.

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 your 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 somthing

Purpose:

Test equipment:

Procedure:

Measuring data:

Results:

Uncertainties of measurement:

Conclusion:

Contents

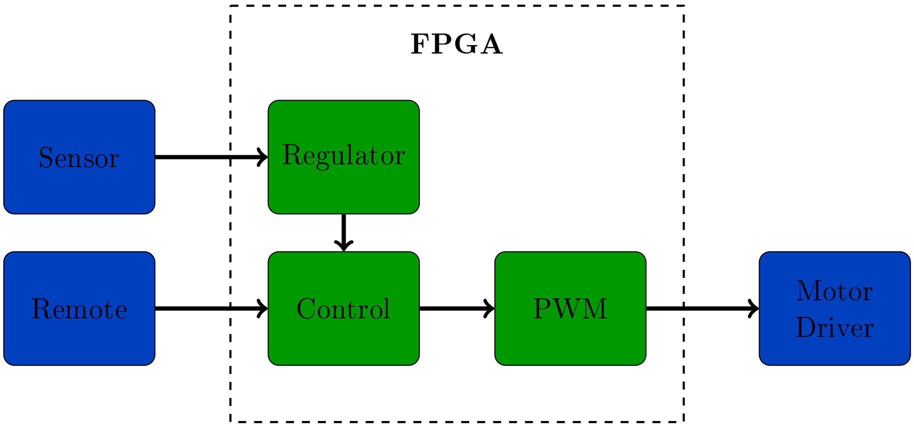


Figure 0.1: simpel Tikz figure

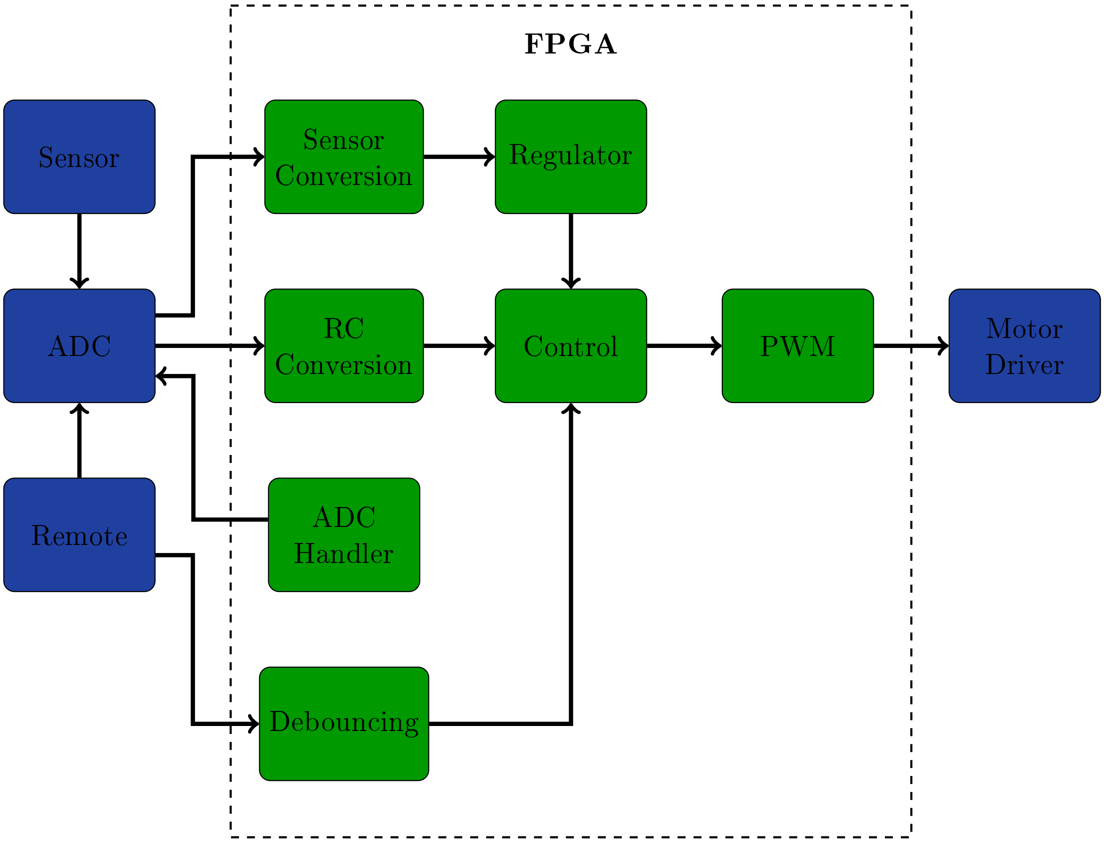


Figure 0.2: Advance Tikz figure to shift line position

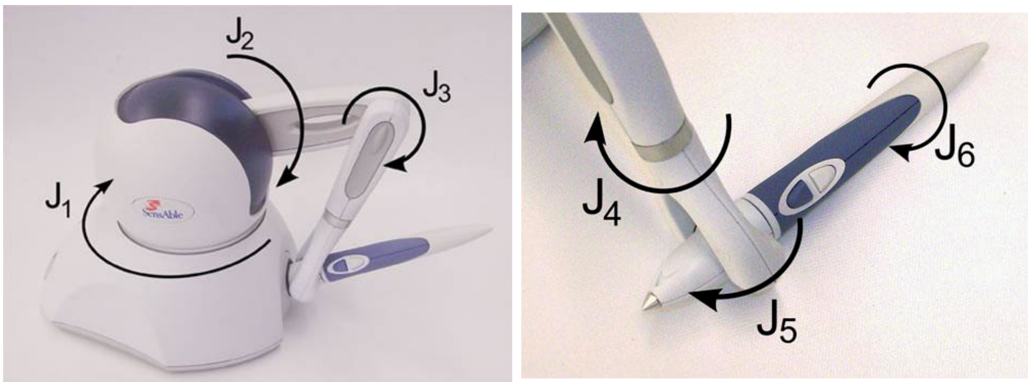
1 System overview

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 Gemagic touch,
- The computer forcommunication,
- 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 manipulates its joint in such a way that the user feels resistance when moving the pin 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*.



(a) Overview of the Phantom omni's first three joints.

(b) Overview of the Phantom omni's last three joint

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 cabel or through ethernet cabel 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

This maby has to be set up every time

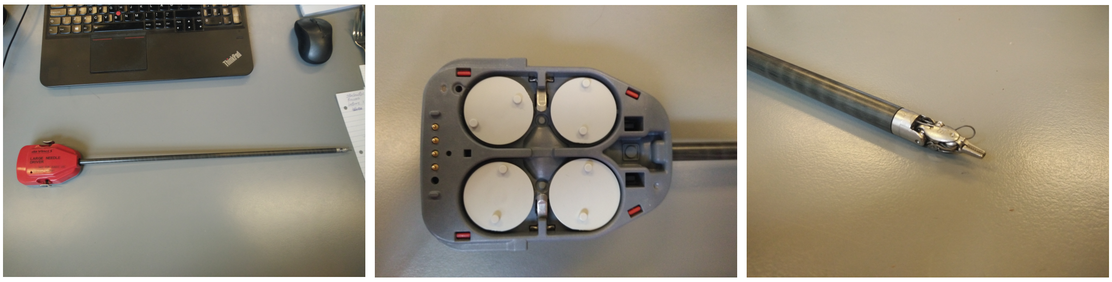
1.2 Communication computer

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.

We have to update the picture so it shows each DOF

The end effector is manipulated by the four wheels seen on *Figure 1.2b*. 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.

update with numbers

1.6 Robot operating system

Kinematics 2

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 to describe each joint and end effector positions for e.g the Geomagic touch or the Endowrist. From the positions it is possible to divert the velocity and acceleration of the joints and end effectors.

In the following the Denavit Hartenberg (DH) notations are going to be used. This is done because it seems to be a good way of describing the kinematics as it eases the calculations of the different positions. The DH notation only uses four parameters do describe the movement of the different joints. Each joint is given its own coordinate frame do describe the link between the different joints. To utilize the DH notation some rules got to be fulfilled and are as 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}

furthermore the joints rotates around the z axis.

need help to describe the following

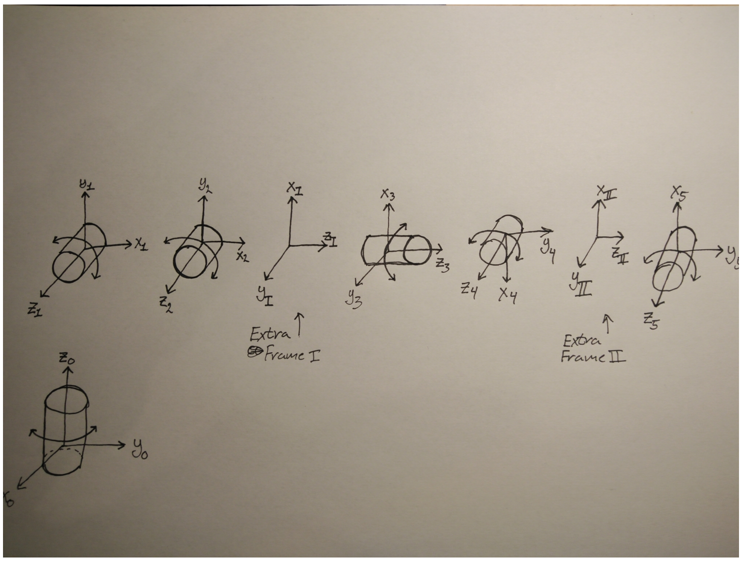
$$\begin{aligned}
A_i &= Rot_{z,\theta_i} Trans_{z,d_i} Trans_{x,a_i} Rot_{x,\alpha_i} \\
&= \begin{bmatrix} c_{\theta_i} & -s_{\theta_i} & 0 & 0 \\ s_{\theta_i} & c_{\theta_i} & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d_i \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & a_i \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & c_{\alpha_i} & -s_{\alpha_i} & 0 \\ 0 & s_{\alpha_i} & c_{\alpha_i} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \\
&= \begin{bmatrix} c_{\theta_i} & -s_{\theta_i} c_{\alpha_i} & s_{\theta_i} s_{\alpha_i} & a_i c_{\theta_i} \\ s_{\theta_i} & c_{\theta_i} c_{\alpha_i} & -c_{\theta_i} s_{\alpha_i} & a_i s_{\theta_i} \\ 0 & s_{\alpha_i} & c_{\alpha_i} & d_i \\ 0 & 0 & 0 & 1 \end{bmatrix}
\end{aligned} \tag{2.1}$$

a is the distance between the axes z_i and z_{i+1} measured along the x_{i+1} axis.
α is the angle between the axis z_i and z_{i+1} measured in a plane normal to x_{i+1}
d is the distance between the origin o_i and the intersection of x_{i+1} axis measured along the z_0 axis.
α is the angle between x_i and x_{i+1} measured in a plane normal to z_0.

2.1 Kinematics for the Geomagic touch

As shown on *Figure 1.1*, the Phantom omni has 6 joints. The coordinate frame for these joints can be derived as shown on *Figure 2.1*. Note that there is two additional frames for the Phantom omni. These are included because the distance between joint 3 and 4, 5 and

6, can not be defined as frame O_3 does not intersect with x_4 and O_5 does not intersect with x_6. This is solved by introducing the two frames upon O_3 and O_5 in such a way that the frames are rotated, thus fulfilling the DH(1) and DH(2) rule and thereby enabling the opportunity of defining the distance.
The DH parameters can then be derived as shown in *Table: 2.2*, where the two additional frames are displayed with roman numbers.



j_i	a_i	d_i	α_i	θ_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

Figure 2.1: Phantom omnis coordinate frames Figure 2.2: This is the caption for table

Find solution to caption figure/table problem!

2.2 Kinematics for the Endowrist

2.3 Kinematics for the Da vinci robot

Bibliography

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