

# Persistence of Vision based Display using ARDUINO

Nikhil Keswaney<sup>1</sup> Gautam Sadarangani<sup>2</sup>  
<sup>1,2</sup>Student

<sup>1</sup>Department of Computer Engineering <sup>2</sup>Department of Electronics and Telecommunication Engineering  
<sup>1,2</sup>Thadomal Shahani Engineering College, Mumbai, India

**Abstract**— This project presents yet another type of display, which uses the phenomena of persistence of vision to its advantage. Human eye can sense difference between two sets of images only if they change at a rate slower than 24 Hz. If the rate is higher, it is perceived as continuous motion by the human brain. Thus a single array (column) of LEDs is programmed to glow in a sequence such that when that array is rotated, it displays a certain message. This message is clearly seen only if the array is rotated at a certain speed. This display uses 20 LEDs arranged in a single array (column), soldered upon a rod that is rotated by a motor. This entire project is run by the Arduino uno microcontroller board. This display has certain advantages over its competitors, mainly lesser power consumption, less complexity and better aesthetic value, making it an apt device to display short messages.

**Key words:** POV, Arduino, ATmega 328, USB. Interfacing

## I. INTRODUCTION

### A. Persistence of Vision

Persistence of vision is a theory in which an after image is thought to persist for one sixteenth of a second on the retina and believed to be the explanation formation; in other words if a human being is shown images that are in synchronization, at a speed of 24 images /second than the human brain will consider it a continuous motion and not separate images. Humans can also interpret motion at rates as low as ten frames per second or slower (as in a flipbook). [1]

Take the motion picture, the scanning of an image for television, and the sequential reproduction of the flickering visual images they produce. These work in part because of an optical phenomenon that has been called “persistence of vision” and its psychological partner, the phi phenomenon—the mental bridge that the mind forms to conceptually complete the gaps between the frames or pictures.[1]

Although the term persistence of vision has come to be seen as inadequate to fully describe this very complex physiological reality, it remains a standard expression and, as such, it serves as a useful metaphor.

In effect, the process we know as persistence of vision plays a role in keeping the world from going pitch black every time we blink our eyes. Whenever light strikes the retina, the brain retains the impression of that light for about a 10th to a 15th of a second (depending on the brightness of the image, retinal field of view, and color) after the source of that light is removed from sight. This is due to a prolonged chemical reaction. As a result, the eye cannot clearly distinguish changes in light that occur faster than this retention period. The changes either go unnoticed or they appear to be one continuous picture to the human observer.[2]

In our project, the single array of LEDs (1D) cannot show an image (2D) by itself; here the rotational motion comes into play by creating an illusion of multiple columns, where only a single column exists. This illusion is obviously a result of persistence of vision. The LEDs are programmed to glow in such a sequence such that a message can be seen when the rod is rotated. The speed and synchronization is a critical factor here. The speed of rotation is dependent on the refresh rate of LEDs and only if both of them are synchronized properly, can we see the intended message.

The speed of rotation also decides the maximum length of the message that can be displayed. The length of the stick from the axis of rotation to the first LED is calculated and then the circumference is found out. Each letter is taken to span a width of 12 columns (lines). The number of lines fitting in one rotation is approximately equal to the circumference calculated in centimeters, assuming width of a single LED to be 1cm. This number is thus divided by 12 to get the maximum no. of letters that can be displayed in a single message.

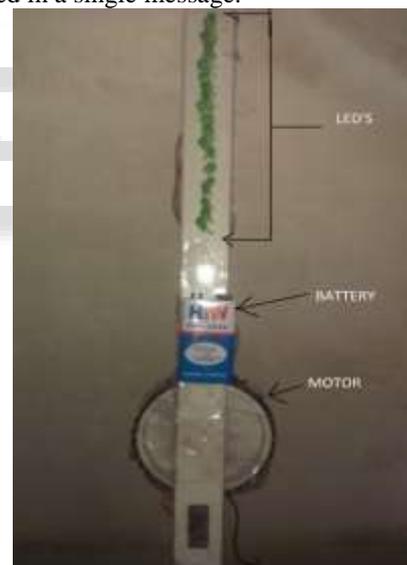


Fig. 1.1: PoV display model

### B. Components Overview (INTERFACING)

#### 1) Arduino

Arduino is an open source computer hardware- software company and user community that designs and manufactures kits for building digital devices and interactive objects that can sense and control the physical world. Arduino boards may be purchased preassembled or as do-it-yourself kits.[3]

The Arduino board is basically a development board, with a microcontroller as its brain. The board has a USB port connector for programming, common input headers like female connectors for GPIOs, ICSP and other pins, to facilitate connections which are temporary in nature. This temporary nature of connections helps in fast

experimentation and testing making it an ideal development platform for hobbyists and professionals alike.

Various versions of the board are available like Arduino UNO, Arduino Mega, etc. They generally vary in different features like memory, 8/16/32 bit microcontroller, no. of pins, etc. The microcontrollers used usually are various 8-bit Atmel AVR microcontrollers or 32-bit Atmel ARM processors. The board contains communication interface including USB for uploading the program from the PC. For programming microcontrollers, the Arduino platform provides an integrated development environment (IDE) based on the Processing project, which includes support for C and C++ programming languages.[3] We will be using the Arduino UNO board for our project.

The microcontroller used in Arduino uno is ATmega328 which is a high-performance Atmel 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1KB EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed. [5]



Fig. 1.2: Arduino Uno

## 2) Motors

Motor positioning and programming is one of the most important aspects of this project as the display depends upon the motor's rotation speed also known as RPM or Rotations Per Minute. This is basically a unit of angular speed as it measures the no. of full rotations of a motor, completed in a minute. This project uses a 1000 rpm, 12 V rated DC motor. The motor speed depends upon the amount of potential difference provided between its two leads. Since the motor is rated 12 V, a full 12 volts at input causes the motor to rotate at its maximum speed, i.e. 1000 rpm. The maximum voltage that can be provided from an Arduino I/O pin is 5 V and the DC current that can be provided is around 50mA, thus we will need to power the motor separately using a battery. In order to control speed the power is given through a 10k pot.

Usually a motor driver circuit is used to connect the Arduino and motor, but since in this display the motor will always be

running, there is no need to connect the Arduino and motor. Also a wire between the Arduino and motor will hamper the rotation.

## II. COMPLETE INTERFACING

This project consists of an array of 20 LEDs on a stick/rod which rotates at a particular speed and displays a message given by the user. We used an Arduino uno to execute this project the 0-13 digital pins and the A0-A5 pins are connected to the LEDs. These pins are then controlled by the microcontroller and according to the algorithm uploaded, these pins/LEDs are switched on or off.

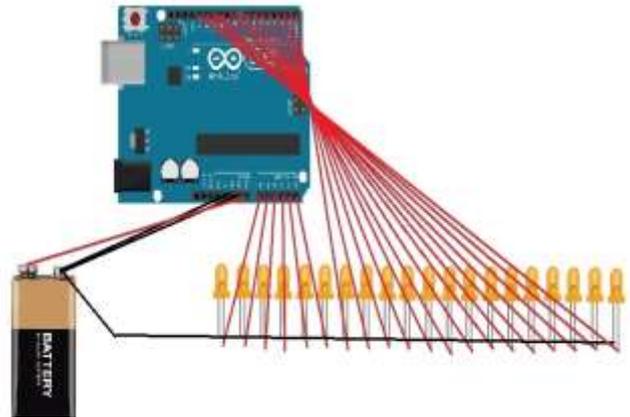


Fig. 2.1: Circuit Diagram

## III. ALGORITHM

The algorithm consists of designing of two main components

- Display calculations
- Main programming

In brief the algorithm displays one line (column) of the 2D image at a time using the array of LEDs.

The below array is used for displaying the letter A.

Similarly there are 25 other arrays in the program from B-Z which will be further explained in the paper.

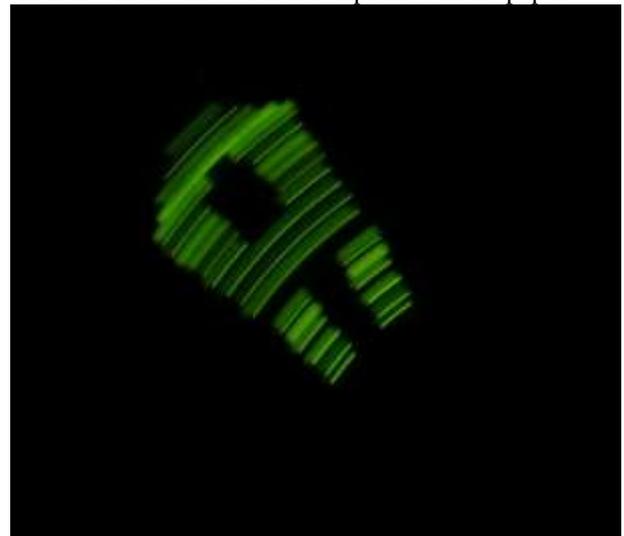


Fig 3.1: Pov display displaying letter A



Multicoloured LEDs can be used to display images instead of just messages using 2D POV display. A two dimensional POV display is often accomplished by means of rapidly moving a single row of LEDs along a linear or circular path. The effect is that the image is perceived as a whole by the viewer as long as the entire path is completed during the visual persistence time of the human eye. A further effect is often to give the illusion of the image floating in mid-air. A 3 dimensional POV display is often constructed using a 2D grid of LEDs which is swept or rotated through a volume [4] or the rod can also be modified by bending to create 3D images.

#### REFERENCES

- [1] Reference  
[http://en.wikipedia.org/wiki/Persistence\\_of\\_vision](http://en.wikipedia.org/wiki/Persistence_of_vision).
- [2] Reference  
<http://www.vision.org/visionmedia/philosophy-and-ideas/persistence-of-vision/136.aspx>.
- [3] Reference Image:  
<http://www.arduino.cc/en/Main/ArduinoBoardUno>.
- [4] Paul, Rathod, Trivedi, Thakar; Persistence of Vision Control Using Arduino, DOI: 10.5815, I.J. Intelligent Systems and Applications, 2014, 01, 102-111 Published Online December 2013 in MECS (<http://www.mecspress.org/>)
- [5] Reference  
<http://www.atmel.com/devices/atmega328.aspx>.

