



XBOT

Motor control on XCORE.AI

ELECOMP Capstone Design Project 2024-2025

Sponsoring Company:

XMOS Ltd.

5th Floor East, Programme

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Bristol, BS1 2LZ

United Kingdom

<http://www.xmos.com>

Company Overview:

XMOS is a fabless semiconductor company, headquartered in Bristol in the UK.

Our mission is to change the way systems are deployed on silicon – disrupting system-on-chip economics and time to market by enabling embedded software engineers to create custom SoC solutions simply by loading software onto our uniquely flexible and accessible hardware platforms.

Technical Director:

Andrew Cavanaugh

Global System Solutions Architect

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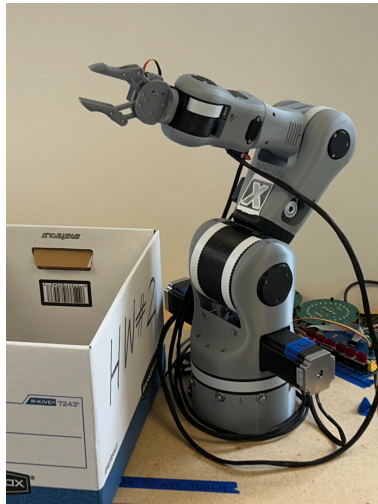
<https://www.linkedin.com/in/andrew-c-7805ba8/>





Project Motivation:

In 2023-24 team XMOS created a functioning robot arm fabricated using 3D printed parts in the capstone lab.



The arm itself consists of one servo motor (for the “hand”) and several stepper motors (for the arm joints). These motors are all controlled by motor control modules, which are driven by an xcore.ai chip. The PCB also includes a second xcore.ai chip that is listening for voice commands to tell the arm where to go. This arm is a great demonstration of how flexible XMOS chips are, and that makes it a useful tool for sales and marketing.

This year we’d like to refine the PCB design and firmware to add functionality and showcase more of the capabilities of our chips. Ideally, the work done on this project would feed into a production ready library for evaluation of motor control capabilities. Some of the elements of this library may also be collaborated on with the other XMOS project.

(Video presentation, from the Summit on May 7th, 2024, can be accessed at:

<https://www.youtube.com/watch?v=S6HddhhdwSc&list=PLOW1iKK9kRQz7BWOMx6gfVj-6FX19qbSr&index=13&t=7s>)



Anticipated Best Outcome (ABO):

The ABO for this project continuation is:

- Replication of last year's final demo
- Updated PCB with no errors
- At least one axis controlled by low-level algorithm
- New demo moving an object between two locations
- (Bonus) implement predictive maintenance ML on at least one subsystem

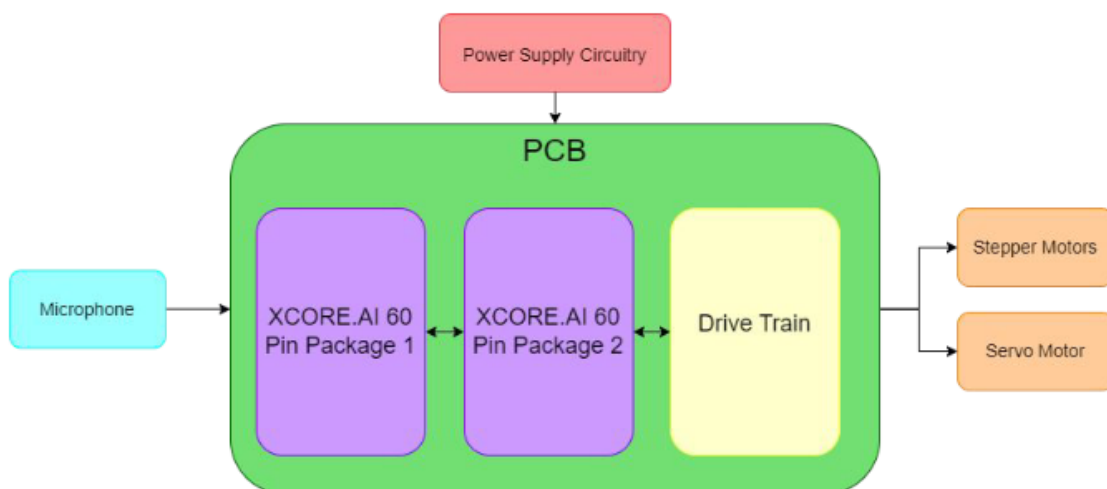
Project Details:

Overall system concept:

At a high level the system is a robot arm that can pick up and put down objects. The purpose of this system is to demonstrate the real-time control capabilities of the xcore.ai processor and how it can add value in the motor control market. Specifically, with:

- High efficiency control algorithms
- Multi-axis control with a single processor
- Predictive maintenance
- Flexible interfacing

Block Diagram:





Hardware/Electrical Tasks:

- Update PCB and replace any obsolete components
- Test arm mechanics and develop safety plan
- Test individual components (motors, drivers, etc.)
- Research motor control algorithms compatible with our hardware

Firmware/Software/Computer Tasks:

- Clone software repo from last year
- Decide what software components to keep
- Understand inverse kinematics, and basic motion planning
- Implement motor control algorithm(s) and combine with existing code
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Composition of Team:

1 Electrical Engineer & 1 Computer Engineer

Skills Required:

Electrical Engineering Skills Required:

- PCB design
- Control theory (desired)
- Electromechanical Systems (desired)
- Power electronics (desired)
- Good with hands / mechanical tools

Computer Engineering Skills Required:

- C/C++ experience
- FPGA / Microcontroller experience
- Computer architecture (desired)
- Digital control theory (desired)



Anticipated Best Outcome's Impact on Company's Business, and Economic Impact

If the ABO is achieved, then XMOS will have a hardware / software reference design that can be rapidly deployed to potential customers for evaluation. Being able to service the robotics market would help XMOS diversify our customer base, which can help the company decouple revenue from the more volatile consumer electronics market.

Broader Implications of the Best Outcome on the Company's Industry:

A platform like xcore being widely deployed in motor control would solve some key problems in the industrial / robotics industry:

- More energy efficient operation
- Ability to reliably integrate new motor control features / algorithms with in-field software updates
- Ability to add predictive maintenance ML algorithms on existing platforms