Proposal for a Persistence of Vison Display

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I. Introduction

The PoVD is an innovating and creative way of displaying information or an animation using the weaknesses of the human eye to create an after image of a flashing light so that it looks as if the light isn't flashing at all

The concept of a Persistence of Vision Display (PoVD) has been around for a long time and has already been constructed by many people. A PoVD makes use of the Persistence of Vision phenomenon which has been put to good use in the animation sector, for example the very early micky mouse cartoons, where they used to make the animation frame by frame. (Kadaf, 2021)

This project will be different in the way that it is made by making use of an H-bridge to control a motor and using a positional sensor that will also be regulating the motor speed.

II. Background

The PoVD works on the concept that the human eye can only process about 10-12 images per second. (Persistence of vision: how does animation work?, 2021)If more than 10-12 images are shown to a viewer under a second, then the image with have an after image effect which could give the impression of a lasting image instead of randomly flashing LEDs. The concept of the after image effects was used in the early animations and movies.

A PoVD will require a micro controller, a positional sensor, sevral LEDs, resistors, a DC motor, a power source, conduction wires and a two structures, one to hold all of the components and one to rotate. (», 2021)

The Hall effect sensor works on the concept of the Hall effect which states that when and electric current flows through a conductive medium in a magnetic field, a voltage is produced. (Hall Effect, 2021). Some other possible options for the positional sensor are a Photodiode (PHOTODIODE BASICS – Wavelength Electronics, 2021), an IR sensor (IR Sensor, 2021), a phototransistor (Phototransistor : Construction, Circuit Diagram & Its Applications, 2021), or an optical encoder (#04 Principle and advantages of optical encoder | Basic Knowledge of Encoder | TUTORIALS | Asahi Kasei Microdevices (AKM), 2021).

To control a DC motor, an H-bridge will be used. An H-bridge is an electronic circuit that consists of transistors which are switched on or off to manipulate the flow of current to either make the motor drive forwards, in reverse or to come to a fast stop. If MOSFETs are used, there is the advantage of being able to withstand higher currents without damage. (H-Bridge Theory & Practice -- Chuck's Robotics Notebook, 2021)

The four main design solutions to choose from are:

1) Half Circular PoVD:

This design makes use of the fewest LEDs and is by far the easiest to construct. It consists of two main hardware parts: the rotating part and the stationary part. The rotating part will hold most of the electronics such as the Arduino nano and PCB. The stationary part will hold the DC motor and the battery. The stationary part can also have the option of a base plate or to be handheld. (», 2021)

2) Spherical PoVD

This design has rotating circle connected to a pole that goes through the middle of the circle. All electronics are in the centre of the circle. Half of the circle has LEDs and on the other side there is a hall effect sensor for reference. (Coward, 2021)

3) Full Circular PoVD

This design works similarly to the half circular PoVD but has a continuous line of LEDs to process more images.

4) Cylindrical PoVD

This design is similar to the spherical design with the exception that the rotating part is rectangular and not circular. (Al-Natsheh, Hammad, Abu Zaid; 2019)

III. Problem Formulation

A PCB which holds a DC motor, an H-bridge, and a microcontroller needs to me designed and constructed.
Another PCB which holds the LEDs and the positional sensor also needs to be designed and constructed.
For the DC motor to work as intended, a motor controller needs to be designed and constructed.
To get the positioning of the images being displayed in the consistent and predictable location, a positional sensor needs to be chosen, used and the signal needs to be fed back as a step response.
A micro controller that is capable of microsecond time delays display is required.

A. Specifications

- The DC motor rotates more than 12 rps (720 rpm)
- The DC motor needs to be controlled by an H-bridge
- The primary PCB must hold the microcontroller, Hall sensor and the H-bridge.
- The secondary PCB must hold the LEDs

- The Hall sensor signals must be received as step responses
- The Hall sensor must be used to control the rotation speed
- The microcontroller needs to be capable of microsecond time delays
- The total cost must come to 1000 SEK (+- 100€)

B. Research Questions

- Are all the specifications met?
- Are there any difficulties that will change the method of the project?
- Is the project restricted by budget?

IV. Hypothesis

. The design and construction of the persistence of vision display will meet all criteria for success in the given time period.

V. Method

A. General

The full circular PoVD must be designed. This general solution was chosen because it has a large display range than a half circular PoVD and has a more practical use than the spherical PoVD.
A rough schematic diagram for the PCBs will be drawn out.
The PoVD structure will be designed in a CAD software.

B. Motor controller solutions:

A motor that can reach the required rotational speed must be chosen.
The H-Bridge for the motor controller must consist of MOSFETs instead of BJT because MOSFETs have less power dissipation due to heat. The H-bridge can be further improved by placing a BJT in front of each MOSFET. This will allow the H-bridge to be controlled by smaller currents with the advantage of being able to withstand larger currents without burning out.
MOSFETs for the H-bridge must be carefully chose.
BJTs for the H-bridge must be carefully chosen.

C. Position Sensor:

The Hall sensor is the best option due to ease of signal response and signal manipulation.
The Hall sensor must be used to control the rotational speed of the dc motor.
The Hall sensor generates sinusoidal response which must be changed to a step response for data processing.

D. Choice of Micro controller

The micro controller must be able to process information in microseconds because timing is crucial when it comes to a PoVD.
The micro controller must have at least a 3kHz. This was calculated by using double the amount of images necessary per second (24 images per second = 400 microseconds) and converting the seconds to hertz (1/0.4 = 2.5 kHz) and rounding up to the nearest kHz to get the required processing power.
The microcontroller needs to be programmed.

E. LED solutions

LEDs need to be chosen.
If there are more LEDs than pins on the microcontroller, a method of controlling more LEDs must be chosen. Some possible methods are:

- Multiplexing
- Shift Register
- Adding Additional Hardware

F. Overall Construction

All of the parts must be put together to complete the PoVD.

VI. Schedule

Section	Expected time
Documentation	2 days (40 h)
Rough overall design	2 days (16 h)
Motor Controller system	2 weeks (64 h)
Positional system	2 weeks (64 h)
Micro controller system	2 weeks (64 h)
PCB construction and design	2 weeks (64 h)
Overall construction	2 weeks (64 h)

Total time: 376 h

VII. Conclution

This project makes use of complex electronic concepts to create a fast rotating display with LEDs that flash systematically to display words and/or images.

Refrences

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