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The Design and Construction of a low cost Propeller Led Display

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Abstract - This paper explains the project which is a special kind of circular LED display. With the help some mechanical assembly, LED count, hardware requirement, and hence overall cost is cut to very affordable price. Also, maintenance and repairing of the display is so easy, that anyone having a little electronics knowledge can take care of this. All the synchronizing can be implemented through software. First of its kind, made using the 20-pin 8051 series microcontroller, this project use the principle of Space Multiplexing. This propeller display is mechanically scanned and displays the characters in digital format. Made from scrap it can be used anywhere and everywhere and the most amazing fact about this display is its crystal clear display. This display consists of just 7 bright LEDs which are rotated to show the display. For building this project, requirement is just a small 20 pin microcontroller, a position encoder, and LEDs. This display can show the messages, which will require a whopping 525 LEDs. So hardware and cost minimization is achieved.

Keywords : *Propeller; Persistence of Vision; Space Multiplexing.*

GJRE-F Classification : *090606, 090601, 090699*

Strictly as per the compliance and regulations of:

The Design and Construction of a low Cost Propeller Led Display

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Abstract - This paper explains the project which is a special kind of circular LED display. With the help some mechanical assembly, LED count, hardware requirement, and hence overall cost is cut to very affordable price. Also, maintenance and repairing of the display is so easy, that anyone having a little electronics knowledge can take care of this. All the synchronizing can be implemented through software. First of its kind, made using the 20-pin 8051 series microcontroller, this project use the principle of Space Multiplexing. This propeller display is mechanically scanned and displays the characters in digital format. Made from scrap it can be used anywhere and everywhere and the most amazing fact about this display is its crystal clear display. This display consists of just 7 bright LEDs which are rotated to show the display. For building this project, requirement is just a small 20 pin microcontroller, a position encoder, and LEDs. This display can show the messages, which will require a whopping 525 LEDs. So hardware and cost minimization is achieved.

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I. Introduction

Propeller is a term associated with a circular rotating object. As this project needs to rotate whole circuit assembly, there must be some prime mover attached to it. So, the term 'Propeller'. This project using bright light emitting diodes for displaying the characters and symbols on its assembly. That's why this project is named as 'PROPELLER LED DISPLAY. ' This is the phenomenon which is related to vision capability of human eye by which an afterimage is thought to persist for approximately 1/25th of a second. So, if someone is observing the images at a rate of 25 images per second, then they appear to be continuous. The best example of this property is the red circle we observe when we rotate the firecracker or incense stick in circle. This project was started with a simple principle which is frequently encountered in our everyday life, which is Persistence of Vision. This phenomenon makes one feel fast moving/changing objects to appear continuous. A television is a common example; in which image is re-scanned every 25 times, thereby appear continuous. Further, a glowing objects if rotated in a circle at fast speed, it shows a continuous circle. By modifying this basic idea, 7 LEDs can be rotated in a circle, showing 7 concentric circles. But if these LEDs are switched at precise intervals, a steady display pattern can be shown. Existing systems do employ POV principle, but for displaying each pixel, individual LED is used. This results in a huge number of LEDs even for small sized displays.

By using a propeller type display, LED count can be kept to a bare minimum. Even 7 LEDs can perform a task of over 525 LEDs.Applications can find their way into cost effective solutions for large public displays, information systems. It can directly replace Railway station information displays, bus stands and many more places.

II. Methodology

a) Hardware Description

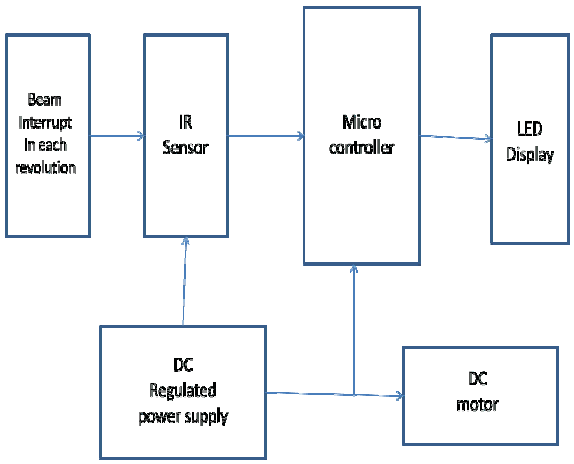

Figure1 : Block Diagram

In this section we will emphasize on detailed overview of each of the block shown in above block diagram. In every description of the block respective schematics and working is explained. The propeller display consists of following blocks, as shown in the block diagram.

- Microcontroller AT89C2051

This project is based around the microcontroller AT89C2051, which is a derivative of 8051 family, from Atmel Inc. This is a 20 pin IC packaged in DIP package. This small sized IC is used, mainly because of its reduced weight. This improves the performance of the display, because reduced weight gives advantage of increased RPM.

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- Led Module

LED module consisting of 7 bright LED is fixed in another side of the arm of our project. These LEDs are connected with each of the port pin of microcontroller, with a series current limiting resistor of 470 ohm.

- DC Motor

Repeated scanning of the display is must for continuous vision. This task is achieved using circular rotation of the whole circuit assembly. So, we used a DC motor as the prime mover.

- Interrupter Module

Interrupter module is our sensor module, consisting of the IR interrupt sensor MOC7811, from Motorola Inc. This sensor was selected from a variety of other alternatives, because of its small size, precise interrupt sensing, and study casing. One great advantage of using this module is, interfacing it with the microcontroller is just a matter of two resistors and a general purpose transistor. Following is the complete circuit diagram of our interrupter module. MOC7811 is the sensing part of the interrupter module, while rest of the circuitry works as signal conditioning ckt. 3 wires emerge out from the module, respectively Vcc, Signal and Ground. Output of the module is LOW, if interrupt occurs, otherwise it remains HIGH. It consists of IR LED and Photodiode mounted facing each other enclosed in plastic body. When light emitted by the IR LED is blocked because of some completely opaque object, logic level of the photo diode changes. This change in the logic level can be sensed by the microcontroller or by discrete hardware.

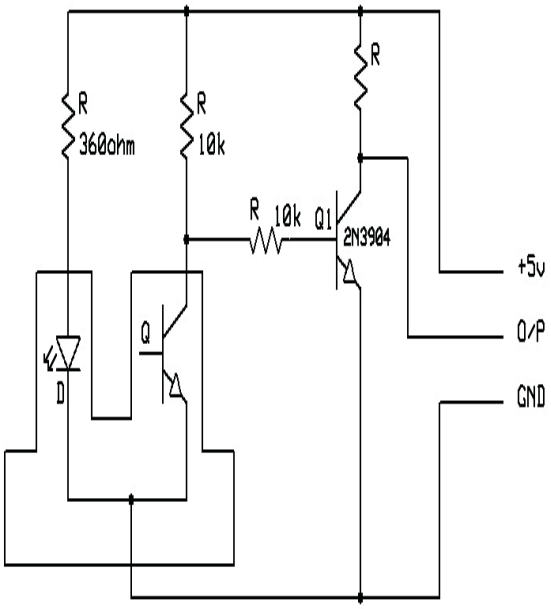


Figure1 : Circuit Diagram of Interrupter Module

- Mechanical Assembly

Mechanical assembly plays a vital role in proper functioning of this project. The display is scanned each time, by rotating the whole assembly in a circular path. The basic idea we developed is on our own, by implementing and modifying different ways to do this. Following diagram shows the most reliable way, that we finally selected. Here, one major challenge was how to bring +5V supply to the spinning circuit. We tried the same by adopting twothree different methods, but finally concluded on the method, as shown in the figure. As seen in the diagram, one supply connection (GND) is provided through the motor's shaft. Other terminal (Vcc) is connected, by arranging a friction disc-brush arrangement. The brush keeps its contact with the disc, so that current can be supplied. Most critical objective was to achieve pristine balance and overall good mechanical strength. For weight adjustment, we have provided one long screw, and weight can be attached or removed by adding / removing metallic bolts. If the assembly is balanced perfect, then it can achieve stability, and rotate at high RPMs too. This will improve the overall efficiency of this display

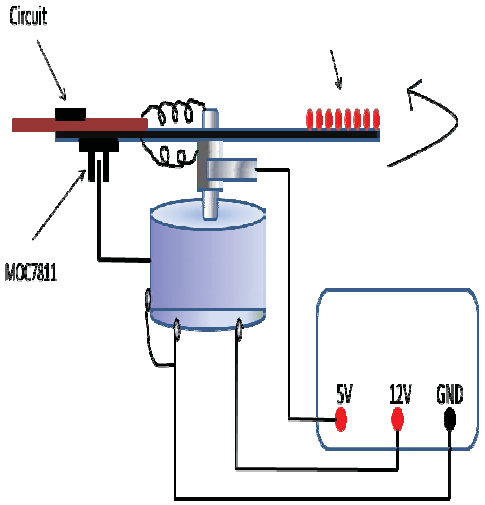


Figure3 : Mechanical Assembly

- DC Power Supply

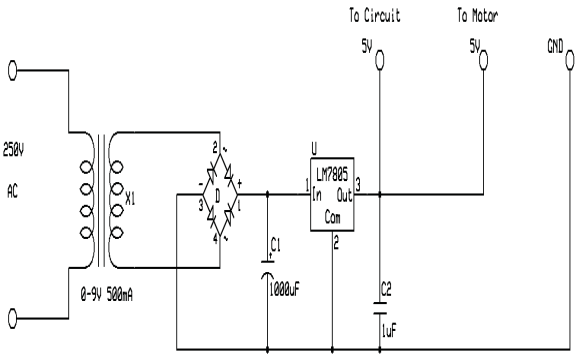


Figure2 : circuit Diagram of Power Supply.

A fixed voltage power supply producing constant +5V consists of step down transformer, a bridge rectifier, filter capacitors C1 and 3 terminal regulator IC LM7805. A step down transformer is selected in such a way that it produces 9V at the input of IC. This power supply is capable of supplying +5v and load current up to 500m A. The capacitor C2 connected between output terminal and ground cancels out any inductive effect due to long distribution leads. Input capacitor C1 is used to improve transient response of the regulator IC, i.e. response of regulator to sudden changes in load. It is also helpful in reducing the noise present in the output. Dropout voltage (Vin-Vout) needs to be at least 2V under all operating conditions for proper operation of regulator.

b) Software Description

- Ride IDE

The Resonance 8051 Development Kits are a complete solution for creating software for the 8051 family of microcontrollers. The Development Kits comprise many different tools that allow projects ranging from simple to highly complex to be developed with relative ease. You will find that with the Resonance Development Kits you can rely on tools that have been tested by real users over a long period of time. Ride provides a familiarity to the tools that will provided a basis for using more complex features. It is assumed that the user is familiar with Windows and has at least some familiarity with the 8051 microcontroller family and the C programming language.

- Algorithm

i. *Main routine*

1. Load proper value in IE register, so that the interrupts INT0 and T0 are enabled. (IE = 83H)
2. Offer higher priority to the INT0 (External) interrupt. (IP = 01H)
3. Configure timer 1 as 16-bit timer, and timer 0 as 8-bit auto reload mode timer. (TMOD = 12H)
4. INT0 should be configured as edge interrupt. (IT0 = 1)
5. Configure port 3 as input port. (P3 = 0FFH)
6. Move input string to the video RAM area. (call 'ramc' function)
7. Start the timers.
8. Initiate an infinite loop.

ii. *Interrupt Routines*

a. External Interrupt

1. Stop the timers.
2. Move th1 and tl1 into convenient registers.
3. Divide this 16 bit value by our total number of segments.
4. Subtract the answer from 256, and load the result in th0.
5. Now, reset the video RAM pointer and character segment pointers to their initial respective positions.
6. Start the timers
7. Return from interrupt

b. Timer 0 Interrupt

1. Call the display routine.
2. Clear timer overflows flag.
3. Return from interrupt

III. Result

- Interrupt Module Testing

This Interrupter module testing is required for detecting exact position of wheel on which whole circuit assembly is mounted. Supply voltage given to Pin. No. 1(Collector) and Pin.No.3 (Anode) of MOC7811=5.5V Output voltage obtained at Pin.No.1 of MOC 7811 without interrupt=5.21v.Output voltage obtained at Pin.No.1 of MOC7811 with interrupt=0.08V

- DC Motor RPM Testing

DC Motor used in this project is 12 V dc motor which is tested by using digital contact-less tachometer. Arrangement was made so that the sensing circuit gives high to low pulse for each completion of revolution. By measuring the time difference between two successive pulses RPS can be calculated which further provide RPM value, as shown below:

Power supply given to DC Motor = 9V

Time interval between two successive pulses as seen on CRO = 30.4ms

- RPS = 1 / (30.4ms) =32.89
- RPS = 33
- RPM= 33x60=1980

- Power Supply Module Testing

Power supply module was designed to provide 5V DC power supply necessary to drive both motor and circuit. AC input is given from 9V 750mA transformer. Results are as follows.

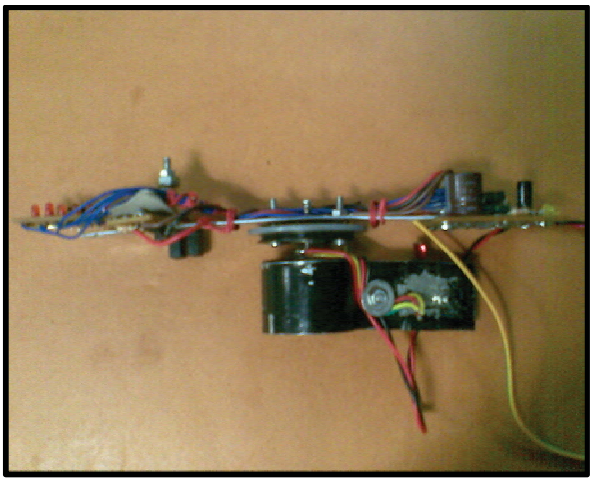
Input voltage, Vs=9V AC.

Output voltage observed, Vo = 4.92V DC

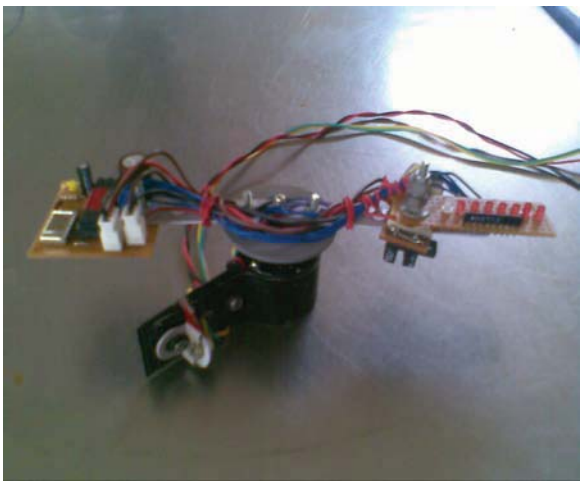
- Display Generated Pattern

Displaying a Quarter circle

Displaying a Half Circle



Displaying a character string



Displaying a number string

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