Project proposal
Controller for Hogger^2 HOG wheel robot

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Hogger^2 is a mobile robot with two HOG (Hemispherical Omnidirectional Gimbaled) wheels belonging to KCiR. In the past, many diploma theses have been written on modeling and controlling a robot with such a drive [4], but none of them have tested them on a real robot, among other things due to the lack of efficient hardware. The goal of this project is to develop controller module (hardware and firmware) for existing chassis (described in [3]) that allows:

- controlling speed of two BLDC motors via BEMF without external controllers (built-in 2-channel triple-half bridge),
- controlling 4 servos via PWM signal,
- reading on-board sensors (6DoF IMU and maybe optical flow),
- transferring data in both ways via ESP32 (interface described in [5]) and/or NRF24L01+ radio module.

The outcome of the project will be a robot with implemented simple algorithm for movement without slippage on the flat ground. Robot should be controlled wirelessly from PC. The most challenging part will be implementation of velocity control of the two BLDC motors (hardware and software part) that will not burn the motors nor itself. Algorithm was described in [2, 1, 6].

Goals	
Must do	**Hope to do**
• custom circuit for BLDC control and sensors • BEMF control algorithm on both motors • controlling of servos • reading IMU sensor • 2-way communication using ESP32 • robot movement in open-loop	• reading optical flow sensor • 2-way communication using NRF24L01+ • EKF for state estimation • robot movement in close-loop (using on-board sensors)

Needed tools:

- KiCad for schematic and PCB design
- STM32Cube for low-level code generation
- Qt for PC executables useful during debugging

References

[1] Electronoobs. My open source Arduino ESC – BEMF zero-cross. YouTube tutorial. `https://www.youtube.com/watch?v=VdkloigaxZo`.

[2] GreatScott! Make your own ESC – BLDC Motor Driver. YouTube tutorial. `https://www.youtube.com/watch?v=W9IHEqlGG1s`.

[3] Damian Góral. Two HOG wheel mobile robot construction. Bachelor's thesis, `https://kcir.pwr.edu.pl/~mucha/Pracki/Damian_Goral_praca_inzynierska.pdf`, Wrocław University of Science and Technology, 2017.

[4] Paweł Joniak. Control problem for two HOG wheel mobile robot. Master's thesis, `https://kcir.pwr.edu.pl/~mucha/Pracki/Pawel_Joniak_praca_magisterska.pdf`, Wrocław University of Science and Technology, 2017.

[5] Tomasz Lubelski. Construction of small mobile laboratory robot of class (1,2). Bachelor's thesis, `https://kcir.pwr.edu.pl/~mucha/Pracki/Tomek_Lubelski_praca_inzynierska.pdf`, Wrocław University of Science and Technology, 2023.

[6] STM32WROBOTYCE. Sterowanie 3-fazowym silnikiem BLDC – pomiar BEMF. Blogpost tutorial. `https://www.stm32wrobotyce.pl/2021/06/30/sterowanie-3-fazowym-silnikiem-bldc-pomiar-bemf/`.