

Assistant Eye

Team #9

Progress Report III

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Block Diagram

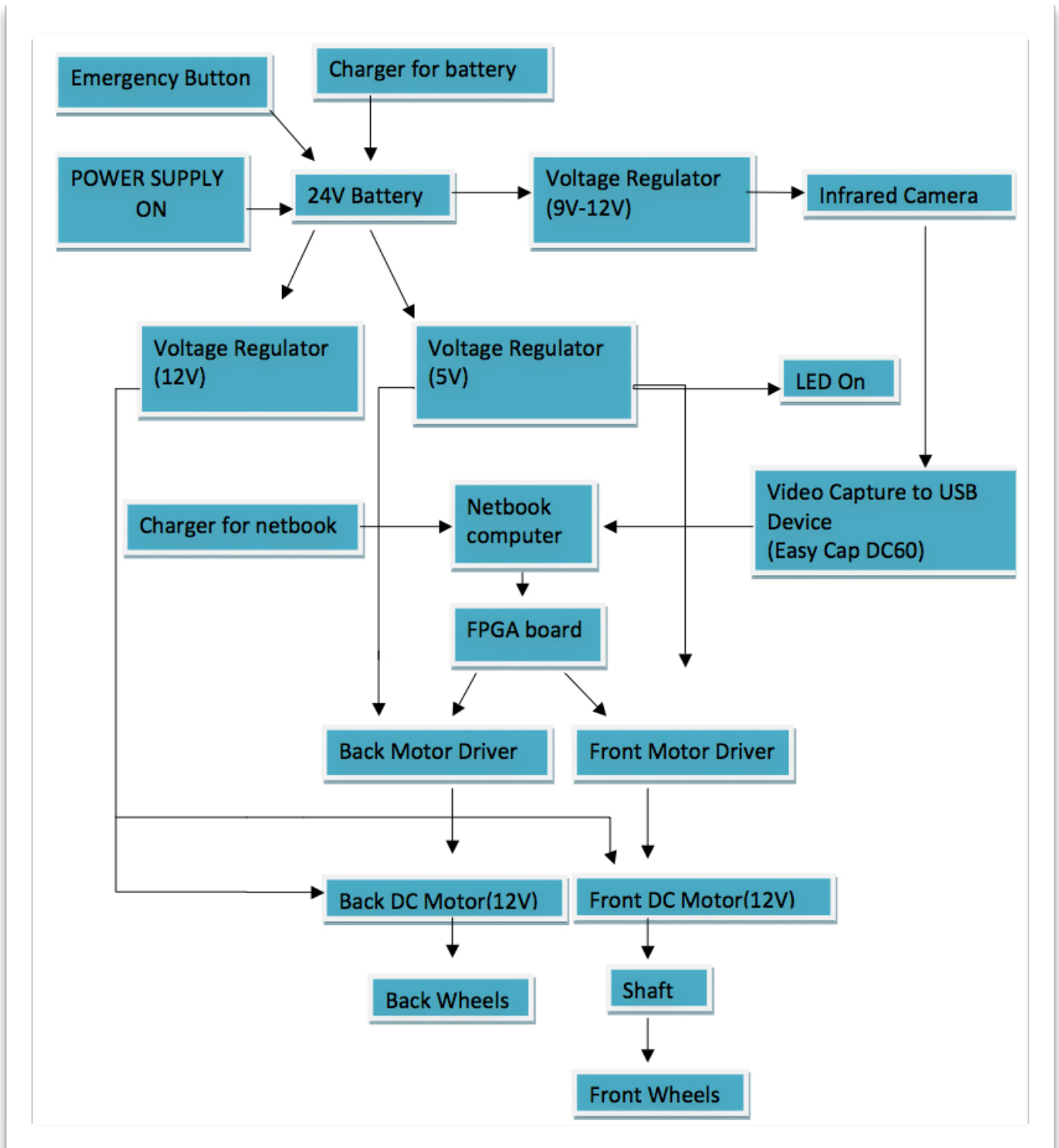


Figure 1. Main Block Diagram

Relationship Between Blocks

Initially, the system should be turned on by the user. This will let 24V battery begin to supply voltage to the system. Directly afterwards, camera starts to take frames of the pupil of eye and LED will turn on in order to show the system start its procedure. Following that part, the changes of the eye position that captured by camera will be calculated by the processor and accordingly, these calculated eye movement signals will be read by FPGA board. When FPGA analyses these signals, based on them, data will send to the motor drivers in order to make driver to move the DC motors. When the signal reaches to the DC motors, correspondingly the wheels are going to begin their movements. Front DC servo motor is planned to be used for turning right or left sides with the help of shaft so that the both front wheels move together and backward DC motor will enable the user to accelerate or slow down with respect of coming signals. There exists an emergency button that directly cuts the voltage support to the system to prevent undesired situations. There are three outputs of the main block, two of them are the DC motors and the other one is LED display, apart from this, there is just one input, which is detection of eye movements. Additionally, chargers can be also considered as input while batteries and net book computer are charging.

Interface Between Blocks

There exists a start system button that enables or disables the system complete the circuit and it will be connected to the system with a wire. When it is on, in the other words, it completes the circuit, 24V battery begins to provide voltage and current to the system. From now on, the system splits into three fields.

First of all is that since the camera needs 12V, initially one of the outputs of battery will be regulated to 12V to supply power to camera. The camera has composite output and the net book computer driver has USB inputs, therefore composite output will be transferred to USB output by video capture to USB device which is EasyCapDC60. The pupil photos will be sent to driver via USB connection and its position will be calculated there.

At the second output of the battery, again a voltage regulator will be used in order to obtain 5V so that required voltage to both the motor drivers can be supplied. How the voltage will be provided to net book is that its own battery is planned to be used for the power, so that there is no extra need to use another regulator for computer. In addition to that, a 5V LED that is attached for the user just after regulator in order to make him/her to understand whether the system is on or off will be on. When both drivers and processor have the start up energy, the communication between camera and computer begins via USB cable and also interaction between computer and FPGA will start via USB connection. When FPGA gets the essential signals for motor drivers, after it analyses them, by its I/O pins it will send data to required motor driver in order to run required DC motor. As a result signal flow of motion process is almost completed.

The last but not least part after the battery is motors that each one are 12V being directly supplied by 12V regulated voltage from the battery are attached to the wheels so as to provide motion to wheels according to the eye movements that are detected by infrared camera and afterwards executed by computer and then it gives the necessary information to both mo-

tor drivers that give orders to motors. Now, motors get the order and move respectively to the coming signal of motor drivers.

Finally there exists an emergency button that is linked with battery and is used for directly cutting the voltage support to the system to prevent undesired situations.

Technology Demonstration Test Plan

During the hardware process, we have changed technology demonstration plan several times according to the professor desires. In the below part the latest desired technology demonstration plan can be found. The schematics of our desired circuit are also provided. Proteus Isis was used throughout the simulation process.

Demonstration Plan

In the simulation, our initial purpose is that while the buttons are pressed the motor will turn correspondingly the buttons. If none of the buttons are pressed, the motor circulation signal will not be sent so that motor will just continue to turn and eventually stop by itself. This is done by using 8051 microprocessor, a L293D motor driver and some capacitors & resistors, an OPAMP, two buttons and a motor. During this process, we benefitted from our previous lecture labs and notes in our university. As a result, we have succeeded in our desired about the circuit. In order to give an example how circuit simply works, we can take into consideration a simple case. When the button 1 in the circuit is pressed once, P1.1 pin of 8051 will be triggered and this leads a signal transmission to the input of L293D first input pin. Besides these, of course the system should be supplied voltage so that 8051, motor driver and motors are “on” state. When motor driver gets signal, the motor will turn clockwise.

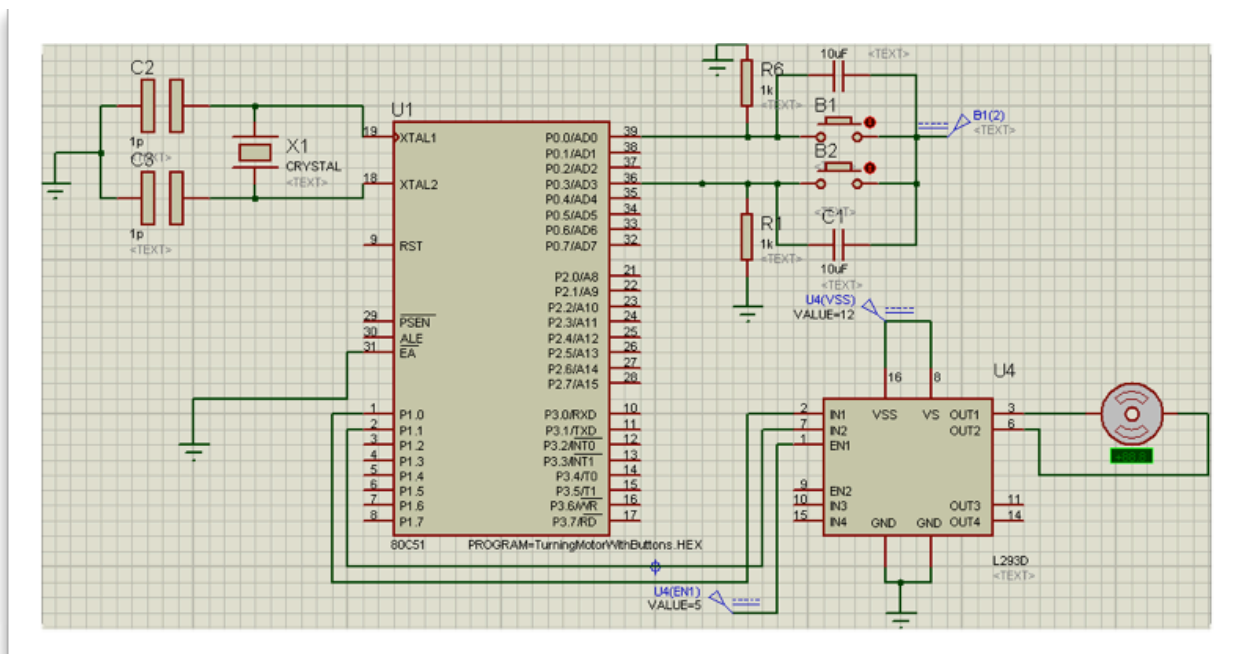


Figure 2. Main Circuit Schematic

Our previous technology demonstration plan:

- I. Connect 8051 to computer.
- II. Adjust Vcc to 5V and ground pin to ground. Check all the connections.
- III. System is in OFF state.
- IV. Load program to 8051.
- V. Press B1. Afterwards, observe motor's working clockwise.
 - A. If the button keeps pressed, there is an increase motor's working speed that means the user looks up in order to accelerate the wheelchair.

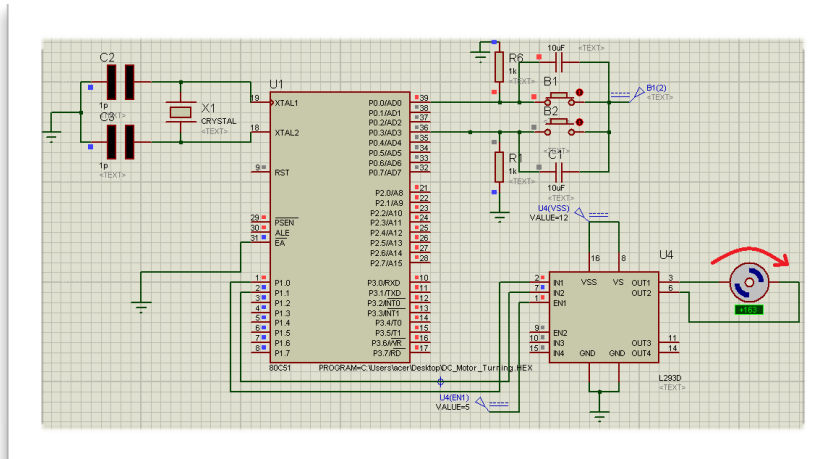


Figure 3. When B1 is pressed

- VI. Release B1.
 - A. If button keeps pressed, decrease motor's working speed that means the user looks down in order to slow down speed of the wheelchair.
- VII. Press B2. Afterwards, observe motor's working counter clockwise.

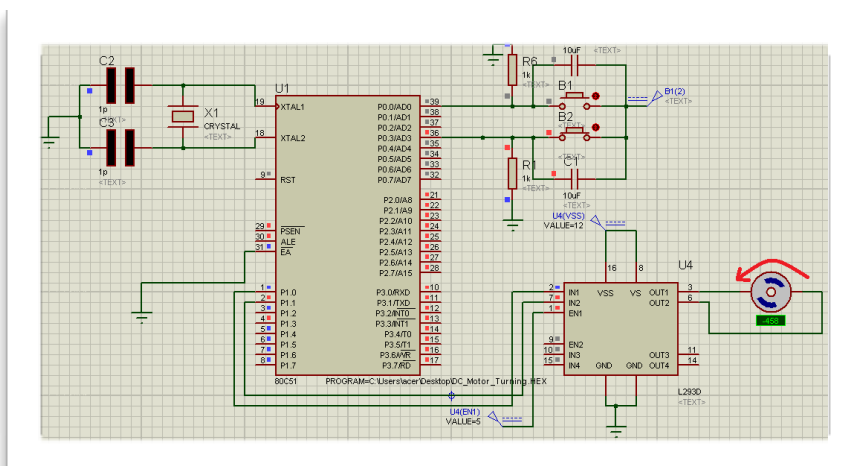


Figure 4. When B2 is pressed

- B. If button B2 released, stop the process.

What is Demonstrated

Hardware Demonstration

Unfortunately we had failed to implement our previous plan due to the problems stated in Problems part. In the latest version of our technology demonstration plan our purpose is to show that the front wheels can turn right or left based on user's control and therefore we put buttons that represents right or left. The process of what we have demonstrated in Interview III is given as following:

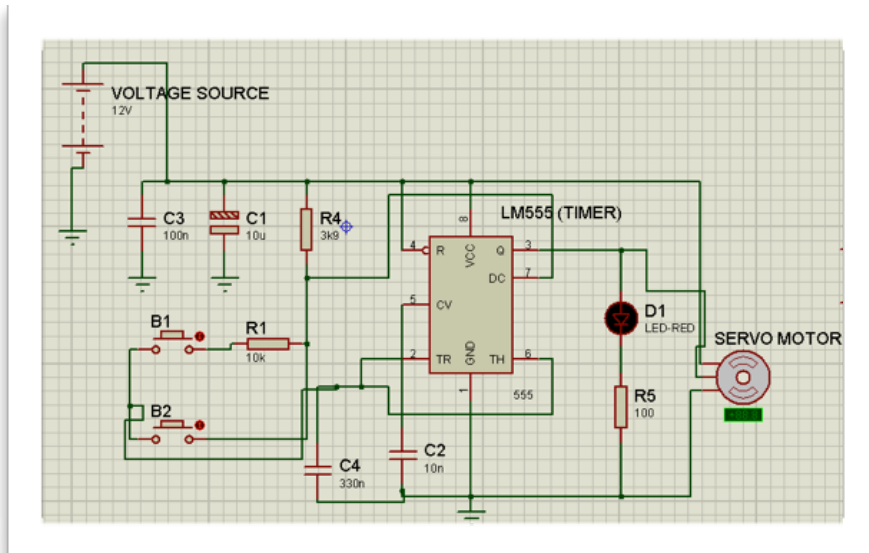


Figure 5. Final Circuit Schematic

- I. Plug in the adapter that provides 12V to circuit.
- II. Check all the connections for convenience
- III. Observe the system is on but there are no motor movements.
- IV. Press B1. Afterwards, observe motor's turning clockwise (positive side).

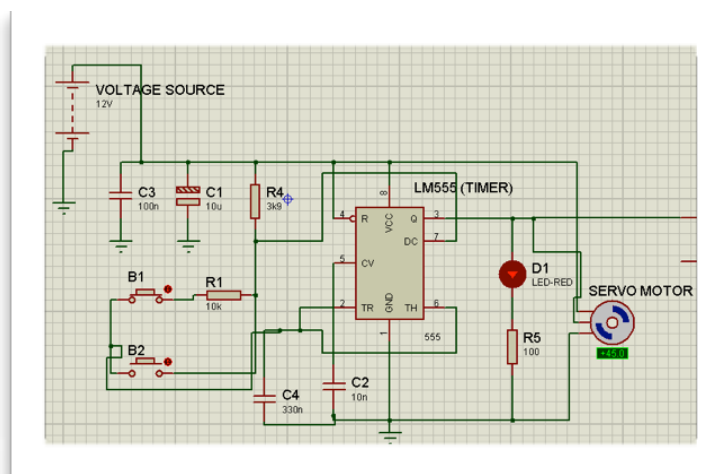


Figure 6. When B1 is pressed

- A. If the button keeps pressed, observe servo motor's keeping its turning process until 45o since this is our servo motor's max angle(+/- 45), which means the user looks right in order to turn right the wheelchair.
 - B. If button B1 released, stop turning more.
- V. Release B1.
- VI. Press B2. Afterwards, observe motor's turning counterclockwise (negative side).

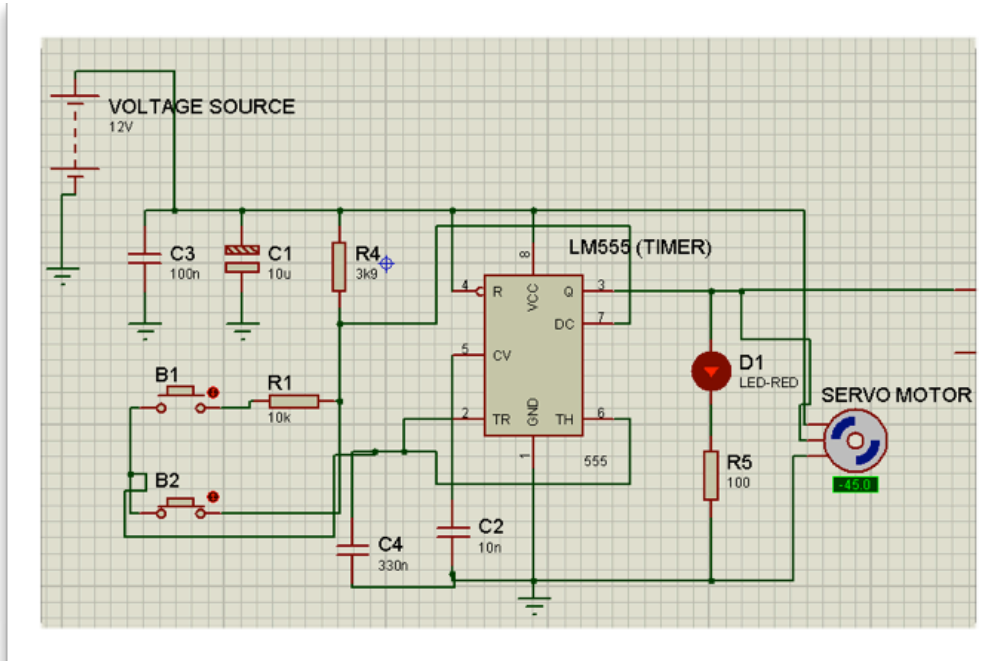


Figure 7. When B2 is pressed

- A. If the button keeps pressed, observe servo motor's keeping its turning process until 45o since this is our servo motor's max angle(+/- 45), which means the user looks right in order to turn right the wheelchair.
- B. If button B1 released, stop turning more.

Software Demonstration

We were going to demonstrate the implementation of my original design in MATLAB as the first prototype for interview 3. We thought it would be better to start testing my design correctness with MATLAB prototype before starting to implement in C. We took some pictures of Turker's eye in a format that is required for the inputs in my original design to be valid. In these pictures, his eyes look towards different directions. We took them such a way that the light and the colors are changing to make the pattern detection much harder. By doing so, we were planning to show the success of my design decisions like grayscale conversion and the area approach for circle detection in these challenging conditions. Our prototype was going to convert these images to grayscale and find the biggest circular area as indicated in the software module and task specification report. The accuracy of these procedures in identifying the eye and figuring out the direction it moved was going to be demonstrated during the interview 3.

At this point, we decided not to demonstrate my software with the real time images taken by a camera since this required very detailed synchronization between the software and the frequency which the images was going to be taken.

Finally, we showed the exactly same prototype that we described in the Progress Report 2 technology demonstration test plan part. We also added real time motion detecting to the original plan and showed the direction of the eye on the screen.

Test Results

Hardware Test Results

Since technology demonstration test plan has been changed compared to the plan in Progress Report II, in this part the test results of latest version will be investigated. At the demonstration, our major purpose is to run the motor and that's what we have achieved. The circuit schematic is given below figure.

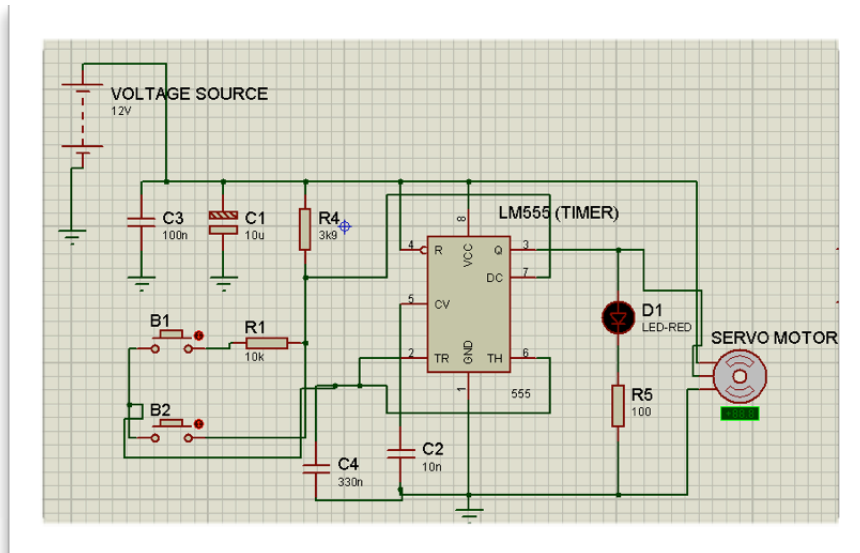


Figure 8. Main Circuit Schematic

The reason why we have used LM555 timer is that, when our researches are taken into account we have observed that in order to run servo motor, it works with pulse width modulation so that we have decided to provide PWM by LM555. To see whether LM555 output gives us square wave signal we put an oscilloscope as in below figure and then test its output signal. This is initially checked in our simulation before implementation of the circuit on the board.

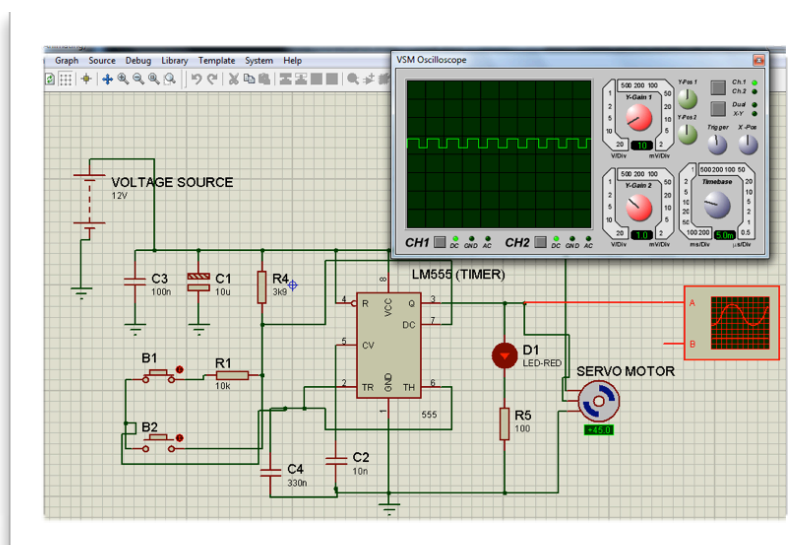


Figure 9. Simulation Scope of Circuit

As it can be seen in the above figure, when VSM oscilloscope screen is taken into consideration, we have successfully created our pulses. Additionally there is a LED in the circuit at the output of third pin which is output pin of LM555. In each high voltage LED turns on and for per low voltage it turns off so that we enable pulse signals in an effective way for the user. During the real life demonstration, again we check the pulses from the oscilloscope in the lab, this figure is stated below.



Figure 10. Scope of Circuit

Software Test Results

The program worked perfectly in the final interview. It managed to take the test inputs that we mentioned in the progress report 2 and detect the direction of the eye. Showing the direction of the eye were added as an extra feature to the original prototype plan and this mechanism worked also worked perfectly. It showed the direction of the eye and where it moved very successfully. Here is some screenshots of the outputs that the software gave:

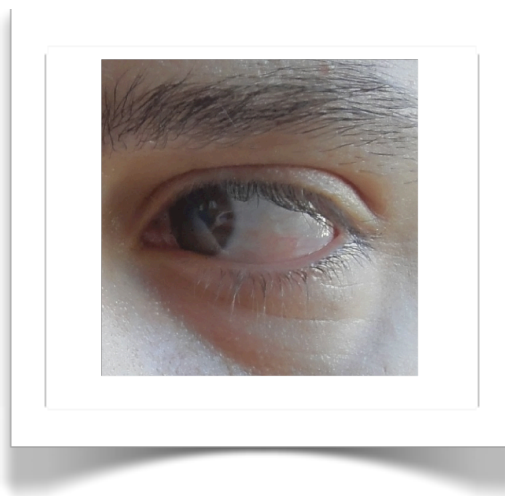


Figure 11. Eye Looks Left

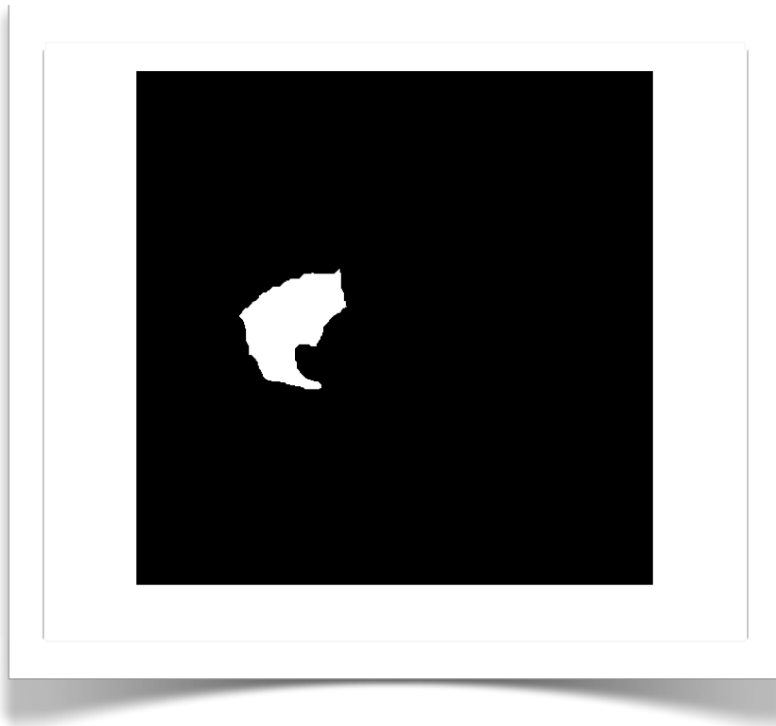


Figure 12. The image matrix output to the first input where the eye were extracted and showed as white

In the main screen of the MATLAB, the output saying "The eye is located at the left" were given after the comparison of the coordinate of the eye with the calibration value. This calibration value is taken at the initial step of the program when the eye is located at the center.



Figure 13. Eye located center

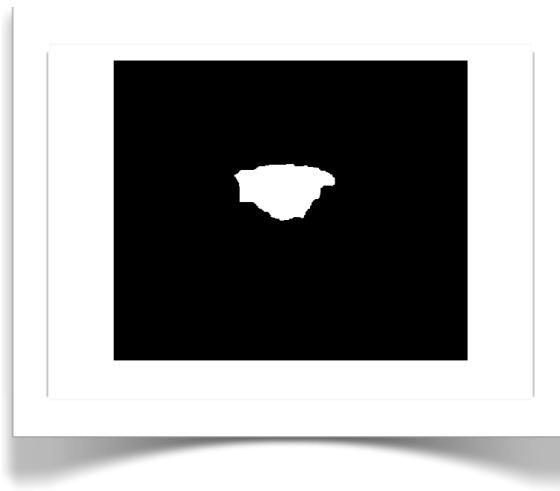


Figure 14. The image matrix output to the second input where the eye were extracted and showed as white

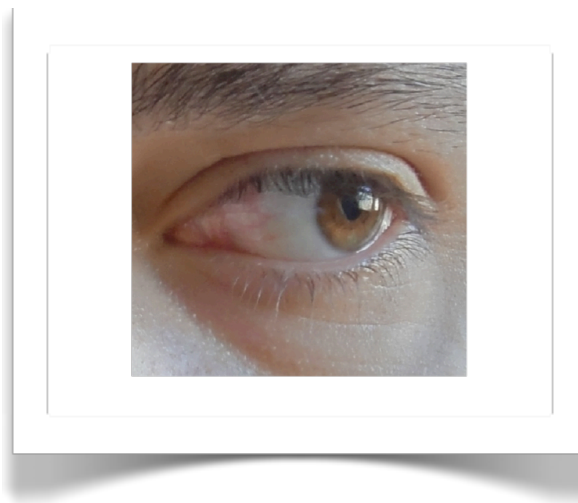


Figure 15. Eye looks right

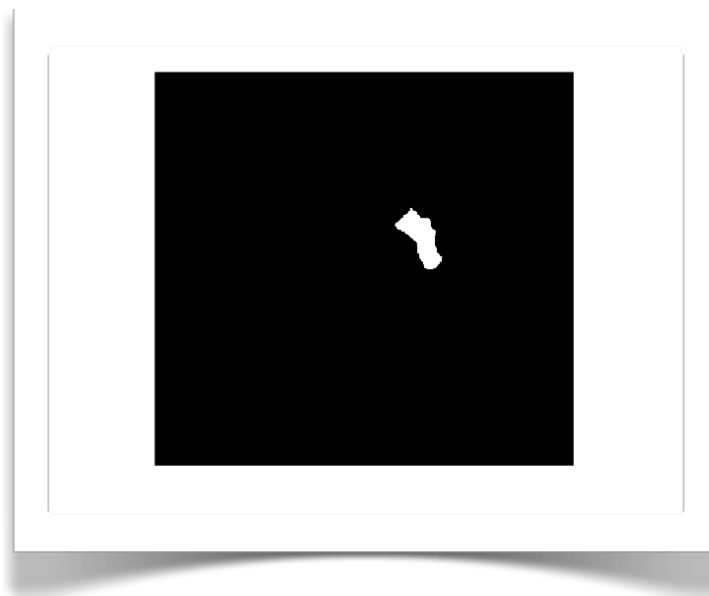


Figure 16. The image matrix output to the third input where the eye were extracted and showed as white

Problems

We have faced loads of problems during the process of developing the prototype. We have created a circuit for Technology Demonstration Test Plan as stated before and below.

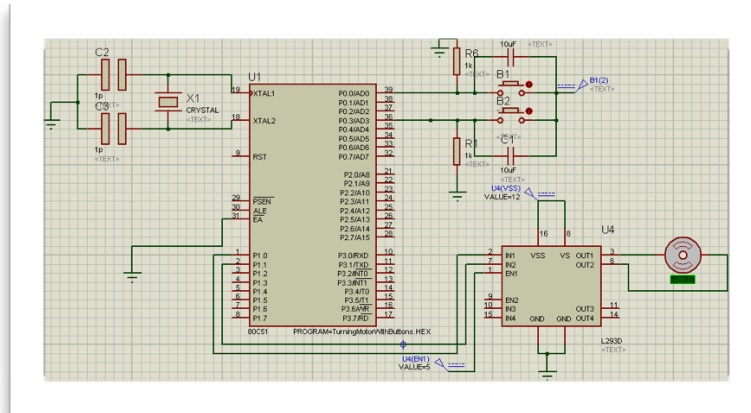


Figure 17. Previous Technology Demonstration Test Plan Circuit

This was perfect for the simulation since we were able to do both implement 8051 and turn motor respectively. Nevertheless, we were unaware that in order to run dc servo motor in real life it requires PWM, therefore we had to also implement a timer in 8051. Unfortunately, we had already spent too much time on creating the circuit in a perfect way and caught unprepared on how DC servo motors work, due to time limitation we had to change our whole plan in order to prove that we have the capability of running DC servo motor. In addition to that, we have also failed to implement assembly code for writing PMW with 8051 timer due to the fact that we had to study microprocessor lecture again in a short time besides our intense lectures, but we could not have managed to write sufficient assembly code.

As a result we had started to check our chances to create whole new circuit with basic components just to show that we have the capability of work with motors. Therefore, eventually we have come up with the circuit as shown below.

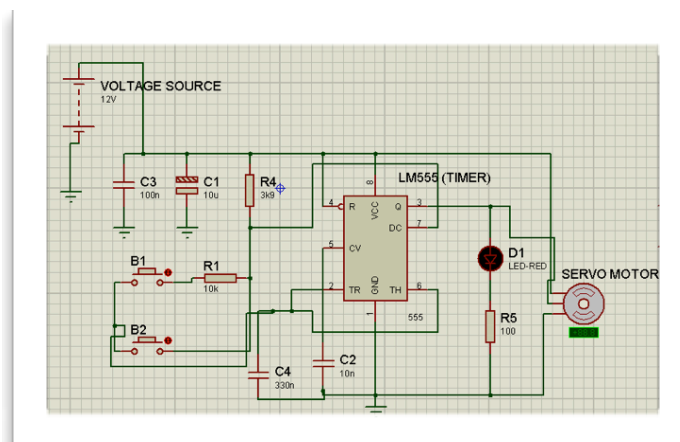


Figure 18. Main Circuit Schematic

The objective is to provide the required PWM to motor by using L555 and run dc servo motor respectively. During the process of creating this circuit we had faced with several issues that are stated in a detailed way in the following.

Corrections Made

We have tested our circuit and it has worked properly on simulation. However, real life application cannot be the same as simulation. When we first constructed the circuit it didn't work. We have changed C4, which set the frequency of servo motor turning, numerous times. Finally, we have decided to use it as 220 nF, but after construction it can be clearly seen that more than 220 nF capacitor is more accurate for the circuit. Thus, we added a parallel 100 nF to C4 and our motor's turning frequency becomes more appropriate.

Discussions

Our very first aim was to complete the prototype by using a DSP card, which was going to deal with reading the data taken from camera, comparing these data with previous ones and determining the action that will be performed by motors. After making detailed researches about DSP cards, and trying hard to design a simulation and implement it into the design, we found that we had to deal with programming part, which we needed to spend so much time and effort on it. Besides this it will be unnecessarily expensive to work with a DSP card. Therefore, we discussed the issue with Prof. Tark Reyhan and by inspiring from his ideas, we came to the conclusion that it would be better and convenient for us to change our DSP card with a 8051 FPGA, which we were much more familiar with. After making researches about how we can implement 8051 to our design, as shown in the demonstration part, we were able to draw our prototype's simulation, which was working as intended. After this, we needed to write the codes in assembly language which will provide 8051 to realize and take specified actions when we press buttons. We tried to make use of the knowledge based on microprocessor lecture, however, unfortunately, we failed to write a working code, because of the limited time we had. Therefore, we wanted to find some other ways to make our design work. We considered using PIC microcontroller instead of a 8051. However, we also had to write codes for motor drivers which was going to provide our motor to turn left/right properly. However, we couldn't write a working code that performs the action we want. In our previous researches, we had found out some examples regarding to servo motors driven by LM555 with a simple logic which is explained in test results part of this report. We knew we had to show a working prototype for our demonstration, therefore we didn't want to waste more time on trying to figure out how to fix the problems, we encountered with 8051 and PIC. Therefore, we decided to use LM555, and after some research we implemented it to our design. By using trial and error method for the values of our capacitors and resistors, we tried to configure the working frequency of the servo motor and find the best calibration that makes it work properly.

Conclusion

As a conclusion, we are at a different point where we plan to be in the beginning of the project. This is because there were many things that we didn't take into account while we were designing the project. The most time consuming issue was that we tried to create our first design with a DSP card, and we had no clue about its working process. Therefore, we did too many research about how it works and how we can implement it to our design. After coming to the conclusion that it will be expensive and much more harder to use DSP card, we tried to find other ways to do it. However, we spent too much time while trying to find out what kind of a card or microcontroller we could use to make our system work properly. While considering to change the hardware parts and trying to create a new design to implement them to our system, we had very limited time to write codes for the microcontroller and motor driver. Because of all these problems we encountered so far, we had to complete our prototype with much more simpler way than we have been considering during the semester. We think, we could come up with a better design and complete the prototype by using 8051 or PIC and present it with a much more satisfactory way, if we didn't deal with the issues that are mentioned about DSP card for most of the semester. For the next semester, not to encounter with unexpected problems that we did, we will make a better plan and organization for the process that we will be going through, so that we will come up with a much more better and successful product when we complete the whole project.

The software prototype were programmed completely and worked perfectly in the interview. Design decisions taken for the software were proven to be correct and the only task left for the second term is to implement the MATLAB prototype in JAVA. There may be some complications during the process but we believe that we will also overcome those.

Appendix

Software Codes

```
a = imread('deneme
sag.jpg');

    figure;imshow(a);

    thr = 60;

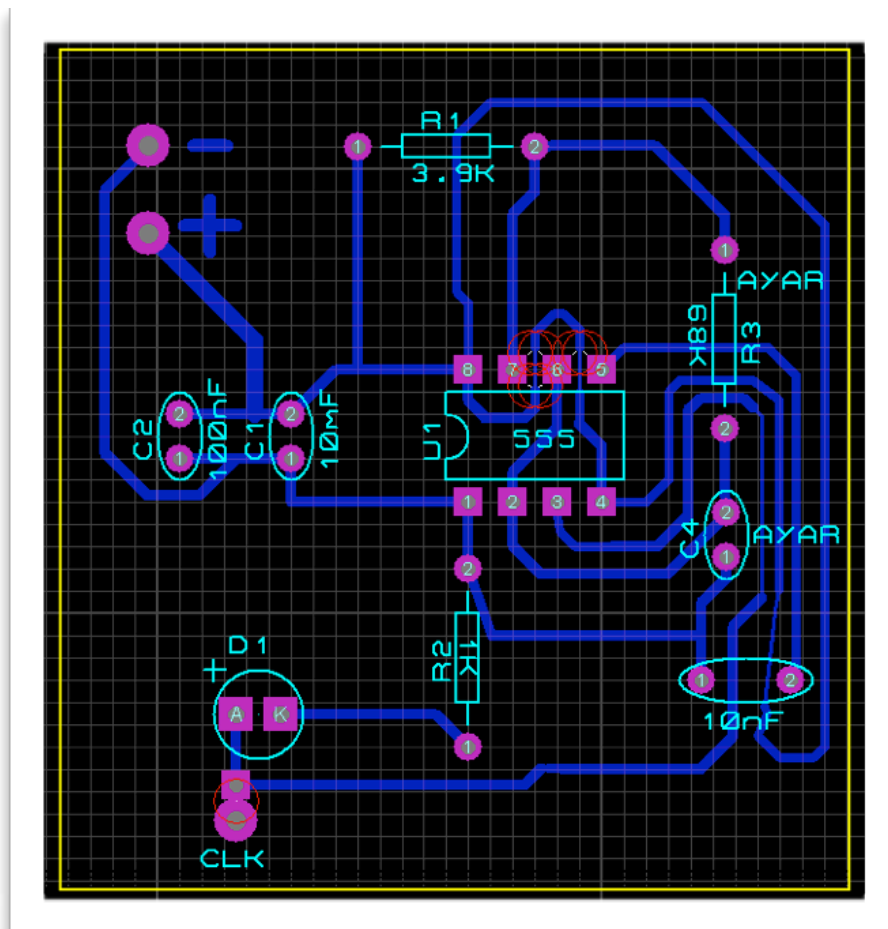
    [dx,dy,dz] =
size(a);
    b = zeros(dx,dy);
    for i=1:dx
        for j=1:dy
if((a(i,j,1)<thr) &&
(a(i,j,2)<thr) &&
(a(i,j,3)<thr))
b(i,j) = 1;
                end
            end
        end
    end
    cn = bwlabeln(b);
    figure;imshow(cn);
    maxNo =
max(max(cn));

    areas = zeros(max-
No,1);
    for i=1:dx
        for j=1:dy
            if(c-
n(i,j)>0)
areas(cn(i,j)) = areas(c-
n(i,j))+1;
                end
            end
        end
    end

    [maxM, indM] =
max(areas);
    myEye = (cn==indM);
    myEye = im-
fill(myEye, 'holes');
    se = strel('disk',
10);
    myEye = imdi-
late(myEye, se);
    myEye = imero-
de(myEye, se);
    figure;im-
show(myEye);
    massX = 0;
    massY = 0;
    counter = 0;
    for i=1:dx
        for j=1:dy
            if(myEye(i,j)==1)
massX = massX + j;
                massY =
massY + i;
                counter
= counter + 1;
            end
        end
    end
    coordinateX = massX/
counter;
    coordinateY = massY/
counter;

    intCoordinateX =
cast(cordina-
teX,'uint32');
    intCoordinateY =
cast(cordi-
nateY,'uint32');
    if(intCordina-
teX<253)
        disp('The eye
is located at the left');
    end
    if(intCordina-
teX>253)
        disp('Goz
Sagda');
    end
    if(intCordina-
teX==253)
        disp('Goz Or-
tada');
    end
end
end
```

PCB Layouts



Mechanical Drawings

