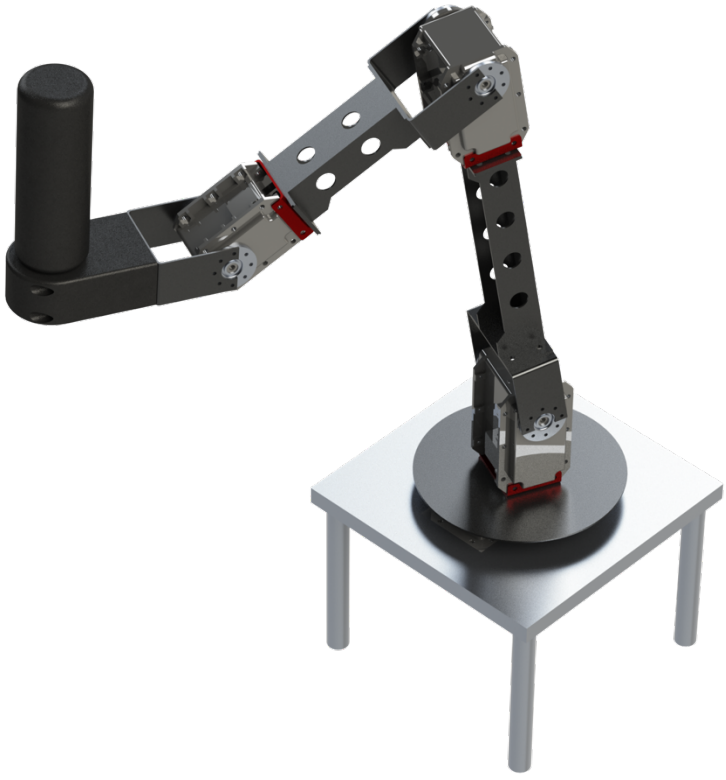
AALBORG UNIVERSITY

Testing of the Rehabilitation Robot

Additional material to group 363's semester report
ROB3 2020



RECOGNITION

The sampling frequency of this test will be the same as the game's (4,5 Hz).
First part will test a constant desired movement in each of the four directions.

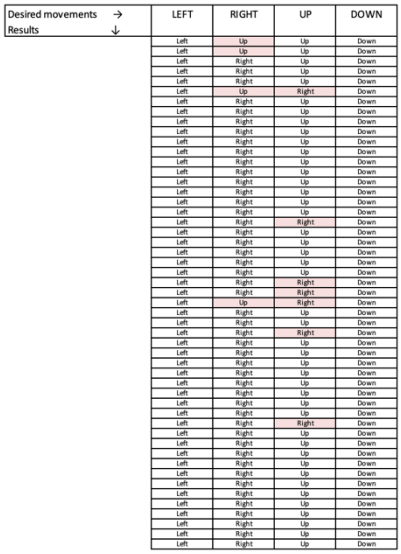
- Done by holding a position by 10 seconds, collecting 50 samples, holding 5 more seconds and then ending.

Second part will test a switch between two different desired movements.

- Done by holding a position for 3 seconds, changing position as fast as possible and then holding a new position for 3 seconds.

PART 1

Data obtained from the test has been placed in the following table:
Wrong directions have been colored red.



Desired movements → / Results ↓	LEFT	RIGHT	UP	DOWN
	Left	Up	Up	Down
	Left	Up	Up	Down
	Left	Right	Up	Down
	Left	Right	Up	Down
	Left	Right	Up	Down
	Left	Up	Right	Down
	Left	Right	Up	Down
	Left	Right	Up	Down
	Left	Right	Up	Down
	Left	Right	Up	Down
	Left	Right	Up	Down
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	Left	Right	Up	Down
	Left	Right	Up	Down
	Left	Right	Up	Down

Recognition of Left
Measured lefts: 50
Overall measures: 50
Success rate: $\frac{50}{50} \cdot 100 = 100\ \%$

Recognition of Right
Measured rights: 46
Overall measures: 50
Success rate: $\frac{46}{50} \cdot 100 = 92\ \%$

Recognition of Up
Measured rights: 43
Overall measures: 50
Success rate: $\frac{43}{50} \cdot 100 = 86\ \%$

Recognition of Down
Measured rights: 50
Overall measures: 50
Success rate: $\frac{50}{50} \cdot 100 = 100\ \%$

Average recognition for all 4 directions: 94,5 %

PART 2

Data obtained from the test has been placed in the following table: First direction is colored yellow, and second direction is colored blue. Wrong directions are colored red.

Desired movements → / Results ↓	RIGHT TO LEFT	UP TO DOWN	LEFT TO DOWN
	Right	Up	Left
	Right	Up	Left
	Right	Up	Left
	Right	Right	Left
	Right	Up	Left
	Right	Up	Left
	Right	Up	Left
	Right	Right	Left
	Right	Up	Left
	Right	Up	Left
	Right	Up	Left
	Right	Right	Left
	Right	Up	Left
	Right	Up	Left
	Right	Up	Left
	Right	Up	Left
	Right	Up	Left
	Right	Right	Left
	Right	Left	Right
	Left	Down	Down
	Left	Down	Down
	Left	Down	Down
	Left	Down	Down
	Left	Down	Left
	Left	Down	Down
	Left	Down	Down
	Left	Down	Down
	Left	Down	Down
	Left	Down	Down
	Left	Down	Down
	Left	Down	Down
	Left		Down
	Left		Down
	Left		

Recognition of Right to Left
Steps between right and left: 0

Recognition of Up to Down
Steps between up and down: 2

Recognition of Left to Down
Steps between left and right: 1

Average steps for all 3 switches: 1 step
Average in seconds: 0,22 seconds

Control System

The robot will be placed in the start-position (which is a given point in the game) while the control system is running. Each joint of the body will be forced 30° out of position, and the angles of the specific joint will be logged by a C++ program.

JOINT 1	JOINT 2	JOINT 3	JOINT 4
30	10	70	-35
30	10	70	-35
30	10	70	-35
30	10	70	-35
30	10	70	-35
23	12	73	-37
13	19	84	-52
8	26	93	-65
8	29	98	-71
8	31	98	-70
8	33	98	-67
8	36	99	-66
8	38	100	-66
8	38	101	-66
8	38	102	-66
8	38	103	-66
8	38	103	-66
8	38	103	-66
8	38	103	-66
8	38	103	-66

Desired angle:	0	40	100	-65
Number of corrections:	3	8	11	7
Settling time:	0.6666667	1.7777778	2.4444444	1.5555556
Overshoot:	0	0	0	7.5757576
Steady state error:	8	-2	3	-1

The settling time, overshoot and steady state error have been calculated with the following formulas.

Settling time is calculated by counting the measured steps from first correcting angle to first steady angle, and then dividing it with the frequency. This can be written as:

$$settling\ time = \frac{steps}{frequency}$$

This result is given in seconds.

Overshoot is calculated by taking the angle with the largest overshoot, dividing it by the steady state angle and multiplying it with 100. This is written as:

$$overshoot = \frac{biggest\ overshoot\ sample}{steady\ state\ angle} \cdot 100$$

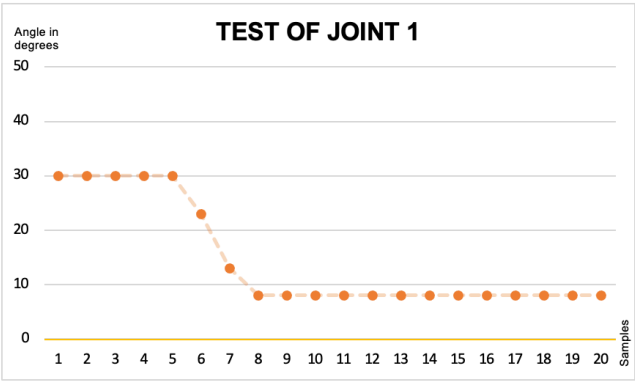
This result is given in percentage.

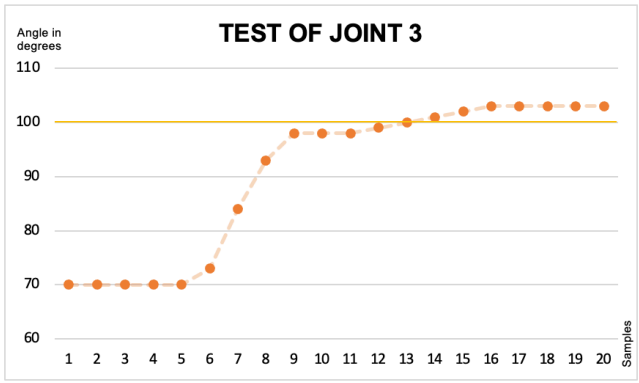
Steady state error is calculated by subtracting the actual steady state angle by the desired steady state angle. This is written as:

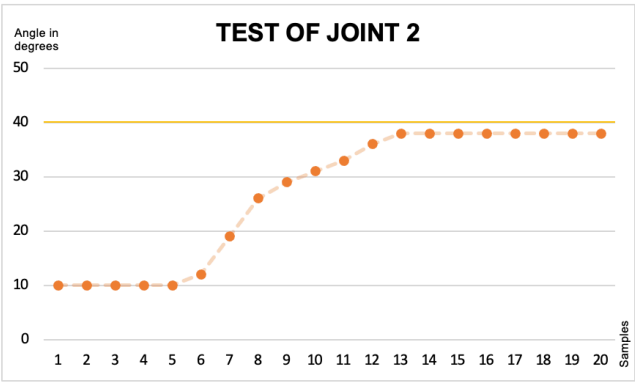
$$steady\ state\ error = actual\ angle - desired\ angle$$

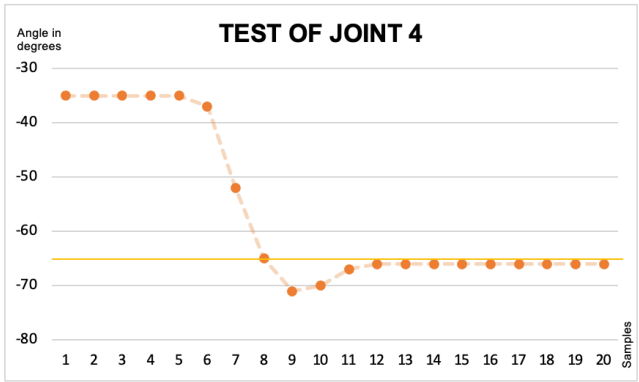
The result is given in degrees.

Below the results has been illustrated.









GUI

The interface will be tested by running a simulation of a normal rehabilitation, but without the physical aspect of the robot. One person will start the program, and every handling will be observed and described.

Handlings

- Clicking “Start”.
- Choses shoulder height between 3 options by clicking. Second option has been chosen.
- Choses distance to patience between 3 options by clicking. Third option has been chosen.
- Choses number of different positions (icebergs) between 3 options by clicking. First option has been chosen.
- “Done” is then pressed.
- A text box asks the user to place the positions within the map. Three positions are clicked on the screen.
- The game starts and can be played by the patient.
- The game is quit by clicking “Quit”

Overall clicks: 8-10 (depending on the number of positions)
Time between options exceeding 0.5 seconds: 0 (no lag)

Repetition

The repetition quality of the entire system will be tested by having the test person reach as many positions as possible within 1 minute. The positions (icebergs) will be placed with approximately 1/2 of the entire (diagonal) length of the map between them.

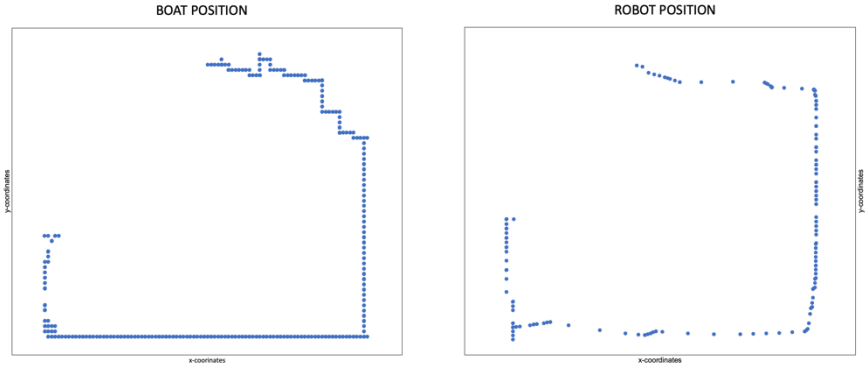
Results

Repetitions done: 5
To find the number of possible repetitions in 45 minutes the following calculations has been mad:
$5 \cdot 45 = 225$ repetitions

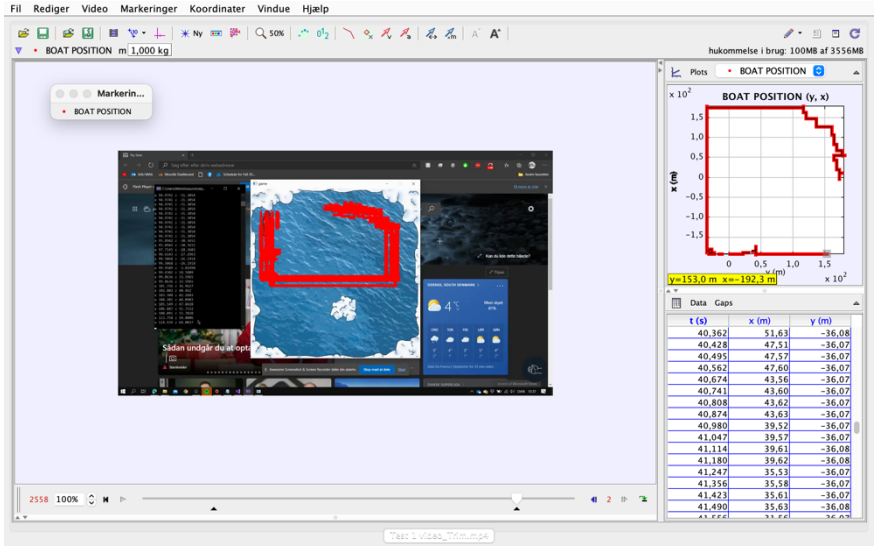
Precision

The precision of the system will be tested by having the test person follow a path close to the border of the map, at the same time the movement of the robot will be calculated by inverse kinematics. The position of the boat will be evaluated by Tracker 5.1.5 Video Analysis and Modeling Tool. The video will be analyzed at 18 FPS and 1080p. The two paths will then be compared.

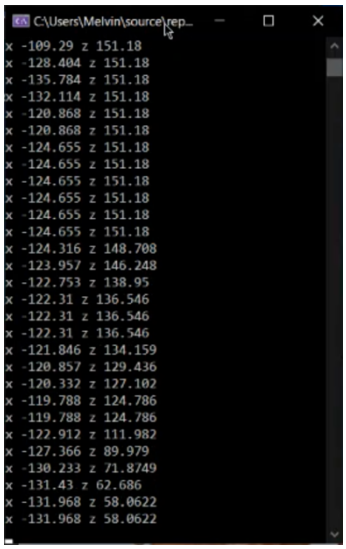
Results



Horizontal is y-coordinates of the recorded movement and vertical is x-coordinates of the recorded movement, both in pixels.



Quick view of the video analysis tool



Output of inverse kinematics

Further information
Test done by: Group 363
Tested on: Benjamin Damsgaard (test person)
Date of test: 03/12/2020 - 04/12/2020
Place of testing: Fredrik Bajers Vej 7
Version: 2.0