Demonstrating Number Theory and Controls through Web-based Application and Drawing Robot

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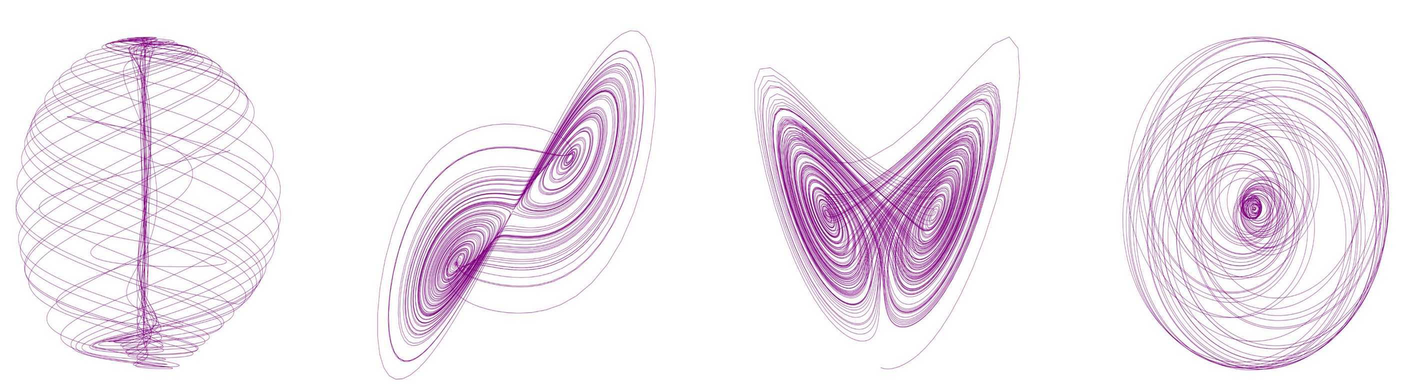
INTRODUCTION

The world is teeming with geometric patterns. Many of these patterns can be represented by mathematical operations. This first instance project aims to study these patterns and create a visual, interactive web-based application that interfaces with a drawing robot.

- **Aim:** Implement controls through robotics, and provide an engaging demonstration by drawing geometric patterns through a robot.
- **Why:** Archiving geometric patterns provides insights and inspirations to a wide range of engineering applications such as autonomous operation.



PROBLEM STATEMENT
To use patterns and number theory to develop control systems and create an informative demonstration in real time.

CORE FUNCTIONS

Primary Function: Build a collection of mathematical patterns using number theory and display the patterns through an interactive web-based application.
Secondary Function: Interface the web-based application to a robotic drawing machine and demonstrate the patterns through robotic control.

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DESIGN AND DEVELOPMENT

Check out our website by scanning the QR code.

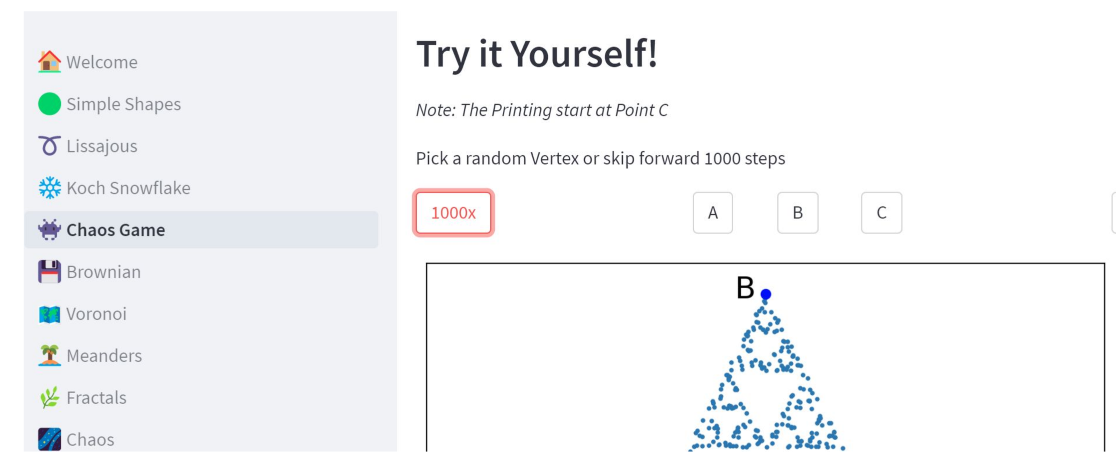

Figure 1: Web-based application

Design Approach:

The design consists of two major components, the web-based application (Streamlit app) and a mecanum wheeled mobile robot (RaspberryPi 2B + MegaPi from Makeblock). After a pattern is chosen[1] and converted an array of points[2,3], the local machine sends the points to the RPi through Bluetooth[5]. The RPi and MegaPi interface through the serial ports with the RPi running the movement algorithm[8] and the MegaPi encoding the DC motors[9].

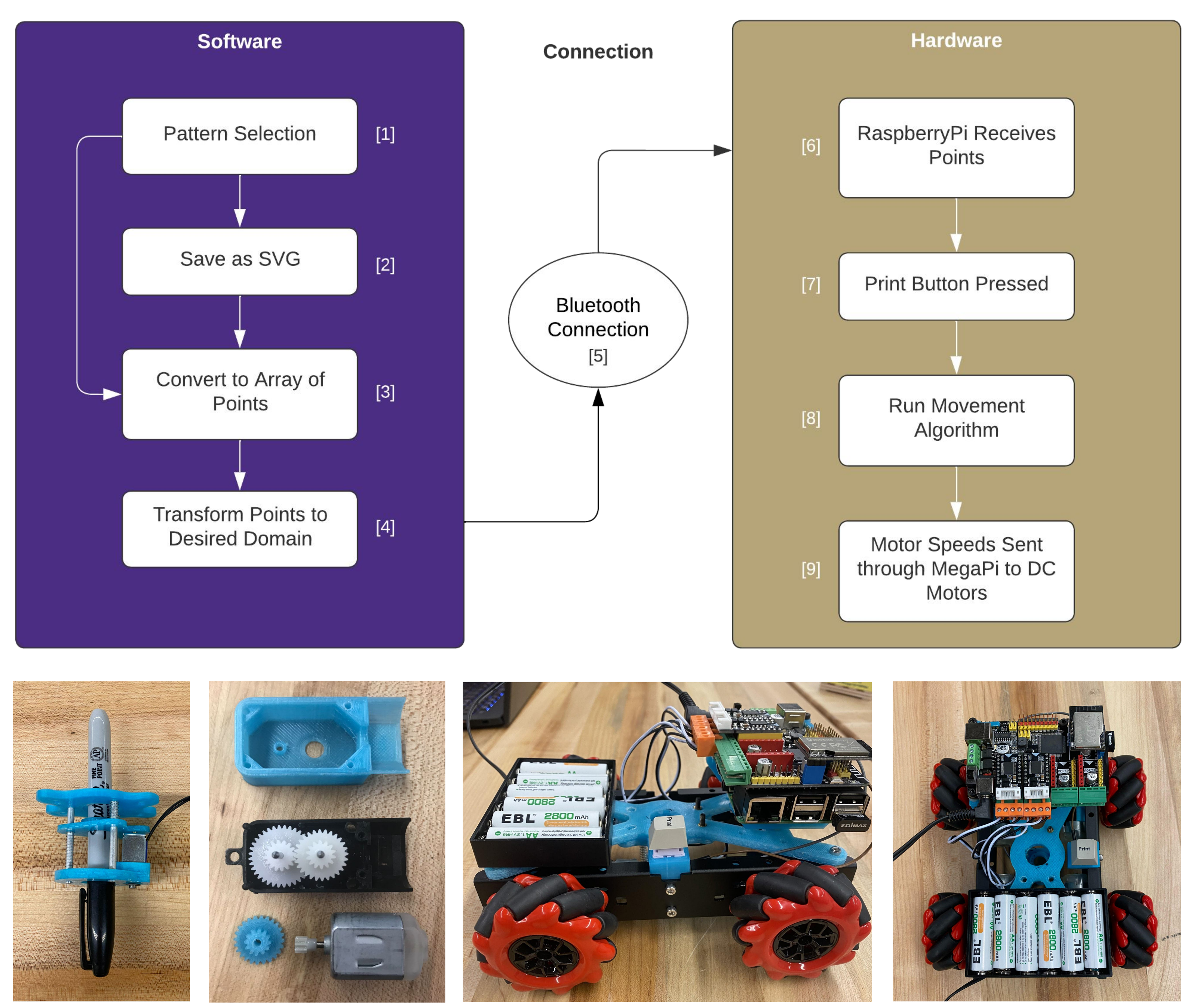

Figure 2: Flow chart and prototype

RESULTS/VALIDATION

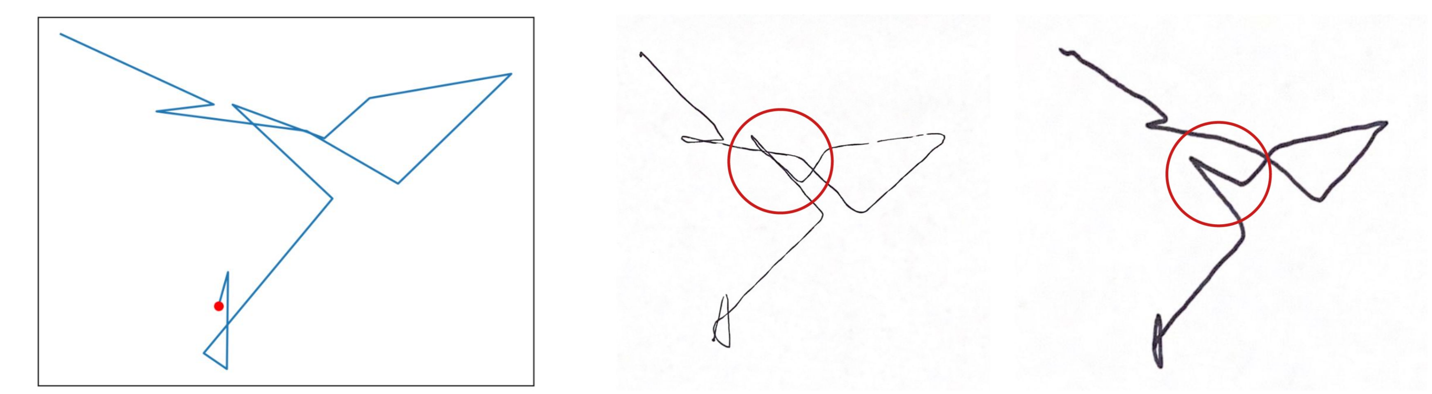

Figure 3: Test pattern, original gearbox print, modified gearbox print

Through test prints we determined that the DC motors were not operational under 1.2 Volts. This prevented movement in the degrees of theta shown in the light gray region of [Fig 4]. Altering the gearbox by adding a 2:1 gear ratio allowed the DC motors to rotate at a lower RPM. This increased the possible movement angles, seen in the dark grey region of [Fig 4]. Resulting in drawings that could replicate this region of angles.

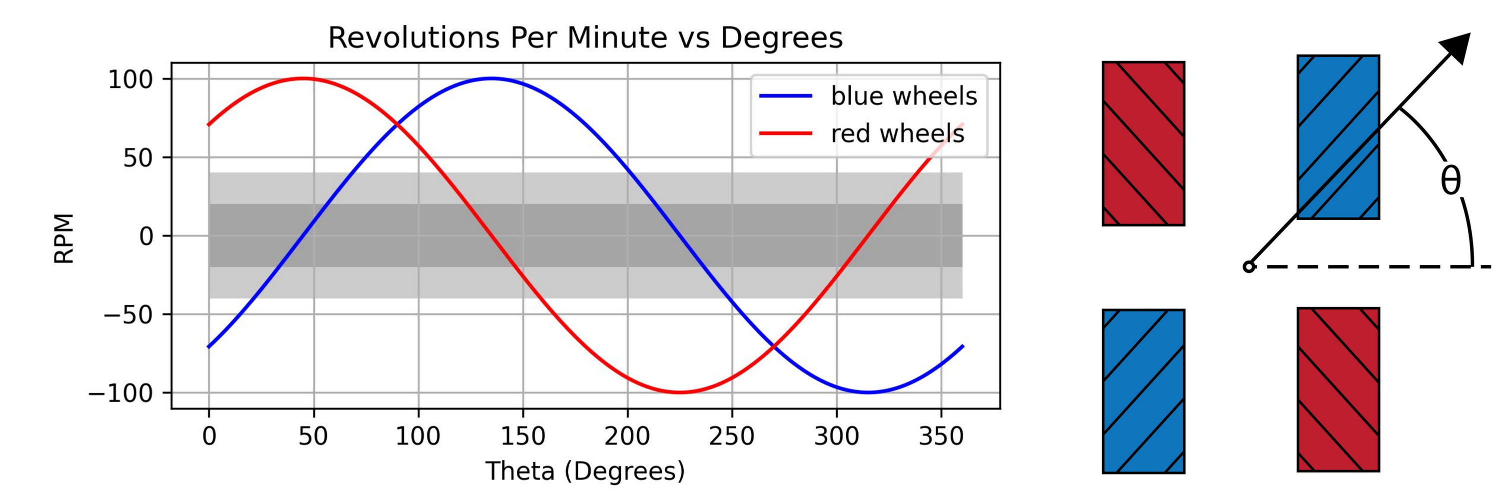

Figure 4: Graph of RPM vs degrees indicating possible movement angles

CONCLUSION & FUTURE WORK

- **Strengths:** Compact, relatively accurate drawings, quick, website UI/UX straightforward
- **Weaknesses:** Robot not user friendly, errors propagate in drawings, no position feedback
- **Next Steps:** Position feedback, collision detection, multi-robot Interaction, stepper motors, pen lifting solenoid, connection through Streamlit hosted web page.

Acknowledgements

Prof. Xu Chen - UW MACS Lab

Mechanical Engineering Capstone Exposition
May 30th 2023, Husky Union Building, University of Washington, Seattle