ROTATING ELVES

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Introduction

◆ Background

A rotating LED is a LED display where many individual LEDs are arranged in a matrix and rapidly cycled through different lighting patterns to create the illusion of movement. Rotating LED displays are often used for advertising billboards, decorative lighting, and other applications where eye-catching visual effects are desired.

(a) Graphics   (b) Animation   (c) Text
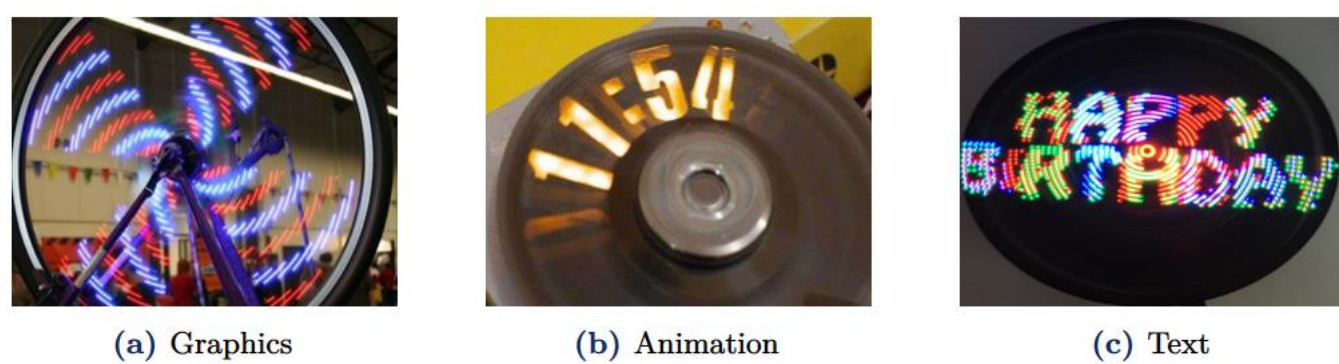
◆ Requirements

- Motor rotates LED system
- Alternatively rotate clockwise and counterclockwise twice within a minute.
- Wirelessly charging
- Sound effect

Methodology
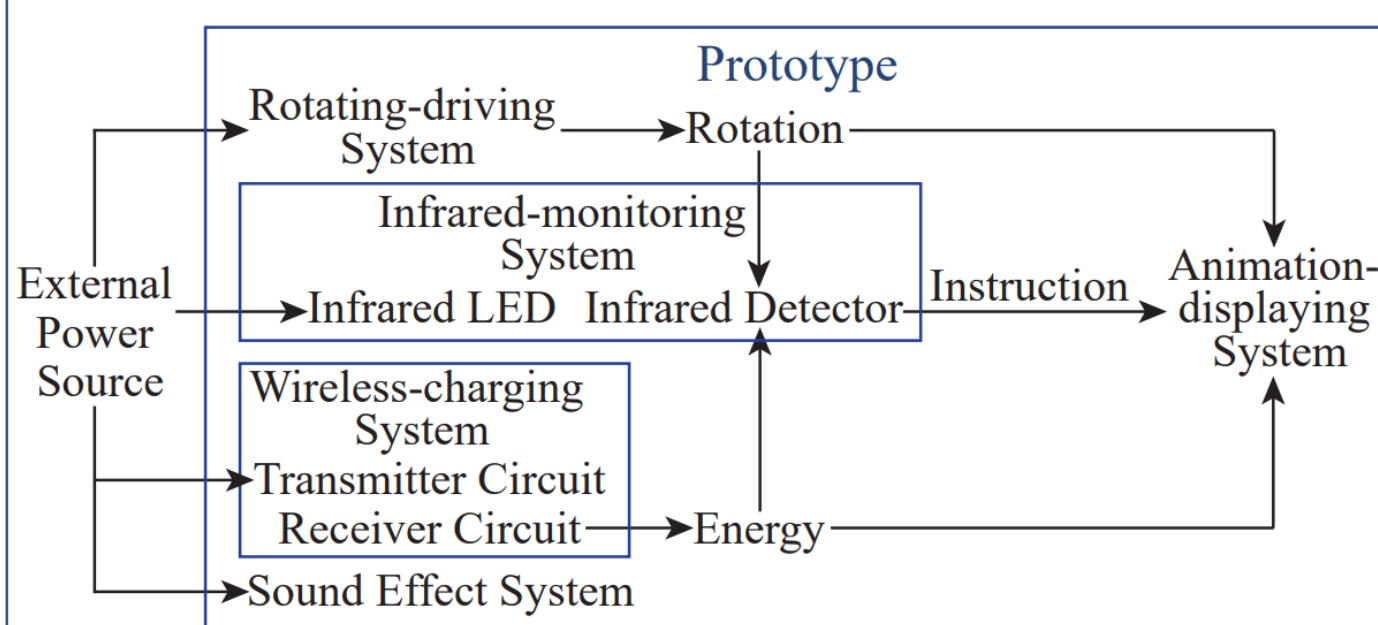
◆ Animation-displaying System

◻ Persistence of Vision (POV)

When the object is moving rapidly, the human eyes can still retain its image about 0.1-0.4 seconds after the image disappearing. So that we need LED to light in the same position within **1/24** second which means the frequency of rotation need to be at least **24Hz**.

◻ Structure

- Two-arm structure → reduce the requirement of rotation speed to achieve POV →relief the motor
- Smaller centrifugal force → enhance the stability
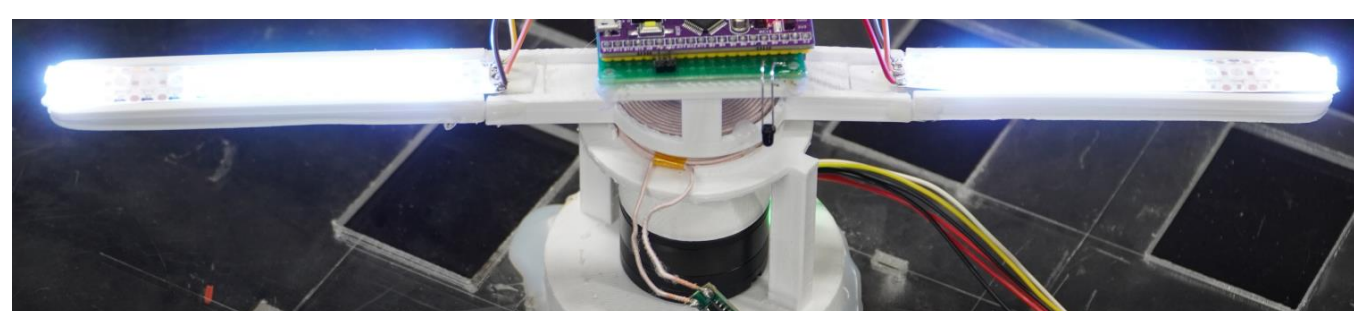
◻ Equipment

Color:
256^3 kinds of colors can be generate using WS2812B RGB light.
Resolution:
32*16 pixels for two-arm structure   WS2812B RGB light

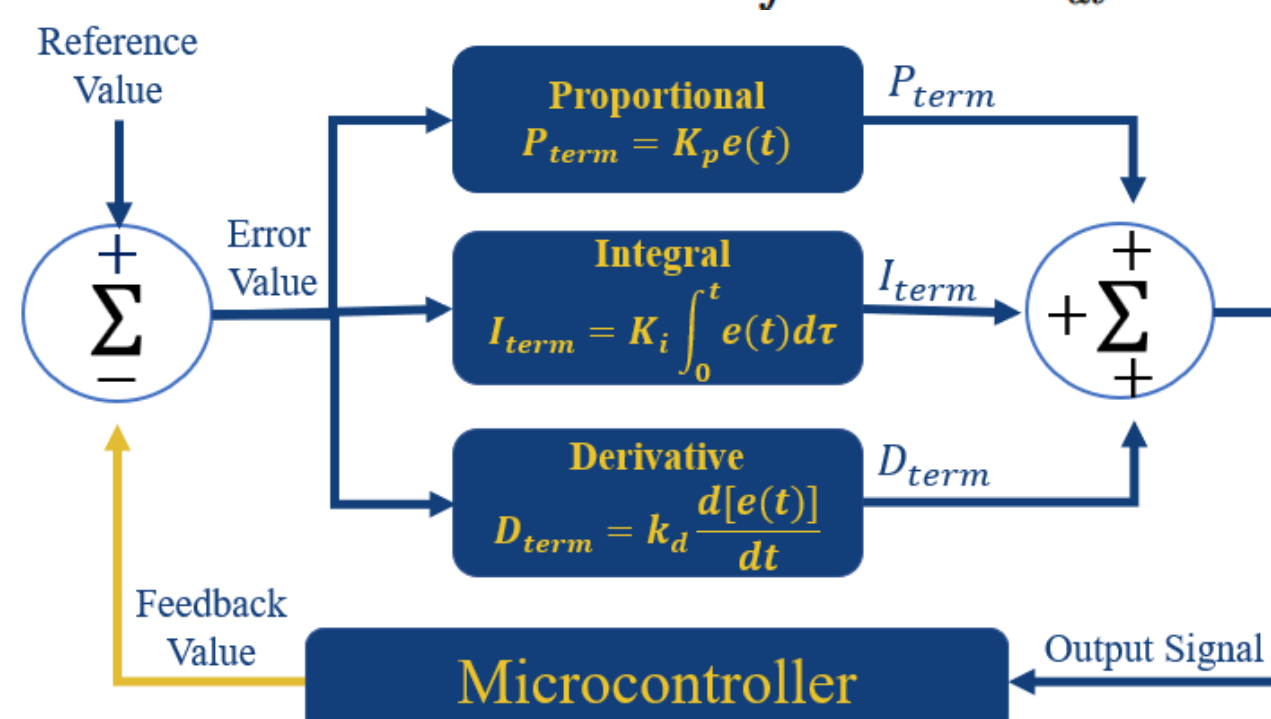#### ◻ Process for displaying animation

1. Decide an image or video to show;
2. Use *POV Converter* to obtain the RGB data of 32*16 pixels;
3. Configure IO port and DMA channel;
4. Update the RGB data in hexadecimal form to STM32f103c6t6;
5. Send the corresponding PWM signal to WS2812B lights
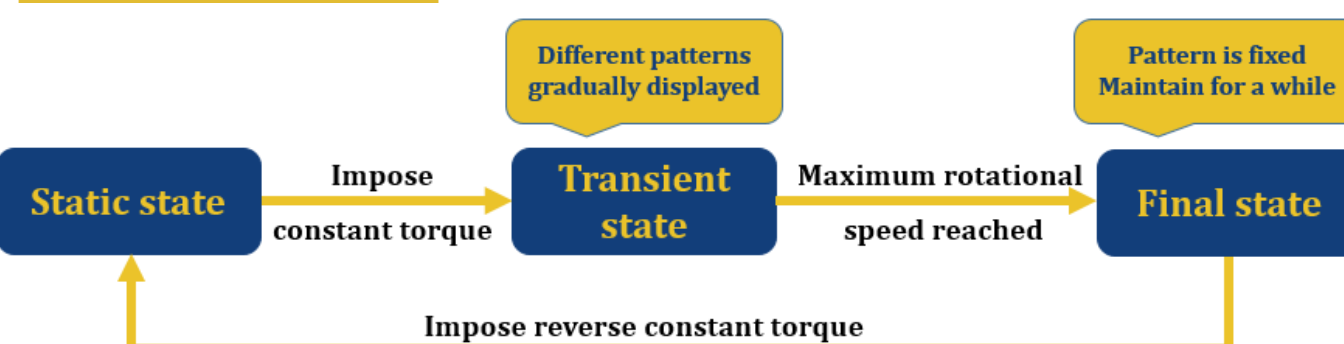
Rotation-driving System

◻ Closed-loop Control

PID controller

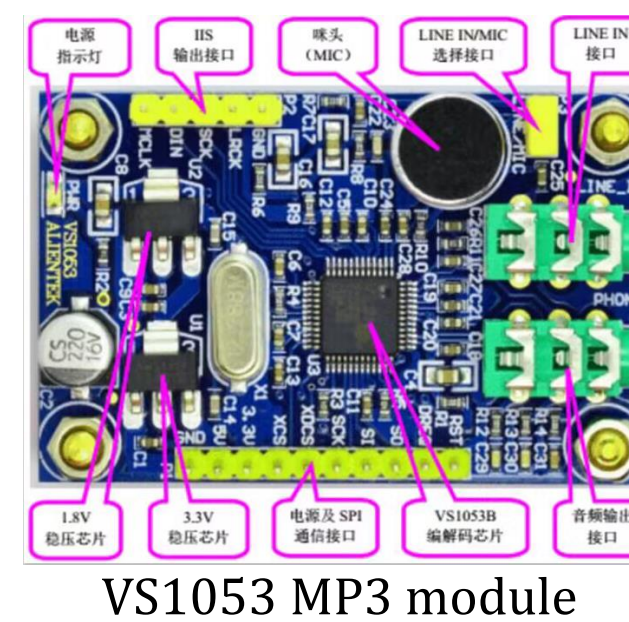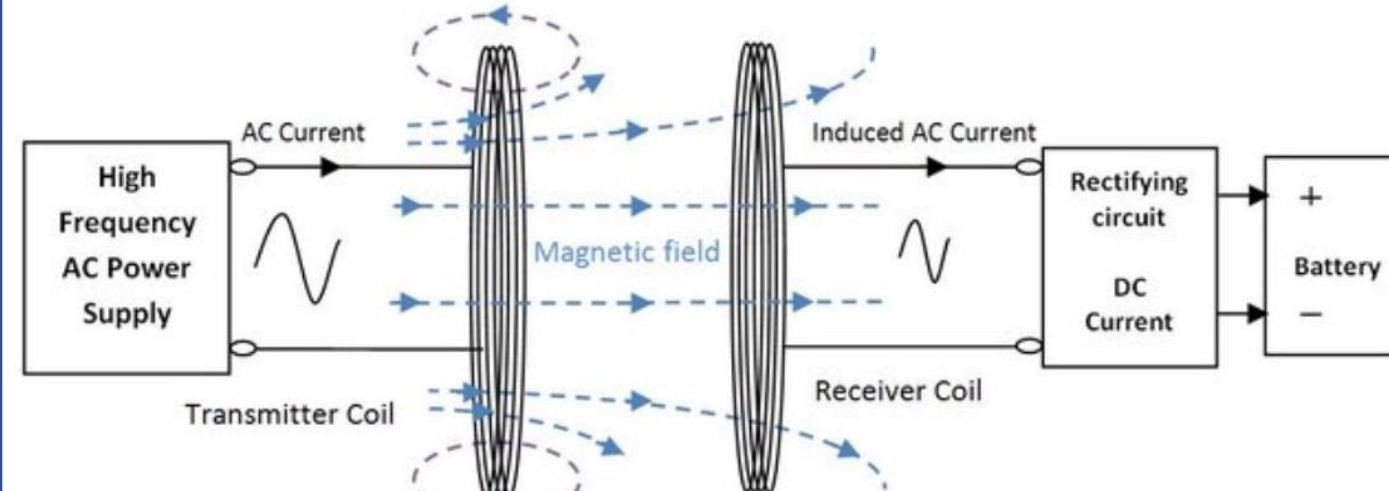$$Output\ signal = K_p e(t) + K_i \int e(t)dt + k_d \frac{d[e(t)]}{dt}$$

Reference Value
Error Value
Feedback Value

Proportional $P_{term} = K_p e(t)$ P_{term}
Integral $I_{term} = K_i \int_0^t e(t)d\tau$ I_{term}
Derivative $D_{term} = k_d \frac{d[e(t)]}{dt}$ D_{term}

Microcontroller   Output Signal

Control process

Static state → Impose constant torque → Transient state → Maximum rotational speed reached → Final state
Different patterns gradually displayed
Pattern is fixed Maintain for a while
Impose reverse constant torque

◆ Wireless-charging System

◻ Principle: electromagnetic induction

High Frequency AC Power Supply   AC Current   Magnetic field   Induced AC Current   Rectifying circuit   DC Current   Battery + −
Transmitter Coil   Receiver Coil

XKT412-26 wireless charging module

VS1053 MP3 module

◆ Sound Effect System

◻ Working principle

Download MP3 file
SD card → read → MCU → Input SPI port → VS1053 MP3 module → Decode Play the music

Function Display

◆ Rotating control
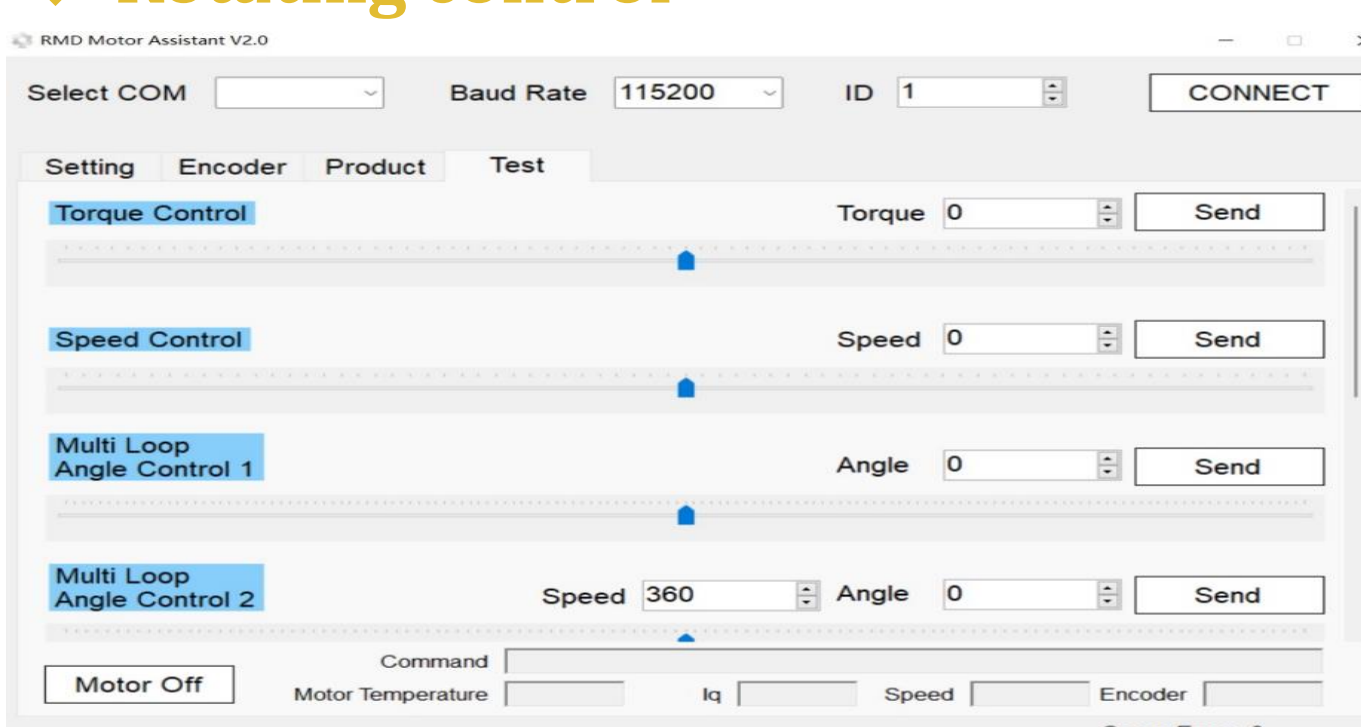
GUI of the supporting software of RMD-L-4005

Structure of Prototype

Position of Controller
Position of LED
Position of Induction Coil
Motor
Base

(a) 3D model of the structure of the prototype   (b) Physical Display of the prototype

◆ Animation Display

(a) Flower with 6 petals   (b) Flower with 8 petals
(c) Flower with 12 petals   (d) Flower with 14 petals
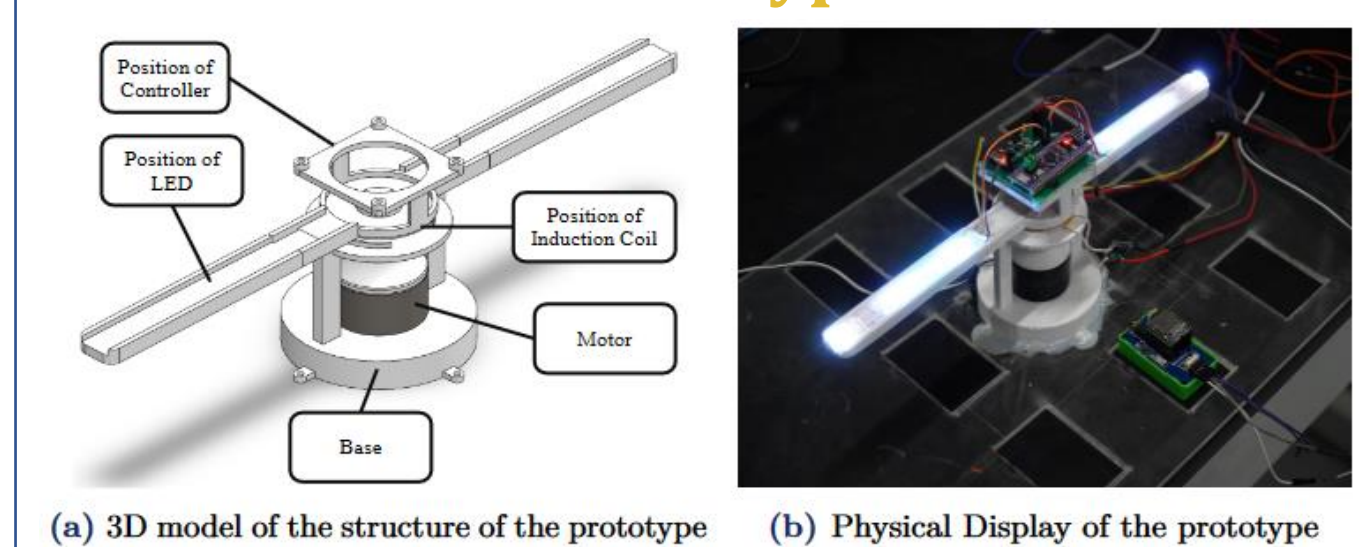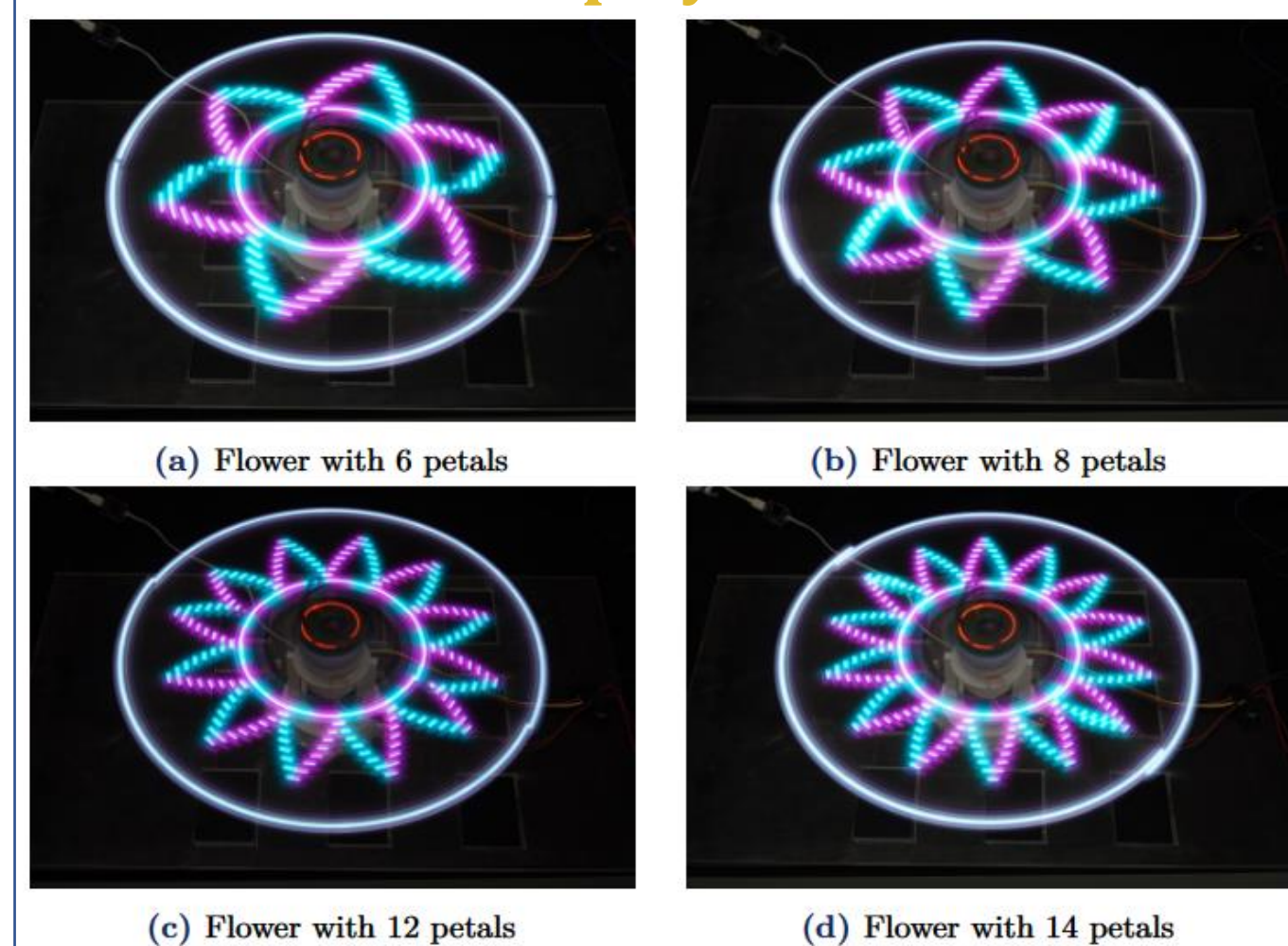
Discussion

The tasks are successfully finished and the prototype can successfully display patterns, animations and play music.

◻ Highlight:

- **Two-arm structure** is designed, reducing the rotation speed by half required by achieving POV.

◻ To be improved:

- Reducing the settling time to steady state.
- More colorful images and animations .

Conclusions

- RMD-L-4005 motor is used for rotating the rotating plate.
- XKT412-26 is employed for **wireless-charging** with 5V DC input and 5.3V DC output.
- The plate can be alternatively rotated **clockwise and anti-clockwise twice** within a minute.
- **Colorful and smoothly changing animations** are displayed by the rotating LED in the transient process and stationary patterns are displayed in the steady state.
- **Sound effect** is equipped in our prototype using VS1053 MP3 module.

Finished the project, we've progressed a lot, not only our personal skills in many aspects, but also the team coherence. Better performance in future could be expected.

Click here to get project report and video demo

Acknowledgement