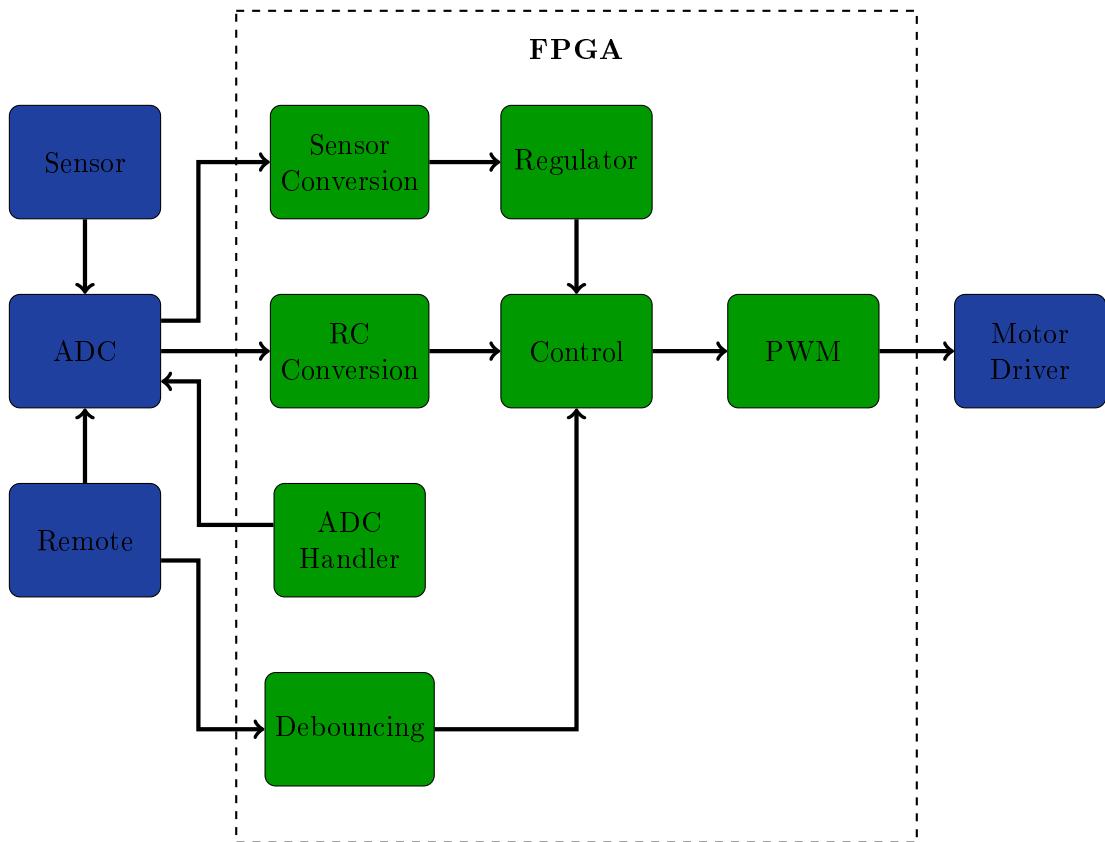


Figure 0.2: Advance Tikz figure to shift line position



# System overview 1

In this chapter an description of the system is made. This is made for the reader to get a better understanding of the setup which where available on Aalborg university. This description includes the following points and will be described in the same order

- The Geomagic touch,
- The computer for communication,
- The test setup,
- and the Da vinci robot.

## 1.1 Geomagic touch

The geomagic touch is a haptic feedback device, which has the ability to manipulate its joint in such a way that the user feels resistance when moving the pen in a certain direction or way. The geomagic touch described in this section is the model Phantom omni and can be seen on *Figure 1.1*.

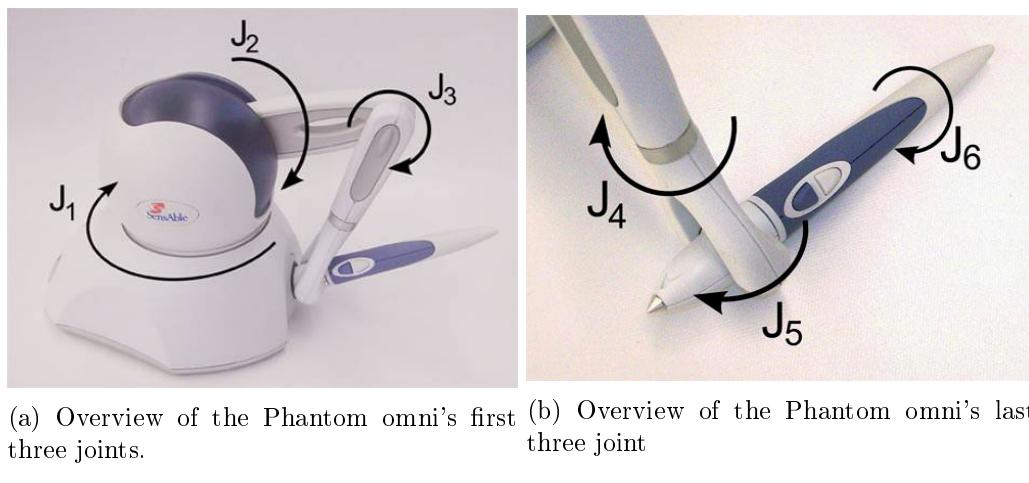


Figure 1.1: Overview of all the Phantom omni's joints[1]

As mentioned the Phantom omni has the ability to generate resistance for the user. In other words, when moved in a specific direction it can create a counter force in respect to a certain position. On *Figure 1.1*, it can be seen that the omni has six degrees of freedom (DOF), where the first three has actuators, see *Figure 1.1a*. This means that the device only has the ability to generate force feedback with three DOF, in this case roll, pitch and yaw.

The connection to the omni can either be made directly through a ethernet cable or through ethernet cable to a usb converter into a computer. For programming the omni an API is included, which enables the connection to the omni. The programming of the omni happens through the languages C++.

include  
other  
languages  
if any

## Installation of the Phantom omni

The Phantom omni can be installed on both Windows, and Linux, embedded systems. Use the provided installation guides on

<http://dsc.sensable.com/viewforum.php?f=15>

**Note to the linux system:** If this installation is running on a non-US version of Linux, a readout of the different joint positions can be corrupted. This is because of the difference in the EU and US compiling, where the ',' and '.' is read different.

To solve this problem, follow the solution given on

<http://dsc.sensable.com/viewtopic.php?t=5644#top>

## 1.2 Communication computer

### 1.3 Test setup

### 1.4 Da vinci robot

### 1.5 Endowrist

An Endowrist, see *Figure 1.2a* is a surgical tool which can be manipulated as a human wrist. It is used in surgical procedures such as Laparoscopic surgeries, better known as minimally invasive surgery (MIS), where small incisions in the human body is made under the surgery. Because the incision cuts are small, blood lose under the surgery and the risk of infection is reduced. This has a positive effect on the recovery time for the patient.



(a) Full view of a Endowrist

(b) Actuator plates, which can alternate the end effector position

(c) End effector of the Endowrist

Figure 1.2: The Endowrist and how the interaction with it are made

As mentioned the Endowrist has the ability to be manipulated as a human wrist and thereby has four DOF, see *Figure 1.2c.* This enables the movement of roll, pitch, yaw and an open closing mechanism that acts as the thumb and index finger of a hand.

The end effector is manipulated by the four wheels seen on *Figure 2.1b.* Wheel one and three defines the movement of the yaw and the closing mechanism. Wheel two moves the pitch and wheel four is for the roll. Each wheel drives a cable inside the Endowrist, which transport a force at one end to the other. The Endowrist is cable driven, which enables the opportunity of making the Endowrist small but it also makes the system nonlinear as the force acting at one end is not directly transmitted to the other end due to friction.

## 1.6 Robot operating system

This  
maby has  
to be set  
up every  
time

We have  
to update  
the  
picture so  
it shows  
each DOF

update  
with  
numbers

# Kinematics 2

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From Chapter 1: *System overview*, an overview of the system available on Aalborg university was introduced. In this chapter the deviation of the different kinematics are made. This is done due to the advantages of simple calculations of the joint positions e.g Geomagic touch or the Endowrist, thus from the kinematics the velocity and acceleration can also be derived.

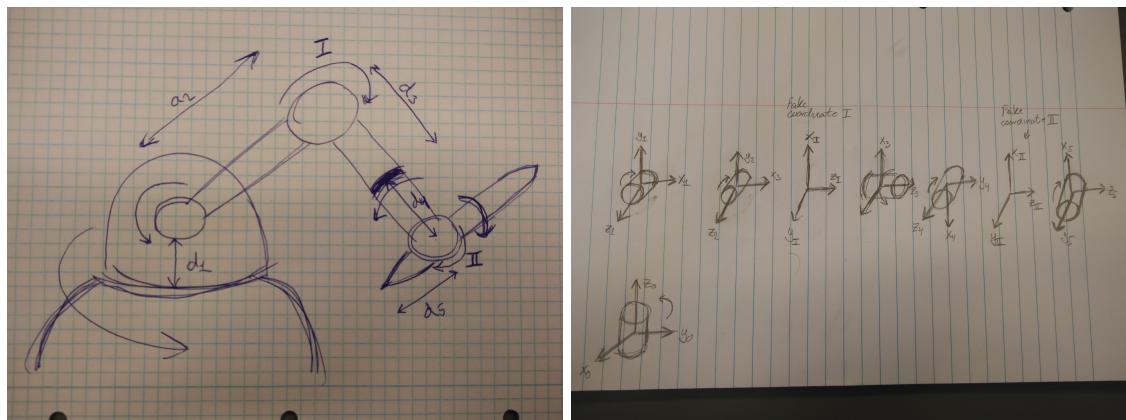
This chapter will use the Denavit Hartenberg (DH) notation to derive the different parameters for the kinematics.

To use the DH notation some rules has to be followed.

- DH(1): The axis  $x_n$  is perpendicular to axis  $z_{n-1}$
- DH(2): The axis  $x_n$  intersects the axis  $z_{n-1}$

## 2.1 Kinematics for the Geomagic touch

As shown on *Figure 1.1*, the Phantom omni has 6 joints, from which the kinematic tabel shown on *Table: 2.1* can be dereived.



(a) Geomagic touch with all rotational joints and their DH parameters.  
(b) Frame coordinate system for the Geomagic touch to the deviation of the kinematics.

Figure 2.1: Shows joints positions, the different DH parameters and the coordinate frame for each joint. The base frame is difined as  $O_0$ .

$j_i$	$a_i$	$d_i$	$\alpha_i$	$\theta_i$
1	0	$d_1$	$\frac{\pi}{2}$	$q_1$
2	$a_2$	0	0	$q_2 + \theta_1$
I	0	0	$\frac{\pi}{2}$	$\frac{\pi}{2} + q_3$
3	0	$d_3$	0	0
4	0	$d_4$	$\frac{\pi}{2}$	$\pi + q_4$
II	0	0	$\frac{\pi}{2}$	$\pi + q_5$
5	0	$d_5$	0	0

Table 2.1: Tabular which contain the kinematics for the Geomagic touch described in Section 1.1: *Geomagic touch*. The Roman numbers defines the fictional joints

## 2.2 Kinematics for the Endowrist

## 2.3 Kinematics for the Da vinci robot

## **Bibliography**

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- [1] Sigverse, “Using phantom omni haptik device,” 2014. Downloadet: 21-10-2016.