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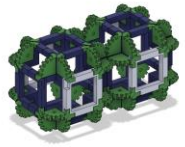
Kubits: A Novel Concept for Modular Robots



Motivation

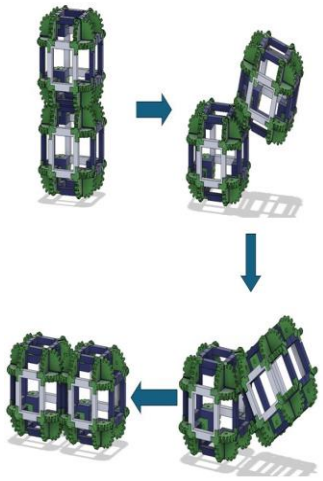
Modular robots are a novel structural and transportation application that facilitates the movement of robots.

Kubits are modular robots that create certain structures using **electro-permanent magnets** that operate by attraction, repulsion, and neutrality to allow the cube to pivot .

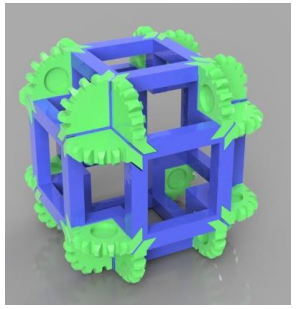
Usage: Kubits can be used in applications such as space exploration, satellites, and smart structures.

Mechanical Design

We aim to utilize the cubic shape for our Kubits using **3D-Printed Ferromagnetic PLA**. Our design will **integrate gears on cube edges to tackle misalignment during movement**



The gears have bumps in the outer shell of the hole to secure the alnico rod in place. The product was assembled using both conductive epoxy and regular plastic Altico.

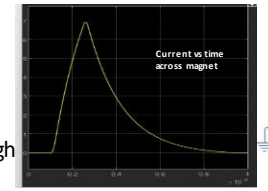


Magnet Characterization

Materials for Magnet Preparation

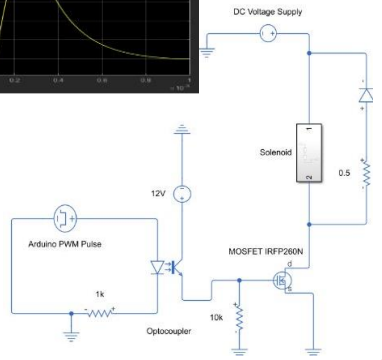
- ALNICO 500 rod 3mm and 6mm in diameter and 3cm in length
- 3D printed Ferromagnetic PLA edges
- Copper wire 0.15mm in diameter (450 turns)
- Conductive Epoxy Glue

The characterization circuit provides a high voltage and high current pulse to polarize the magnet in the current flow direction. **This circuit utilizes an external power supply**. Successful simulations were done on SIMULINK.



Circuit Components:

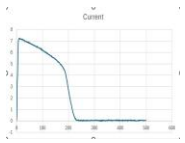
- High DC Voltage Supply (90-120V)
- IRFP260N MOSFET (High Voltage – High Current)
- 12V DC Voltage Supply for MOSFET Gate
- PC817 Optocoupler for circuit isolation and safety
- ACS 712 Current Sensor for magnet current
- 2 Arduino DUE for electric pulse & current data reading
- Freewheel Diode & resistors for safety



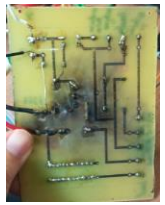
PCB & Design Assembly

EXPERIMENTAL RESULTS

- **Magnetization of 450 turns 3mm rod**
- **90V and 100 microseconds pulse**



- **Demagnetization of 450 turns 3mm rod**
- **90V and 100 milliseconds pulse and in the opposite direction**



Internal Supply Circuit

Requirements:

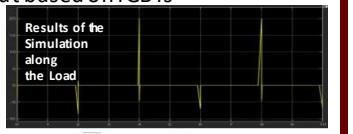
- **Internal High-power supply**
- Energy Storage.
- Trigger
- Capacitor Systems
- Charging and Discharging of the Capacitor.
- Resistive Charging vs Inductive Charging.

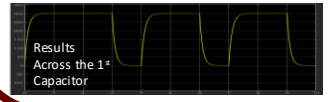
We utilize Marx Generators

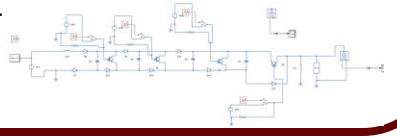
Design 1 Simulation:
Capacitors: 1 pF, Resistors: 1 kOhm, VDC = 20 V, VDC for MOS = 100,-100 V

Design 2 Simulation:
C1 C2 = 10uF, 10 pF.
R2, R4 = 1k ohm, R3, R5 = 10k ohm.

Design 3 Simulation: controllable output based on IGBTs







Future Work

- Downsizing the PCB.
- Run more tests to detect the upper-most limit for PCB tolerance for Power Supply.
- External to Internal Power Supply.
- Optimize the magnetic force between the magnets
- Complete the paper about the integration of the gears