MATS - MODULAR ACTUATED TRANSFORMING SYSTEM

MAKE ROBOTS MODULAR AGAIN!

MATS: The Next Generation Building Blocks

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1 Intro

In this project, I have chosen to explore the physical components relevant to my master's thesis.

MATS (Modular Actuated Transforming System) is a modular robot with two types of modules: Brick modules for connections and Joint modules with actuated servos. Unlike many modular robots, MATS allows easier morphology changes without manual disassembly and reassembly for each configuration.

The cable management of robotic systems like this can often also become messy, with wires running between modules. This project focused on creating a clean, efficient system with screw-free, robust connections to simplify assembly and maintain functionality.

A unique feature of this robot is the absence of core modules; all Brick modules are identical, simplifying assembly and ensuring consistent functionality.

I focused on a minimalist yet functional design to simplify manufacturing while ensuring intuitive use and visual appeal, covering both the fastening mechanism and cable management.

2 Tools

The following components were used in the development of MATS:

- U2D2 USB communication converter
- U2D2 Power Hub Board
- Dynamixel AX-18A servo
- 3D printed modules with PLA and ABS
- Neodym magnets

The modules are inspired by Revolve2, which I plan to use for my master's thesis. The software used to directly control the robot is the Dynamixel SDK, a software development kit that supports multiple programming tools and languages, including Python and ROS.

For this project, I programmed the robot's movements using Python and tested various custom movements that I developed. The robot communicates directly with a PC via a U2D2 USB communication converter.

3 Conclusion

After iterations, I finalized a strong, minimalist Brick design, 3D-printed in PLA and finalized in ABS. The Brick has a female connector with 8 holes for 90° rotations, a central magnet, and built-in Molex connectors on each side, while the servo has matching pegs and an opposite-polarity magnet. Future work will focus on:

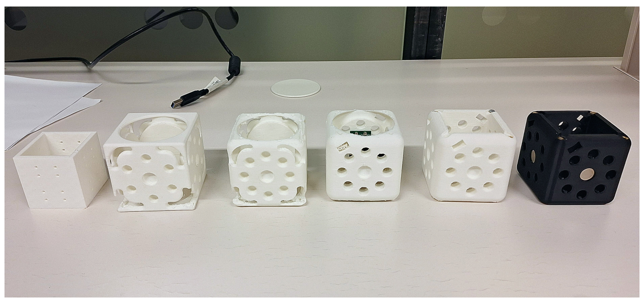
Design

- **Integrate Molex connectors:** *Combine with mating connectors for seamless integration and use magnets for attachment and servo communication.*
- **Expand connectivity:** *Modify Brick modules for six-sided connectivity instead of four-sided to increase flexibility.*
- **Add adapters:** *Develop connectors for linking modules directly, including 360° revolute joints for modular manipulators.*

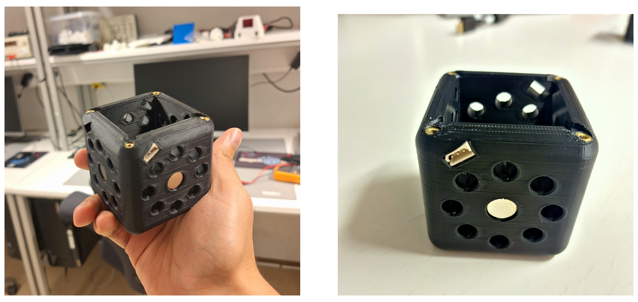
Hardware and Software

- **Use a microcontroller or a Raspberry Pi:** *Enable wireless control and communication with the robot.*
- **Incorporate a battery as the power source:** *Address the challenge of module size, or consider a core module to house the battery and hardware.*
- **Use simulations, evolutionary algorithms, and artificial intelligence:** *Optimize the robot's movements efficiently.*
- **Address the reality gap:** *Develop methods to transfer optimized movements from simulations to the real-world robot, minimizing performance differences.*

This project developed a durable, visually appealing modular robot with easy-to-assemble modules, seamless connections, and efficient cable management. Its minimalist design simplifies use and supports future advancements in modular robotics.

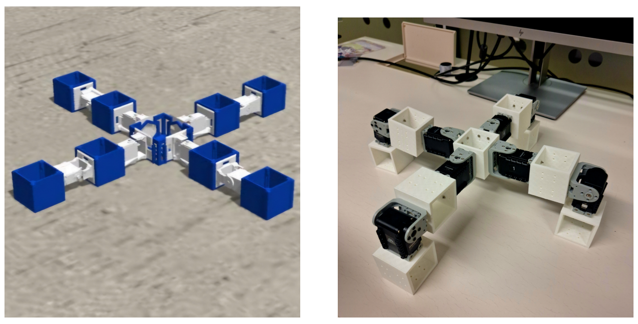


Evolution of gen. 1 to 6 of the Brick module

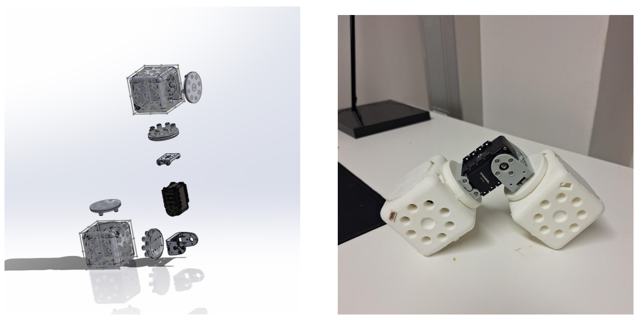


The latest generation (gen. 6) of the Brick module

The latest generation (gen. 6) of the Joint module



Left: Revolve2 simulation of a spider robot
Right: Spider with 3D-printed gen. 1 modules



Left: SolidWorks Exploded view of the modules
Right: 3D-printed gen. 4 modules in a worm config

If you are interested in collaboration on this project or have any questions feel free to contact me at amalmuda@ifi.uio.no

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