Persistence of Vision Display Using Arduino

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***Abstract**- This paper mainly emphasizes on the POV (Persistence Of Vision) display technology. This paper mainly focuses on maximum and efficient use of the energy and has many advantages over a traditional CRT, LCD or LED display, like power savings, less complexity, easy configuration, attractiveness etc. The Arduino platform brings newer coding and a different understanding of peripherals that provide low-cost, easy-to use technology to create the project. We also aim to build the newer display to work with modern forms of interfaces.*

Keywords- Light Emitting Diodes, RGB LED, Arduino Nano, POV.

I. INTRODUCTION

The core phenomenon on which the entire project is based is the Persistence of vision. Persistence of vision is the phenomenon pertaining to the human eye by which an afterimage is thought to persist for approximately one twenty-fifth of a second on the retina. The way this phenomenon of persistence of vision works is based on the belief that human perception of motion (brain centered) is the result of persistence of vision (eye centered). Any motion that we see around us is the direct implication of persistence of vision phenomenon at work. Persistence of vision is still the accepted term for this phenomenon in the realm of cinema history and theory. Blinky POV is a reprogrammable LED kit that uses persistence of vision to create the illusion of text or a small picture floating in the air.

The purpose of this project is to design and create a persistence of vision (POV) display. The display will allow the users to upload an image to be displayed through the Wireless communication. A persistence of vision (POV) refers to the phenomenon of the human eye in which an afterimage exists for a brief time (10ms). A POV display exploits this phenomena by spinning in one dimensional row of LED’s through a two dimensional space at such a high frequency that a two dimensional display is visible.

The phenomenon of POV is evident in a number of events like for e.g.: When we rotate a fire cracker stick at high speed, we observe a continuous circle being formed as shown in fig1.

Fig1: Demonstration of persistence of vision

II. PERSISTENCE OF VISION DISPLAY USING ARDUINO

Persistence of vision is just a fancy way of saying optical illusion. In this project what it does is just flash LED’s so fast that your eye is tricked into seeing things.

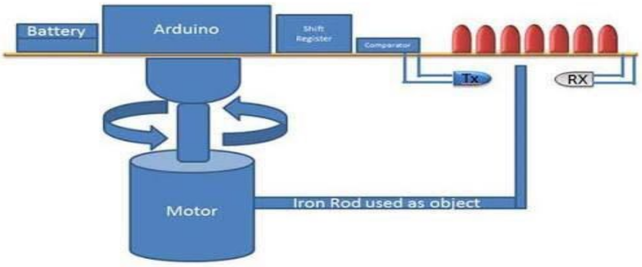


Fig 2.1: Block Diagram of Persistence of vision Display

Description :

The overall design of this project can be grouped in the following three categories:

- Electrical design
- Mechanical design
- Software design

The display consisted of the following components:

1. Arduino Nano: Central controller for switching the LEDs at appropriate time.

2. IR sensor –Used to provide Interrupt so that it can start the display routine again.
3. DC motor –12 V: Used to rotate the assembly at high speed to induce the persistence of vision effect.
4. LED display –10 general purpose LEDs strip: Used as display agents.

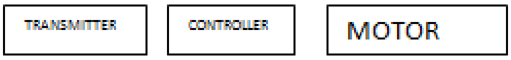


Fig 2.2: Block diagram of persistence of vision display

Working of LED:

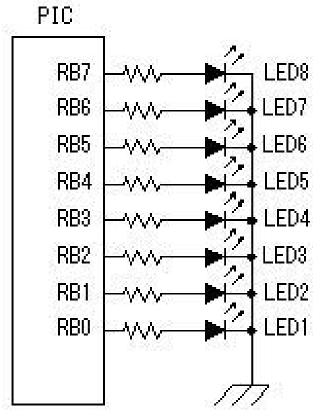


Fig 2.3: Working of LED

The LED should light when the input to the transistor is high and the LED should turn off when the input of the transistor is low. The circuit should draw as little current as possible in order to switch the LED on in order that the switch can be used.

Design:

The circuit is simple transistor circuit using the transistor switch. In this case the transistor is either off or fully on (the voltage across the collector and emitter is almost zero and the transistor is saturated and cannot pass any more collector current). The circuit design becomes something like this:Note that the current limiting resistor for the LED circuit has been change to 220ohms. The 10Kohms resistor is used to drive the transistor. By breaking the connection we turn the transistor off and hence turn the LED off. By restoring the connection we turn the transistor on and hence turn the LED on. The value10kohms has been chosen to provide a very small current to the base of the transistor.A BC547 transistor is a tiny three terminal device capable of converting small signal inputs into large amplified outputs, probably one of the greatest inventions of mankind so far. Even the sophisticated chips to date have (millions of) transistors embedded within them and configured into complex circuits, assigned with many discrete and specific operations through different stages. All transistors basically function in the same manner. They are broadly distinguished by their power ratings or handling capacities. A BC547 is a general purpose, small signal transistor fit for almost all types of circuit applications and therefore extensively used for making an unlimited range of electronic gadgets today.BC547 cannot hold more than 45volts, therefore this voltage becomes its maximum safe operating voltage, which must be incorporated with its collector load. I(max) is the maximum tolerable current that can loaded across the collector /emitter pin-outs of the devices. Here it's 100mA for all. Though, this value is the breakdown limit, above which the part may just burn off, it may be noticed that the transistors start heating up well inside the reach of this limit, probably around 70mA. Thus it's advised to operate them at around half the value of their individual I (max) ratings'(max) is the maximum power handling capacity of the devices, or the load rating which can be connected across its collector/emitter. This value quite corresponds to I(max) and are interconnected. P(max) here is 500mW or half watt for entire group. An increase in the hFE level simply attributes the particular device with more sensitivity, which means it can be triggered with minute base currents, yet switch heavier loads across its collector.

Working:

As shown in the figure, connect a resistor of some minimum safe value to the base of the transistor, say a 220 ohms resistor, this will ensure that at least the device cannot get damaged through its "base" pin-out, because the resistor will never allow the relevant currents to develop to dangerous levels across the vulnerable base/emitter junction of the transistor.

For testing the basic working pattern of the transistor, you would further need to fix a pot along the "base", positive and the negative terminal. Next connect an LED and a resistor to the collector of the transistor, with the help of the diagram. The LED will provide you with immediate visual information regarding the happenings with the circuit. The collector resistor again ensures that the UCEO is kept within the specified limits, safeguarding the transistor as well as the LED.

Initially keep the pot's knob somewhere at the midway of its rotation. Apply a DC potential across the shown terminals, and you will find the LED coming ON immediately. This happens because a small part of the voltage reaches the base of the transistor and switches ON its collector to ground and allows the voltage to complete , illuminating the LED.

Now adjusting the pot's slider arm more towards the ground, you'll find, makes the LED gradually dim, and ultimately switch OFF, at some particular point of the pot setting. This happens because the required magnitude of base potential, instead of reaching the transistor gets grounded through the pot.

III. LED DISLPAY CIRCUIT

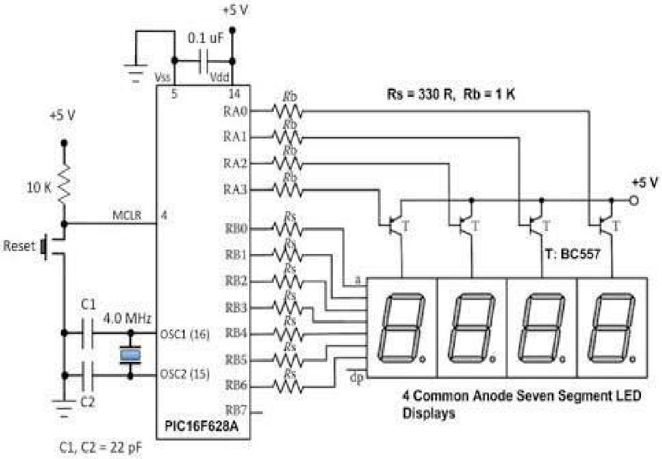
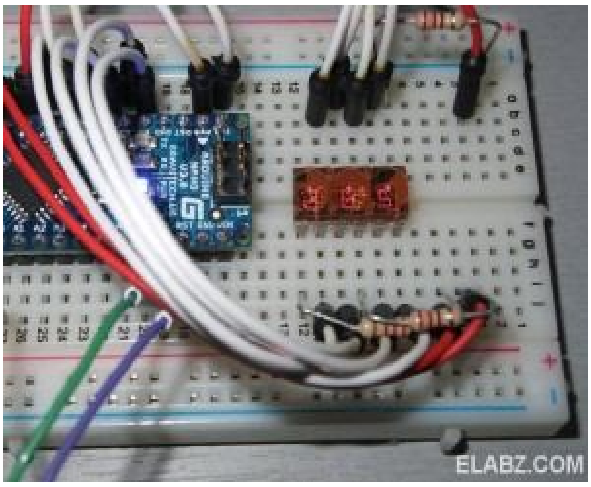


Fig 3.1 :LED Display Circuit

One of the important features of this circuit was going to be its simplicity and therefore some sacrifices were made. For example, you would normally have 8 current limiting resistors, one for each segment anode. That would make each segment's current equal to the next which, in turn, will make all digits equally bright. In this case I only used 3 resistor – one for each common cathode. All anodes comprising one digit therefore share one limiting resistor and so the digit "8" that has 7 segments is less bright than digit "1" that has only two. Also the 22Ω limiting resistor is the only working properly with digits having 5, 6 or 7segments. The rest of the digits are having their segments lit with currents higher than needed. So you're welcome to improve this circuit by eliminating the 220Ω current limiting resistors in the common cathode lines and use 8(7 if the digital point is not used) 550Ω+ in the anode lines instead.



One other characteristic of this circuit is the large number of Arduino's output lines used. Nano has 14 digital outputs. From those we are using 8 for the anode (even though the digital point is not used in the software I include here- another improvement direction) and 3 for the cathodes.

So, there are 3 digital outputs left for either activating other types of outputs or making a 6-digits display by adding the second HP5082-7433 if all the rest of Arduino connections in this project are inputs

So, to finish with the hardware part of the project, here is how the breadboard looks like (left). It's a pretty simple circuit that can be thrown together in 5 minutes or less. Now on the software part. there are two different sketches attached here- ne is for the simplest circuit that has no inputs whatsoever and only counts from 0 to 999(in a loop). The other one is for the circuit with a 5KΩ linear potentiometer which has its wiper (middle contact) connected to the Arduino's Analog input 0 and its other contacts to ground and +5V respective.

IV. ARDUINO NANO

The Arduino Nano is a small complete, and breadboard – friendly based on the ATmega328 (Arduino Nano3.x) or Arduino ATmega168 (Arduino Nano2.x). Arduino Nano has more or less the same functionality of the Arduino Duemilanove, but in a different package. The Nano was designed and is being produced by Gravitech.

Memory:

The ATmega168 has 16KB of flash memory for storing code (of which 2 KB is used for the bootloader); the ATmega328 has 32 KB, (also with 2 KB used for the bootloader).The ATmega168 has 1 KB of SRAM and 512 bytes of EEPROM (which can be read and written with the EEPROM library), the ATmega328 has 2 KB of SRAM and 1 KB of EEPROM.

Power:

The ArduinoNano can be powered via the Mini- USB connection, 6-20V unregulated external power supply (pin 30), or 5 V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source.

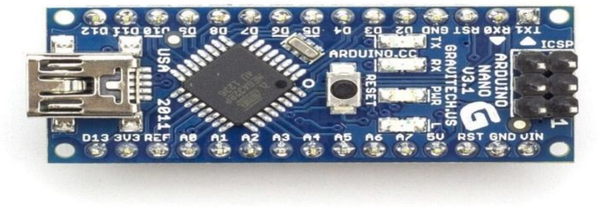


Fig 3.1: Arduino nano

Communication:

The Arduino nano has a number of facilities for communicating with a computer , another Arduino or the microcontrollers. The ATmega168 and Atmega 328provide UART TTL(5V) serial communication, which is available on digital pins 0 (RX) and 1(TX). An EDI FTL232RL on the board channels this serial communication over USB and FTDI drivers(included with the Arduino software0 provide a virtual com port to software on the coputer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via FTDI chip and USB connection (but for serial communication pin 0 and 1). A Software Serial Library allows for serial communication on any Nano’s digital pins .The ATmega168 and ATmega328 also support I2C(TWI) and SPI communication. The Arduino software includes a wire library to simplify use of the I2C bus. To use the SPI communication.

Programming

The Arduino Nano can be programmed with the Arduin software. Select Arduino Diecimila, Arduino Duemilnove or Nano w/ ATmega 168” or “Arduino Duemilanove or Nano w/atmega 328” from the tools>board.The Atmega168 or Atmega328 on the Arduino comes preburned with a bootoader that allows you to uload new code to it without the use of an external hardware programmer. It communicates using original STK500 protocol.You can also bypass the bootloader and program the microcontroller through the ICSP(In-Circuit Serial Programming) header using Arduino ISP Rather than requiring a physical press of the rest button before upload , the Arduino Nano is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines(DTR) of the FT232RL is connected to the reset line of the ATmega328 via a 100nan0farad capacitor . when this line is asserted (taken low), reset line drops long enugh to reset the chip. The Arduino software uses this capability to allow you to upload code simply prsessing the upload buton in the Arsuino environment. This means tha bootloader can have shorter timeout, as the lowering of DTR can be well-coordinated with the stat of the upload’

V. CONCLUSION

The paper really demonstrated competence combining a difficult integration of the mechanical and electrical system to build persistence of vision display. We built a general standalone system which can receive input from any device wirelessly to print out a display based on the pixel information. We demonstrated this by connecting with the alphabet character recognition system. The onboard system is fully contained system, capable of outputting the display varying RPM speeds and not carrying about what the system interfaces with it as long it follows a standardized wireless protocol developed by us.

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