Persistence of view page

Author: Belciug Matei
Group: 335CA

Introduction

My project consists of a spinning arm with a led strip on it that can **display a square page**. By utilizing the effect called `persistence of view` which means observing the illusion of a source of light that is no longer there, a page is displayed by having the arm spin at very high speeds in a motion similar to a clock limb's. Its purpose is to create such displays for user defined pictures having a resolution of 32×32. The user can utilize a custom mobile app to draw the desired design and save it locally on the phone and upload through wifi the desired image to the device to be displayed. I think this is useful for entertainment purposes as it looks visually appealing and it showcases an interesting visual effect (the aforementioned `persistence of view` effect).

General description

Block Diagram

The Stationary Base

The Base serves as the structural foundation and provides the mechanical energy required for the system.

1. **Power Management**: A high-capacity 2S Lithium-Ion battery pack (18650 cells)provides a nominal voltage of 7.4V. This is managed by a BMS (Battery Management System) module, which ensures balanced charging and protection. This rail powers both the Arduino Nano and the high-speed RS-385 DC Motor.
2. **Speed Control Logic**: The Arduino Nano acts as the dedicated motor controller. It reads an analog signal from a 10k Potentiometer via an ADC. Based on this input, it generates a PWM signal to drive the IRLZ44N MOSFET, which regulates the motor speed through ground switching.
3. **Status Monitoring**: The Arduino Nano utilizes the I2C protocol to communicate with an LCD display, providing the user with real-time feedback on system parameters.
4. **Synchronization Reference**: A fixed Base Magnet is mounted on the chassis. It acts as the physical “zero-point” reference for the rotating arm.

The Spinning Arm

The arm is an autonomous unit that handles high-speed image processing and synchronization.

1. **Processing & Connectivity**: The ESP32 is the core of the arm. It manages the wireless data reception and the high-speed timing required for the POV effect.
2. **Independent Power Supply**: To avoid the complexity of slip rings, the arm carries its own 3.7V LiPo battery, rechargeable via a TP4056 module. An MT3608 Boost Converter steps this voltage up to a stable 5V to power the ESP32 and the LED strip. A Voltage Divider allows the ESP32 to monitor the battery's health through an ADC pin.
3. **Rotational Synchronization**: Every time the arm passes the base magnet, the A3144 Hall Effect Sensor triggers an ISR (Interrupt Service Routine) on the ESP32. This allows the software to calculate the exact duration of a full rotation and synchronize the start of the image frame.
4. **Visual Output**: Once synchronized, the ESP32 pushes image data to the SK9822 LED strip using the SPI protocol. By refreshing the LEDs at precise intervals throughout the 360° rotation, a square image is formed in the air.

Mobile Communication

The interaction between the user and the hardware is handled wirelessly to allow for real-time updates.

1. **Data Transfer**: A Custom Mobile App allows the user to draw or select images. This data is converted into a coordinate matrix and transmitted to the ESP32 via WiFi using the UDP/TCP protocol.
2. **Dynamic Updating**: Because the ESP32 stores the received data in a frame buffer, the user can update the displayed image “on the fly” without stopping the motor or connecting any cables.

Hardware Design

Component list

I. The Spinning Arm

1. Microcontroller: ESP32 DevKitC V4

- buying site: ESP32 DevKitC V4 sale
- datasheet: ESP32 DevKitC V4 datasheet

2. LED Strip: SK9822

- buying site: SK9822 sale
- datasheet: SK9822 datasheet

3. Rotation Sensor: A3144 Hall Effect Sensor (Digital output).

- buying site: A3144 sale
- datasheet: A3144 datasheet

4. Logic Battery: 3.7V LiPo Battery, capacity: 500mAh

- buying site: LiPo Battery sale
- datasheet: not needed

5. Voltage Regulator: MT3608 Boost Converter Module

- buying site: MT3608 sale
- datasheet: MT3608 datasheet

6. Charging Module: TP4056 Lithium Battery Charger with Micro-USB

- buying site: TP4056 sale
- datasheet: TP4056 datasheet

7. Resistors for ADC: 1x 0.25W 10kΩ and 1x 0.25W 22kΩ

- buying site R1: Resistor 10K sale
- buying site R2: Resistor 22K sale
- datasheets: not needed

8. Capacitor 1000µF 10V

- buying site: Capacitor sale
- datasheet: Capacitor datasheet

II. The Base

9. Motor: RS-385 DC Motor (6V - 12V high-speed motor|]]

- buying site: RS-385 sale
- datasheet: RS-385 datasheet

10. Controller: Arduino Nano Atmega328P compatible

- buying site: Arduino Nano Atmega328P compatible sale
- datasheet: Arduino Nano Atmega328P datasheet

11. IRLZ44N N-channel 49A, 55V

- buying site: IRLZ44N sale
- datasheet: IRLZ44N datasheet

12. 1N4007 rectifier diode

- buying site: 1N4007 sale
- datasheet: 1N4007 datasheet

13. Base Batteries: 2x 18650 Li-ion Cells 2500mAh, 3.7V, Samsung 25R

- buying site: Li-ion Cells sale
- datasheet: not needed

14. Battery Holder: Dual-slot 18650 Holder (Series connection for 7.4V - 8.4V|]]

- buying site: Dual-slot 18650 Holder sale
- datasheet: not needed

15. Base Charger: BMS Module 2S Li-ion Battery Charger 3.7V 4A OKYN609

- buying site: BMS Module sale
- datasheet: not needed

16. Magnet: Neodymium Magnet 5mm x 2mm

- buying site: Magnet sale
- datasheet: not needed

17. Power Switch: ON/OFF toggle switch.

- buying site: ON/OFF toggle sale
- datasheet: not needed

18. 1602 LCD Display

- buying site: not needed (already owned)
- datasheet: 1602 LCD Display datasheet

19. Slider Linear Potentiometer

- buying site: Slider Potentiometer sale
- datasheet: not needed

20. Resistors: 2x 0.25W 10kΩ

- buying site R1: Resistor 10K sale
- datasheets: not needed

Electrical Schematics

I. The Spinning Arm Schematic

II. The Base Schematic

Software Design

Descrierea codului aplicaţiei (firmware):

- mediu de dezvoltare (if any) (e.g. AVR Studio, CodeVisionAVR)
- librării şi surse 3rd-party (e.g. Procyon AVRlib)
- algoritmi şi structuri pe care plănuiţi să le implementaţi
- (etapa 3) surse şi funcţii implementate

Rezultate Obţinute

Care au fost rezultatele obţinute în urma realizării proiectului vostru.

Concluzii

Download

O arhivă (sau mai multe dacă este cazul) cu fişierele obţinute în urma realizării proiectului: surse, scheme, etc. Un fişier README, un ChangeLog, un script de compilare şi copiere automată pe uC crează întotdeauna o impresie bună .

Fişierele se încarcă pe wiki folosind facilitatea **Add Images or other files**. Namespace-ul în care se încarcă fişierele este de tipul **:pm:prj20??:c?** sau **:pm:prj20??:c?:nume_student** (dacă este cazul). **Exemplu:** Dumitru Alin, 331CC → **:pm:prj2009:cc:dumitru_alin**.

Jurnal

Puteți avea și o secțiune de jurnal în care să poată urmări asistentul de proiect progresul proiectului.

Bibliografie/Resurse

Listă cu documente, datasheet-uri, resurse Internet folosite, eventual grupate pe **Resurse Software** şi **Resurse Hardware**.

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