



Hochschule
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Software Development Project

Motion primitives for Freddy

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Definition

Motion primitives¹, skill or behavioural building block:

- atomic unit of robotic behaviour
- configurable and hence reusable in different contexts
- composable with other motion primitives
to build more complex behaviour

¹ Kinematic constraints and motion primitives 2022.



Robile platform of Freddy: Capabilities

- Modular mobile robot platform
- Four identical pair of wheels which can be actuated independently
- Communication with wheel-units (in master-slaves architecture) is made over EtherCAT
- Available sensors: motor encoder, IMU (Inertial Measurement Unit) - consists of gyroscope and accelerometer



Robile platform of Freddy: User interface

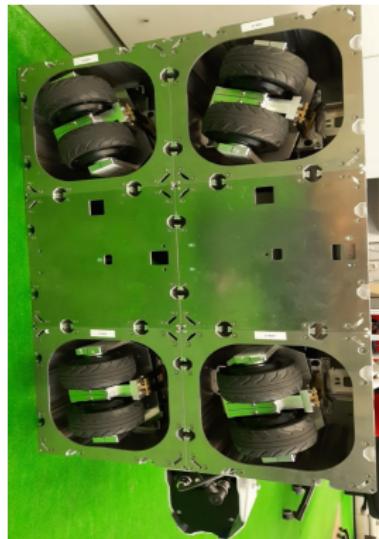
- Control interface: velocity(power limited) and force(current controlled)
- Programming language: C



Robile platform



(a) Top view



(b) Bottom view

Figure 1: Top and bottom view of Robile platform



Problem definition

Controlled movement over the ramp using motion primitives for the Freddy robot

Project goal

Develop a control interface for Freddy robot to perform a motion over the ramp ^a

^a Considering environment is static



Velocity control - video



Safe ramping behaviour - video

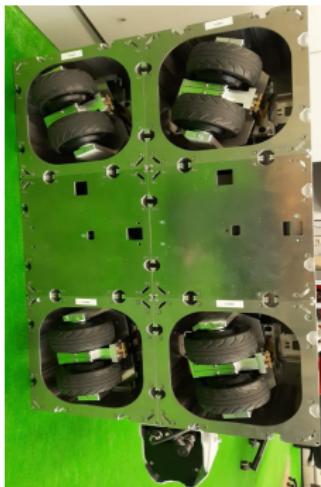


Wheel configurations

- Possible different configuration of the platform i.e., 4 wheeled , 2 wheels + 2 castors, tricycle etc.



(a) 2 active wheels
and 2 castor wheels



(b) 4 active wheels



Required libraries

- Simple Open EtherCAT Master (SOEM) - communication between robot and the actuators.²
- robif2b - robot control interface³
- GSL - GNU Scientific Library⁴
- WS21 SDP repository: Motion Control of the KELO 500⁵

²OpenEtherCATsociety 2022.

³Rosym-Project 2022.

⁴Dr M. Galassi 2021.

⁵ws21-kelo-500-motion-control 2021.

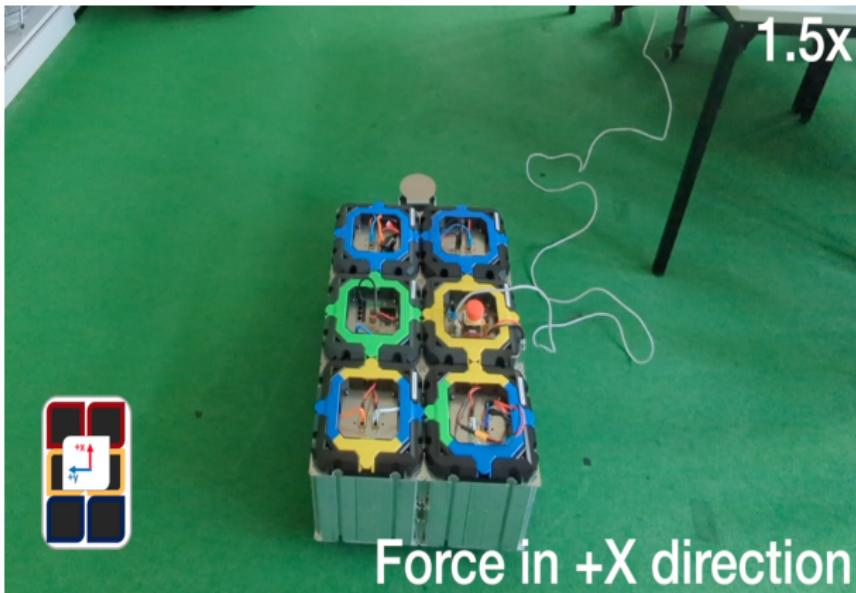


User story 1

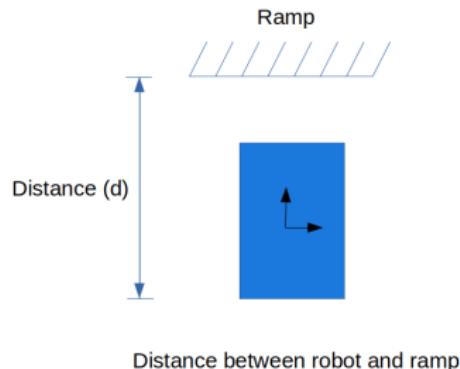
Unique Identifier : D1	Estimate : 2 weeks
Task Description : <ul style="list-style-type: none">Understand force control distribution on Freddy robot.Test previous SDP code on Freddy.Evaluate overlap between previous SDP and ramping behaviour.Refactoring the existing code.	Acceptance Criteria : <ul style="list-style-type: none">1. Move robot in translational forward/backward and left/right as well as rotational clockwise/anticlockwise manner.2. Drive up the ramp with the different platform-level force setpoints.
Risk : Low	Real Effort : 2 weeks



Acceptance criteria 1 - video



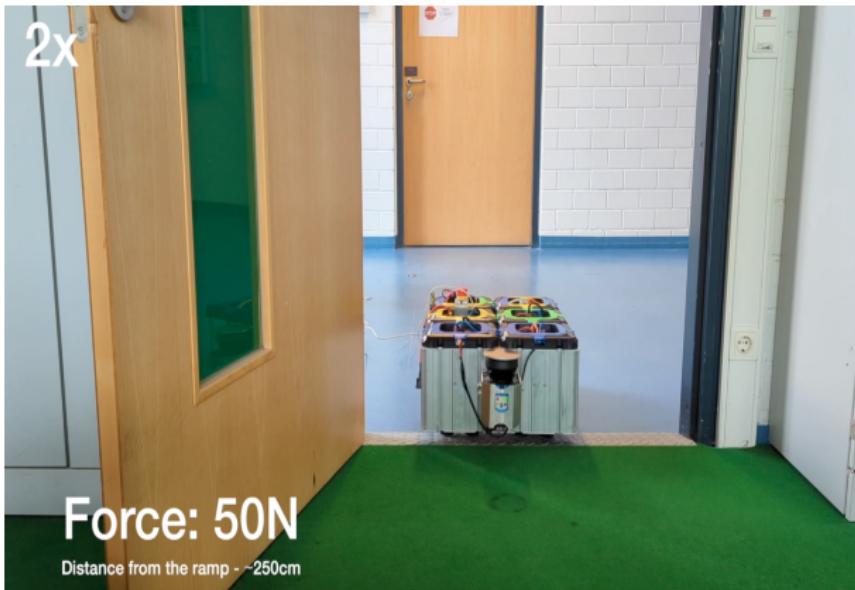
Robot distance w.r.t. ramp



■ Robile platform



Acceptance criteria 2 (d=250cm) - video



Acceptance criteria 2 (d=125 cm) - video



User story 2

Unique Identifier : D2	Estimate : 2 weeks
Task Description : <ul style="list-style-type: none">Orient wheel units to the desired configuration w.r.t. base of the robot.	Acceptance Criteria : <ul style="list-style-type: none">Bring the wheels to 0, 90, 180 and 270 degrees.
Risk : High	Real Effort :

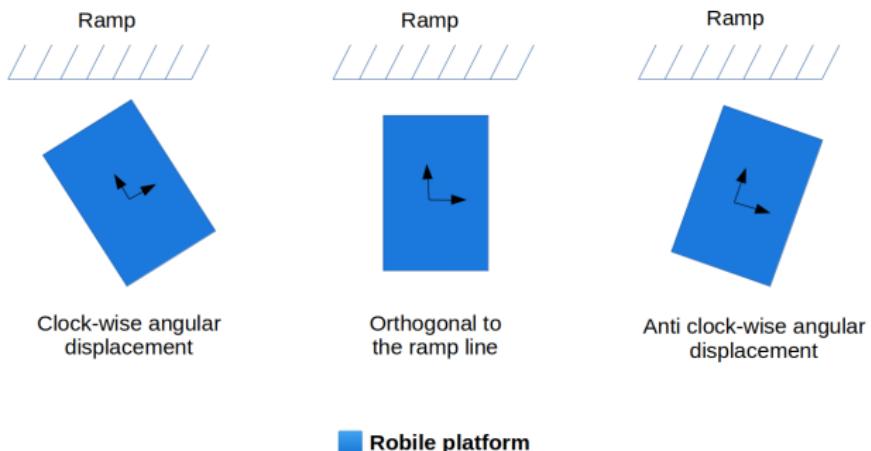


User story 3

Unique Identifier : D3	Estimate : 3 weeks
Task Description : <ul style="list-style-type: none">Align the robot with a ramp baseline.	Acceptance Criteria : <ul style="list-style-type: none">The robot should be aligned with the baseline of the ramp from different starting orientations:<ul style="list-style-type: none">-> w.r.t. to the baseline of the ramp,1) clockwise angular displacement,2) anti-clockwise angular displacement, and3) orthogonal to the line.
Risk : High	Real Effort :



Robot alignment w.r.t. ramp



User story 4

Unique Identifier : D4	Estimate : 4 weeks
Task Description : <ul style="list-style-type: none">Understand the ramp-up behaviour for the Freddy robot.Implement ramping behaviour on the robot.	Acceptance Criteria : <ul style="list-style-type: none">The robot should be able to complete the ramp slope.The robot should be able to safely stop after finishing the ramp.The robot should also be able to run over a small bump (ramp up and down).
Risk : High	Real Effort :



User story 5

Unique Identifier : D5	Estimate : 2 weeks
Task Description : <ul style="list-style-type: none">Integrate all sub-modules as a complete state machine.	Acceptance Criteria : <ul style="list-style-type: none">The robot should be able to autonomously drive over the ramp.The robot should be stopped after the finishing ramp behaviour.
Risk : High	Real Effort :



Collaboration plans



Figure 2: Project Roadmap

- GIT version control: Motion Primitive Freddy repository
- Communication medium: Slack
- Meeting frequency: internal meeting twice a week and with the advisor, every Thursday (in-person/online)



References

-  Bruyninckx, Herman (2022). **Building blocks for complicated and situational aware robotic and cyber-physical systems**. Accessed on 21.04.2022. URL: <https://robmosys.pages.gitlab.kuleuven.be/composable-and-explainable-systems-of-systems.pdf>.
-  Dr M. Galassi, Dr J. Theiler (2021). **GSL - GNU Scientific Library**. Accessed on 21.04.2022. URL: <https://www.gnu.org/software/gsl/>.
-  **Kinematic constraints and motion primitives** (2022). Accessed on 21.04.2022. URL: <http://sbpl.net/node/48>.
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Thank you for your attention!
Questions?

