



**Faculty of Electrical
Engineering**

WARSAW UNIVERSITY OF TECHNOLOGY
www.ee.pw.edu.pl

100
years



SENE 2025

README-driven learning in embedded systems education within the context of power electronics and drives



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This presentation was made by a human :)

Experiment! Verify! Validate!



SM-SH55 vs. SM-SH56
Keep calm and RTBM!

Szczyrk, 2011



Inspire! Walk the talk! Be authentic!

Procent absolwentów, którzy po uzyskaniu dyplomu podjęli i ukończyli studia II stopnia

dla kierunków z grupy inżynieryjno-techniczne, studia I stopnia

	podjęli studia II stopnia	ukończyli studia II stopnia
absolwenci z roku 2014		
absolwenci z roku 2015		56,4%
absolwenci z roku 2016		59,2%
absolwenci z roku 2017		58,1%
absolwenci z roku 2018		54,7%
absolwenci z roku 2019		55,9%
absolwenci z roku 2020		50,3%
absolwenci z roku 2021		48,0%
absolwenci z roku 2022		41,2%
absolwenci z roku 2023		17,6%

<https://www.kierunki-studiow.info/studia-inzynieryjno-techniczne/1st/warszawa>

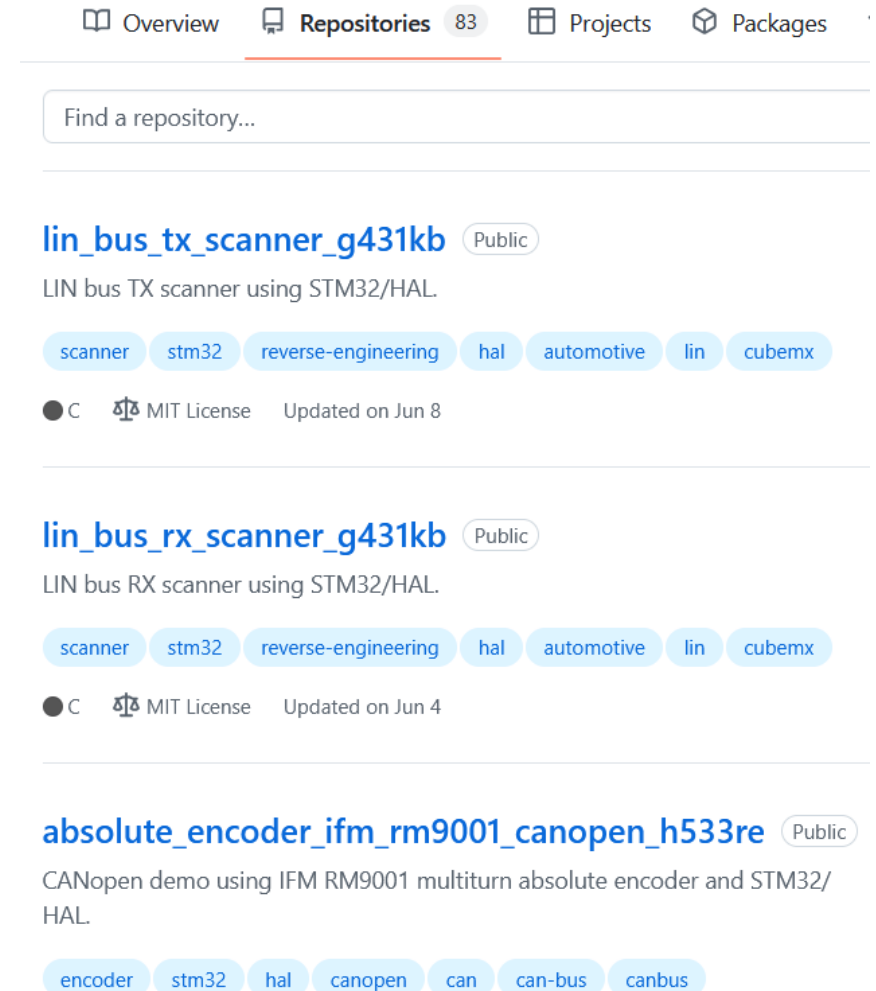
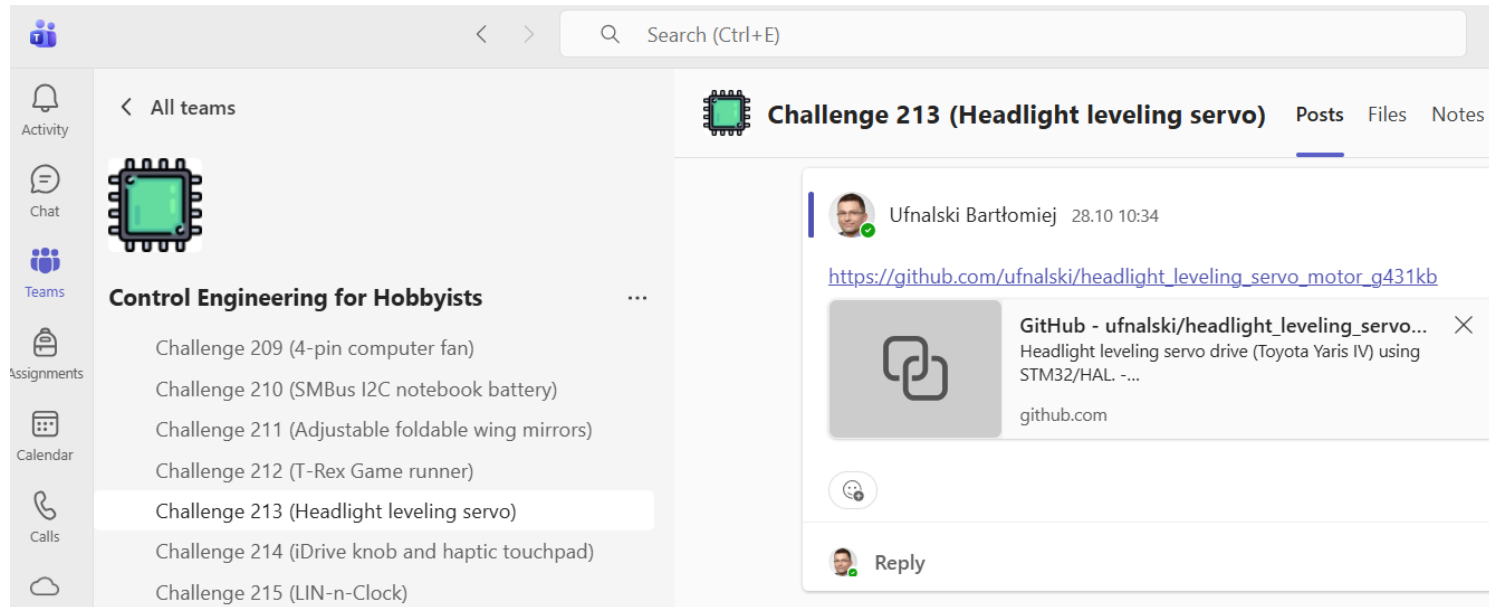
Dear Engineer/Educator!

What teaching techniques, props and platforms do you use?

- Reverse engineering?
- Pre-owned car parts?
- GitHub/GitLab?



210+ challenges on MS Teams and 80+ repositories on GitHub later – the point of no return

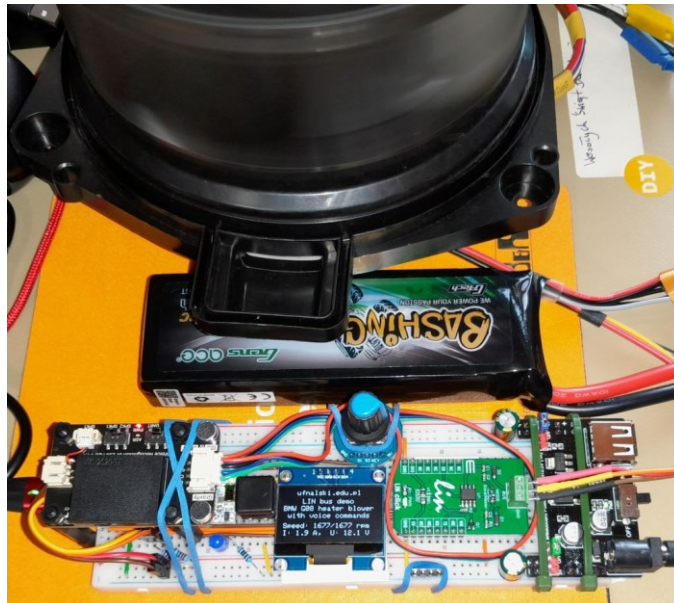
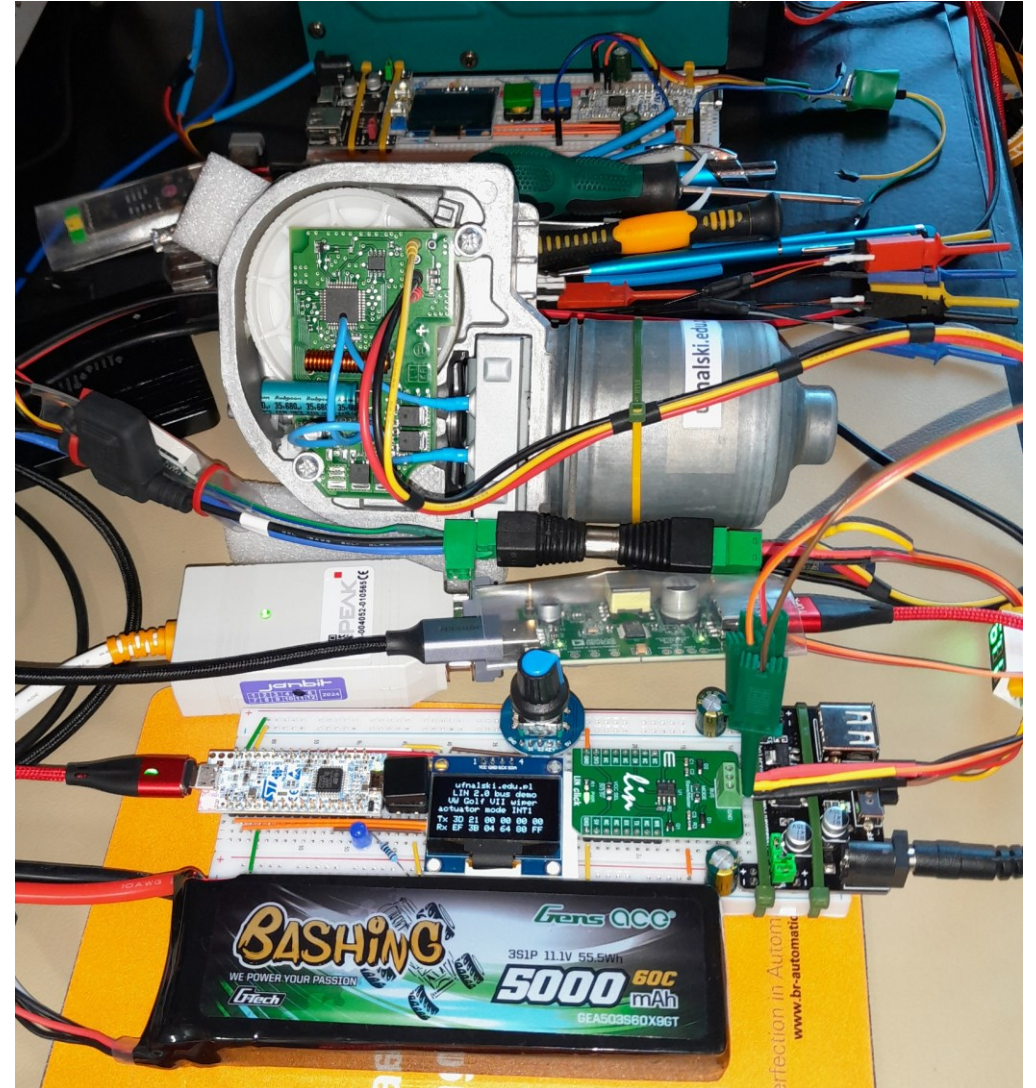
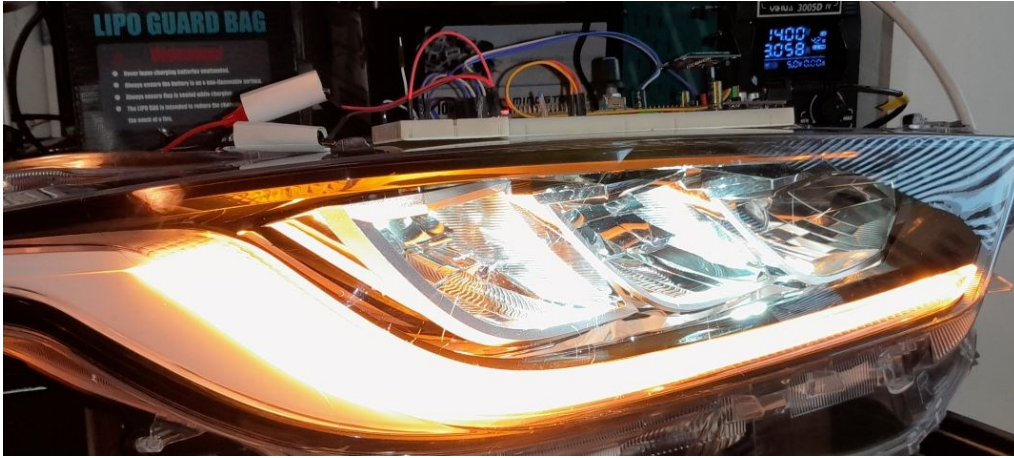


Modern vehicles full of electric (servo) drives

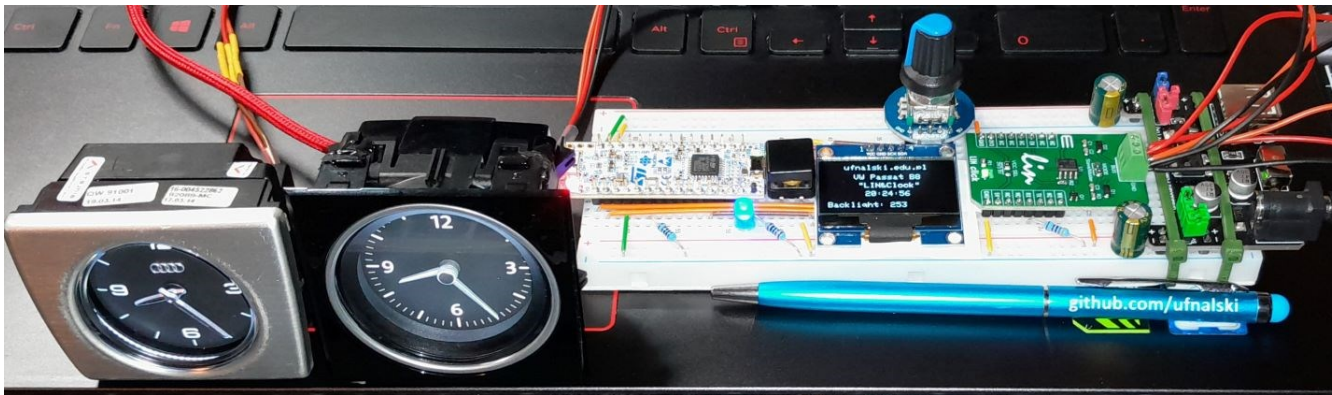
- Headlight levelling servos
- Coolant pumps
- Wiper actuators
- HVAC blower and flaps
- Electrically actuated wing mirrors
- Analogue gauges
- Analogue clock faces
- Door locks
- Power windows
- Electric tailgate actuators
- ...



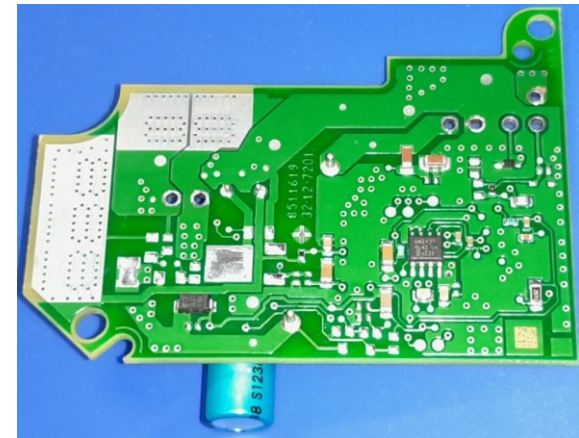
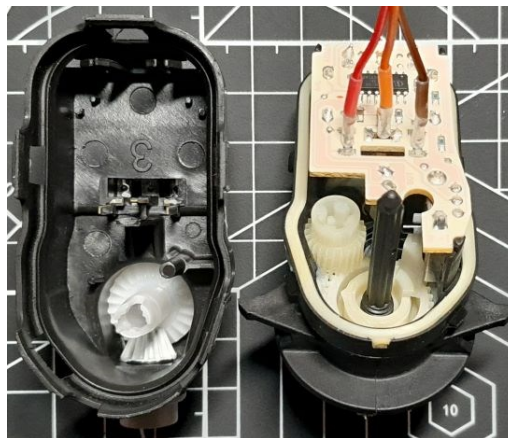
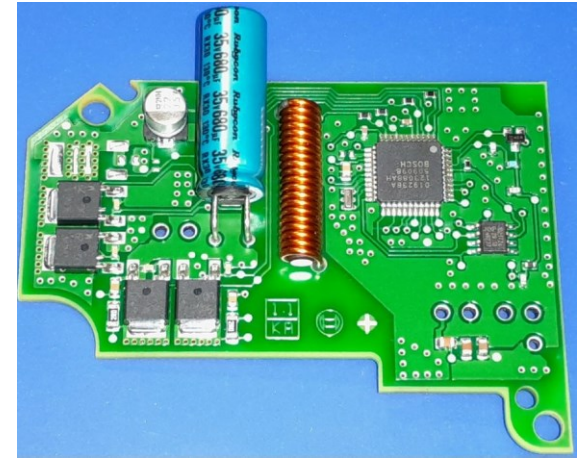
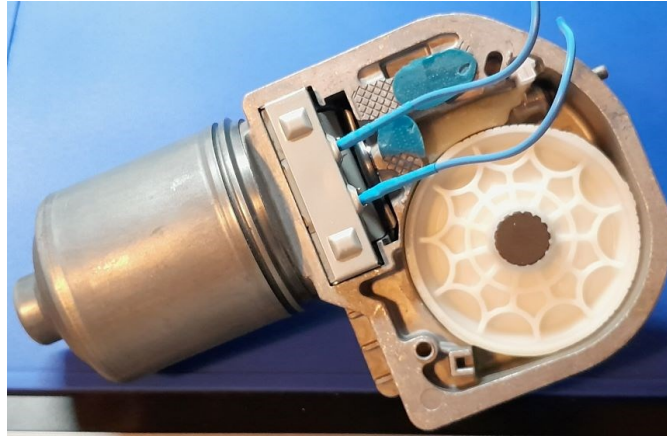
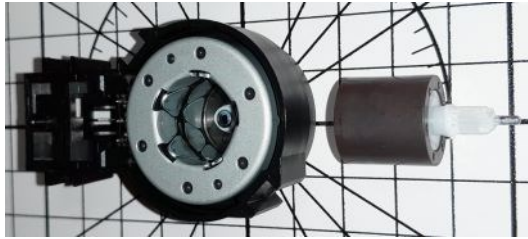
Starring



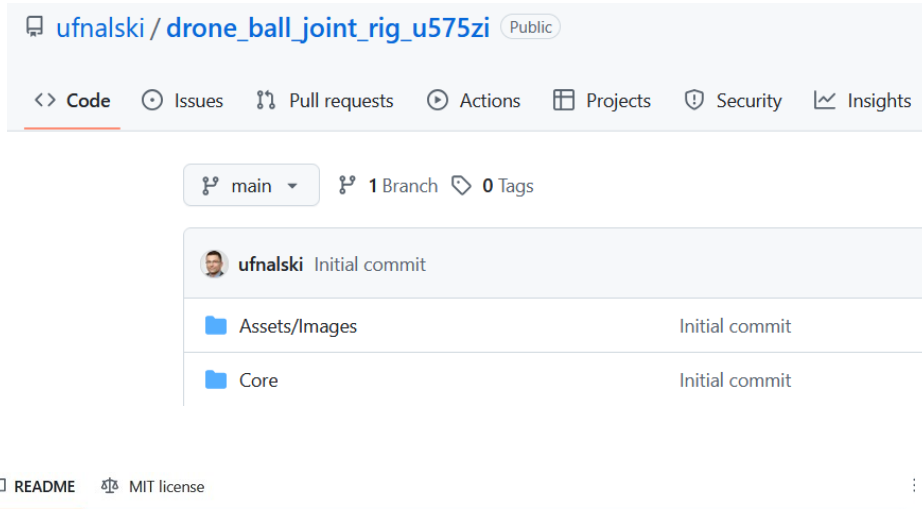
Starring



Starring

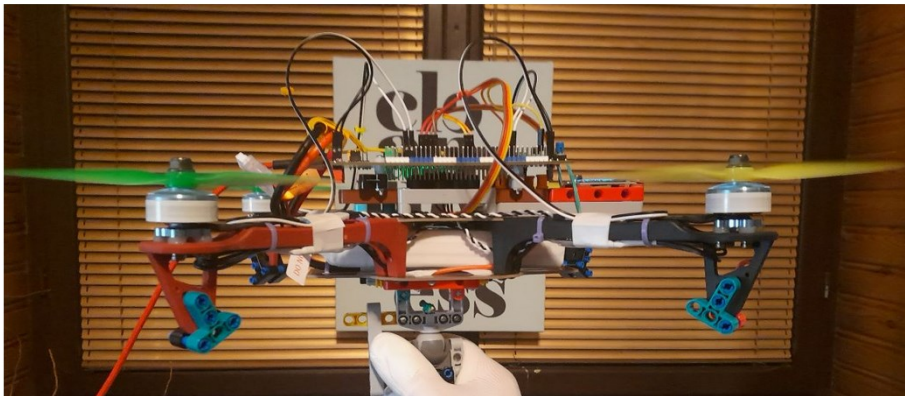


README.md on GitHub



Drone ball joint test rig (STM32U575ZI)

An STM32 HAL example of PID control for a 2-DOF quadcopter. The demo features ESCs (electronic speed controllers) that support DShot (Digital Shot) protocol, and an AHRS from Bosch Sensortec [BNO055](#).



Embedded webserver (using ESP32-S3)

- [ESP32 Web Server \(WebSocket\) with Multiple Sliders: Control LEDs Brightness \(PWM\)](#) (Sara and Rui Santos, Random Nerd Tutorials)
- [Arduino IDE 2: Install ESP32 LittleFS Uploader \(Upload Files to the Filesystem\)](#) (Sara and Rui Santos, Random Nerd Tutorials)
- [ESPAsyncWebServer](#) (ESP32 Asynchronous Networking)
- [AsyncTCP](#) (ESP32 Asynchronous Networking)
- [Arduino_JSON Library for Arduino](#) (Arduino Libraries)
- [Understanding CRC](#) (Bastian Molkenhain)

BNO055 library

- [BNO055 STM32 library](#) (MIT license)

Hardware

- [TMOTOR Velox V2207 V3 Brushless Drone Motor](#) or [TMOTOR Velox V2306 V3 Brushless Racing Freestyle Drones Motor](#)
- [ESC Little-Bee Mini 30A BLHeli S 2-6S OPTO \(7g\) - DShot - Multishot OneShot125](#)
- [OLED display 1.3" 128x64px I2C](#)
- [BNO055 AHRS from Bosch Sensortec](#) (Adafruit)
- [Ethix S4 lemon lime props](#)
- [ESP32-S3 Microcontroller, 2.4 GHz Wi-Fi Development Board, dual-core processor with frequency up to 240 MHz](#) (Waveshare)

README.md on GitHub

Control system tutorials

- [What Is PID Control? | Understanding PID Control, Part 1](#) (MathWorks, Brian Douglas)
- [Anti-windup for PID control | Understanding PID Control, Part 2](#) (Brian Douglas, MathWorks)
- [PID Controller Implementation in Software - Phil's Lab #6](#) (Phil's Lab)
- [Drone Simulation and Control, Part 1: Setting Up the Control Problem](#) (MathWorks, Brian Douglas)
- [Drone Simulation and Control, Part 2: How Do You Get a Drone to Hover?](#) (MathWorks, Brian Douglas)
- [Drone Simulation and Control, Part 3: How to Build the Flight Code](#) (MathWorks, Brian Douglas)
- [Drone Simulation and Control, Part 4: How to Build a Model for Simulation](#) (MathWorks, Brian Douglas)
- [Drone Simulation and Control, Part 5: Tuning the PID controller](#) (MathWorks, Brian Douglas)
- [Drone Control and the Complementary Filter](#) (Brian Douglas)
- [Understanding Sensor Fusion and Tracking, Part 2: Fusing a Mag, Accel, & Gyro Estimate](#) (MathWorks, Brian Douglas)
- [Understanding Kalman Filters](#) (MathWorks)

Calculators and configurators

- [xcopterCalc - Multicopter Calculator](#) (eCalc)
- [Fe](#) (Flight Evaluation)
- [BLHeliSuite](#) (ESC configurator)
- [BLHeli](#) (bitdump)
- [BLHeli_S \[forked\]](#) (Betaflight)

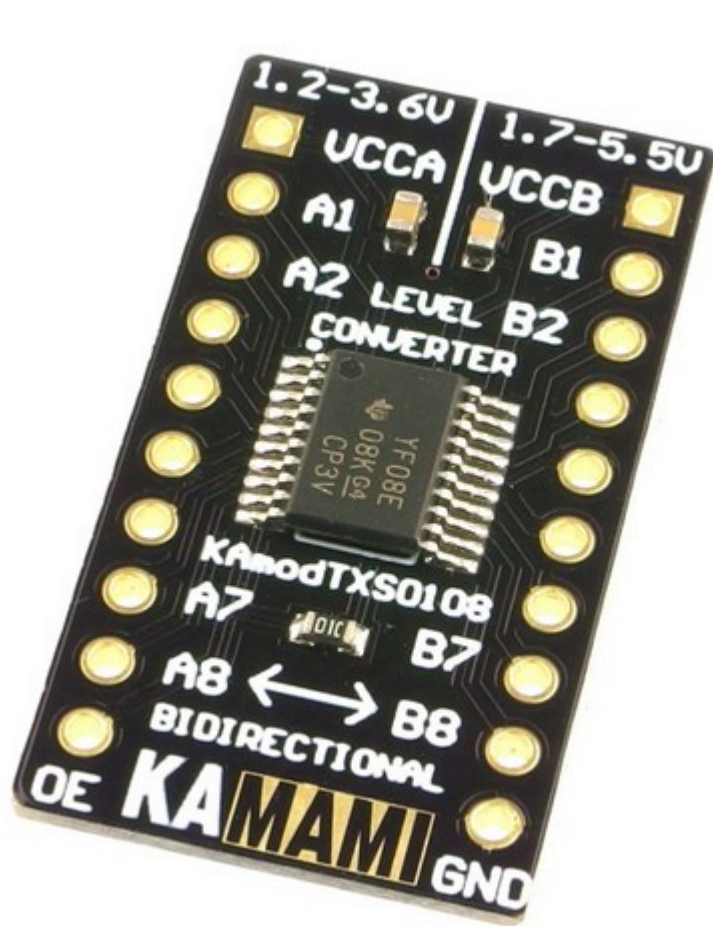
Numerous open-source quadcopter projects

- [Arduino drone - Part1 Flight Controller](#) (Electronoobs)
- [Arduino DRONE II Part 1 receiver PWM read](#) (Electronoobs)
- [Make a TINY Arduino Drone with FPV Camera - Will It Fly?](#) (Max Imagination)
- [M-HIVE STM32 drone programming from scratch](#) (ChrisWonyeobPark)
- [dRehmFlight VTOL Teensy Flight Controller and Stabilization](#) (Nicholas Rehm)
- [Projects YMFC-AL and YMFC-32](#) (Joop Brokking)
- [DIY Esp32 Flight Controller under 6 Dollars! \(500 INR\)!](#) (Pratik Phadte)
- [We built a Drone using ESP32 | Now on Kickstarter](#) (Circuit Digest)
- [Bitcraze](#) (repos), [Crazyflie](#) (drone)
- [drone_stm32f1](#) (LowLevelCode)
- [DIY Drone ESP32](#) (Desktop Make)
- [ArduPilot](#) (autopilot software suite)
- [The Betaflight Open Source Flight Controller Firmware Project](#)
- [INAV](#) (flight controller and autopilot software system)
- [PX4](#) (autopilot for drone developers)

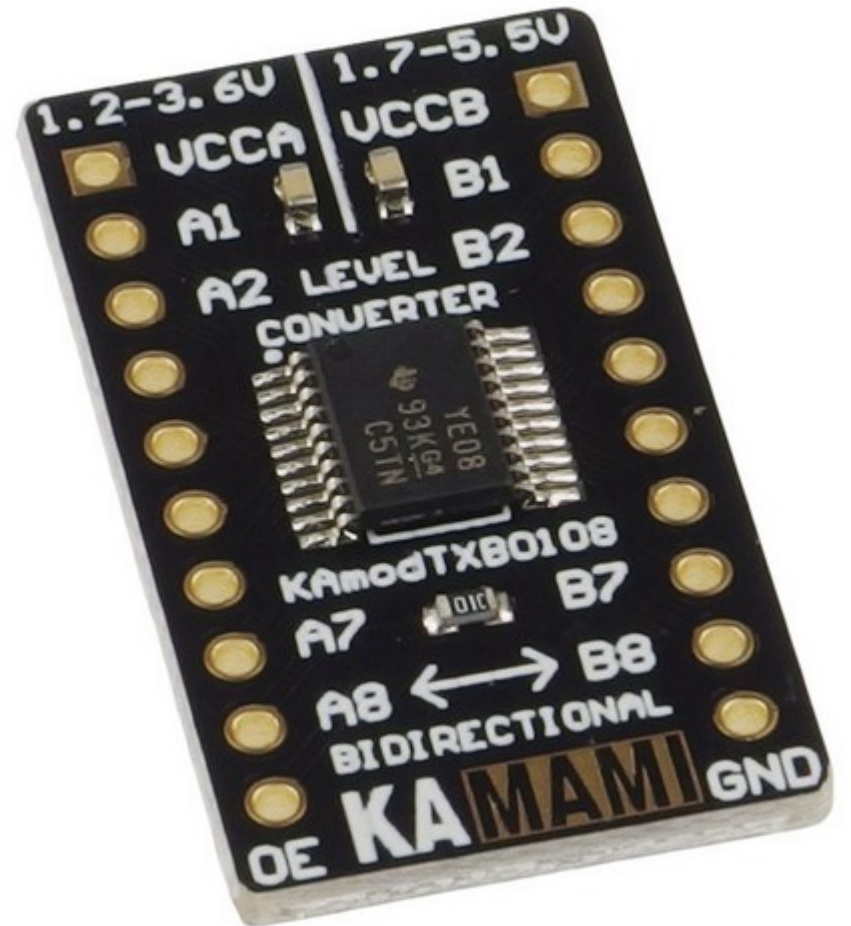
Note

There are also countless tutorials on knocking together your own quadcopter without any need to write a single line of code, see e.g. "[The Idiot's Guide to Making a DIY Drone! \(I am the Idiot\)](#)", but this is obviously not our plan here. The goal is to write some code along the way.

Debugging is fun!



TXS0108 vs. TXB0108

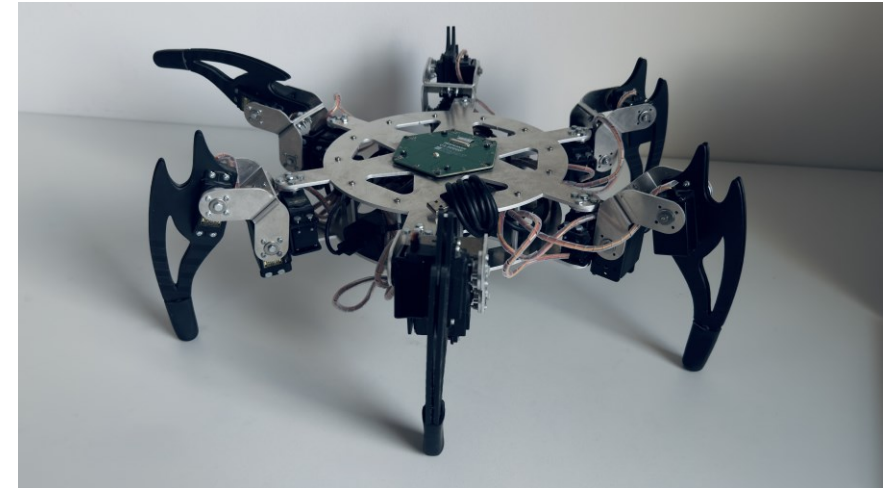


Validation: Success stories 2024/2025 (Warning! I'm bragging!)

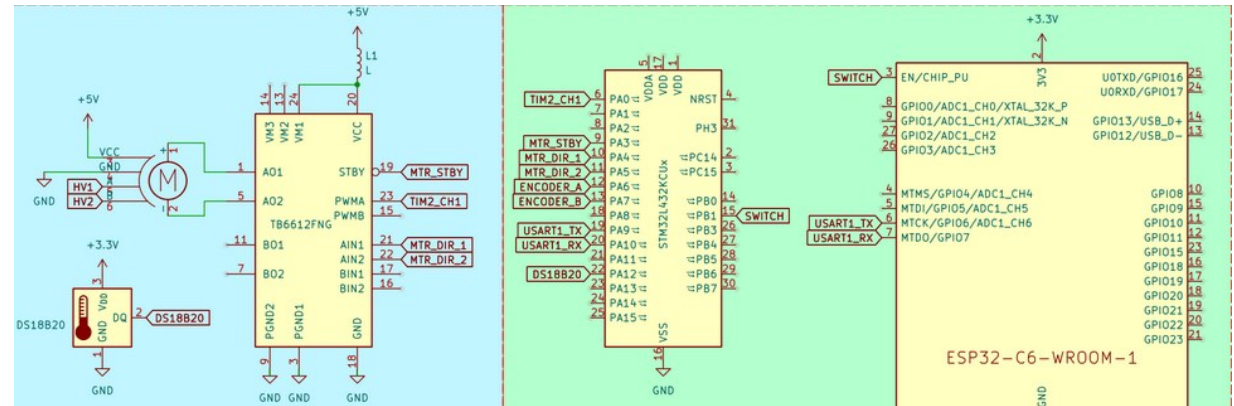
- 10/10 attendance
- students from other faculties enrolling in my M.Sc. courses
- a professor attending my Ph.D. workshops
- an automotive aftermarket company using my public repos

Success stories 2025

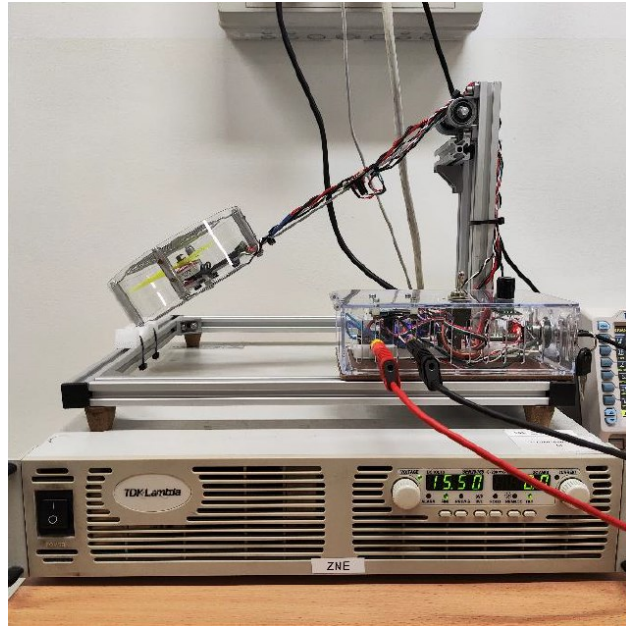
<https://github.com/Gl0dny/hexapod>



<https://github.com/Bulkabol/Motor-control-using-BLE-and-WiFi>

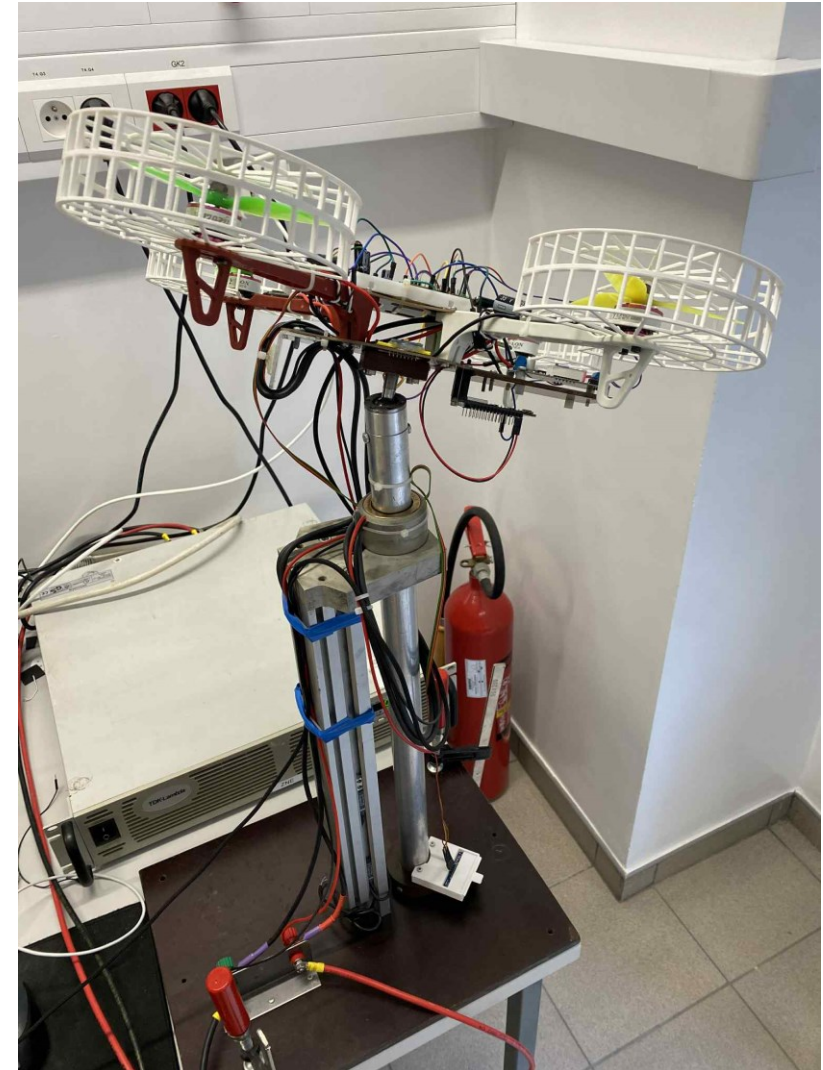


Success stories 2025



https://github.com/Maciej-Iwanczyk/1DOF_HELIROPTER_CONTROL

https://github.com/MRogul/Drone_Control_System_Master_Project



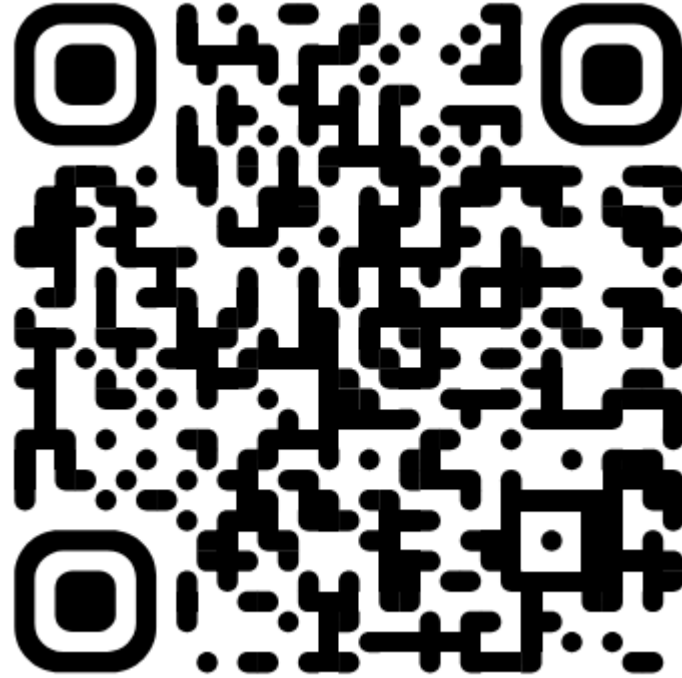


Thank you for your kind attention!



WARNING

Control engineering – do try this at home!



<https://github.com/ufnalski>