

MIDDLE EAST TECHNICAL UNIVERSITY NORTHERN CYPRUS CAMPUS ELECTRICAL AND ELECTRONICS ENGINEERING PROGRAM

$\mathsf{EEE}-400$

Summer Practice Report

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Company name: Arçelik **Company division:** Household appliances company **Company location:** Sincan – Ankara

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1.INTRODUCTION

I got the chance to do my internship in Arçelik which is one of the biggest companies in Turkey under koç group and I was able to work in R&D department on one of the projects that have been hold for us to do. Also, the internship was in a dishwasher planet in Sincan-Ankara. I started my practice on 27th August and finished on 21st September. The main purpose of my internship was to understand and visualize the concepts and the work of engineers. Moreover, this internship was important for me to know what R&D departments do and how do they deal with the problem that they receive and how do they solve them.

I wrote this report while doing my internship and it explains all the details that I have learned and all the observation and work that I have done so far. In this report I started with showing the information of this company then with weekly description of the work that I pursued and ending the report with a conclusion that summarize what I have done followed by the references. Furthermore, I had a partner in my project from Bilkant University who finished his second year and he is called Amir.

2. DESCRIPTION OF THE COMPANY

2.1 - Company name

Arçelik Household appliances company



2.2 - Company location

Ahi Evran Mahallesi, 06930 Sincan Osb/Sincan/Ankara Tel: (0312) 589 20 20

2.3 - Brief history of the company

Arçelik is established in Sütlüce in 1955 by Mr. Vehbi Koç and it started producing the first washing machine in Ankara in 1959. Ankara dishwasher production plant begins production in 1993. Arçelik launches its new washing machine, 8124 HST Economist, which consumes 50% less power than A energy class.[1]

2.4 - Main Area of Business

Arçelik is a company specified in household appliances such as dishwasher, washing machine, refrigerator,...ets.

2.5. Organizational Structure of the Company

In **Fig.2.1**, it is shown the structure of the worker in the company in which each team has a team leader and above that comes the departmental senior manager and so on.



3. FIRST WEEK

3.1 - Safety Rules and Receiving our Equipment

In the beginning of the first week we got a session about safety rules and how to work in the factory field, and they explained how to deal with emergency situations such as fires and gas leaking. Also, there was a device that measures the electrostatic over the human body to prevent any danger that it might cause for the worker inside and outside the factory. Moreover, we got our shoes which is made specifically for the worker in the factory field to protect the foot since it's padded with metal from inside. By time basing, they prepared for us our laptops and ID cards, so it can make our work much easier while doing the internship. Furthermore, we got the chance to see the factory from inside and following the production line of dishwasher machine and then we went to the lab where they test the machines and improve their efficiency.

3.2 - Problem and Project

After having a walk in the factory and watching the production line, engineer Faruk suggested for us to improve the buttons panel testing process as it was done manually, and the project purpose is to improve it and make it automatic.

The testing process was simply having the buttons panel and the worker checks the LEDs and buttons' capacitors one by one manually. As it shows in figure below where I was testing the panel manually and check whether it is working or not.



Fig.3.1

Fig.3.2

In **Fig**.3.1, I was checking the buttons and pressing all of them and in **Fig**.3.2, the results appear on the computer to give either pass or fail. Regarding the LEDs, it is something back to the worker to decide if they are working or not which shows that there is a present of error.

Simple explanation about the general idea of our project:

The project is exactly having the panel, then applying a pressure on it to check the capacitors behind the buttons and then taking a photo for the LEDs and applying some image processing method to check them and give a result about either it passed or failed.

Furthermore, according to the company calculation, this project is mainly useful in saving extra time to produce more unit which will increase the productivity of the company. In other words, normal worker will take in average 30 seconds to check the panel, but with this project it should abate to 12 seconds per unit and that means 2.5 times faster than before.

3.3 - Researching and Building Background

Since it is a new idea provided by the R&D team so nobody has an idea about how to make the project and how to build it but they helped us in the technical information and provided for us all the required components that we asked for, and that's why we started researching and learning how to build the code and the prototype.

As far as I went in searching and learning, I learnt new things about how to deal with the images and how to work on them.

After a week of searching and building our background, we found out that the best language to use is MATLAB as it is easier to use, and it supports building an interface which we used to make a guide for the workers. Also, there are a lot of functions which are predefined in the libraries of the language that supports image proceing. That was the part related to the LEDs functioning test. Regarding the buttons functioning test, we decided to use a hydraulic motor after finding that the lab has an air compressor which will work perfectly with our motor, which we are going to use the air pressure to push a long metal through our hydraulic motor so that the buttons will be pressed to check if they are giving signal or not.

Fig.3.3 shows the panel that we were testing through our prototype.



4.SECOND WEEK

4.1 – Building the Code

As a new user of MATLAB language, it was difficult to work on it first but by time I knew the basics through online course provided by MATLAB itself and later I started working on the coding part of the project.

The process was going through specific steps which are ordered like that:

- 1- Taking photos for the panel when it's on and off
- 2- Subtracting the two images
- 3- Transforming the RGB image to grayscale image
- 4- Finding the bright spots in the image
- 5- Centroiding the spots
- 6- Counting the number of the spots
- 7- Check the testing data with the predefined one to specify either pass or fail

For taking photo part, we were using a full HD webcam **Fig.**4.1 provided by the lab engineers to use it for the project. Moreover, we add extra layer atop of the lens of the camera as shown in the figure, so it can reduce the intensity and brightness from the surrounding area.



Fig.4.1

In the first part of the process, the camera take three different photos for the panel where it takes a photo when the panel is off (**Fig.**4.2), when the LEDs are on (**Fig.**4.3), and when 7 segment LEDs are on (**Fig.**4.4) and according to the code the camera should operate after sending a command to the panel to turn on which part of it.



Fig.4.4

This is the part of the code that does the previous process

```
tempTypeOn(:,:,3) = 0;
end
                                                Seven Segment Code
%Led Off Code
ledalloff = [2;0;0;0;3];
                                                pause(4);
fwrite(s,ledalloff);
                                                %Led Off Code
pause(2);
                                                ledalloff = [2;0;0;0;3];
takephoto('temp off',1);
                                                fwrite(s,ledalloff);
tempTypeOff = imread('temp off.jpg');
                                                pause(2);
tempTypeOff1 = tempTypeOff;
                                                takephoto('temp_off_1',5);
tempTypeOff(:,:,3) = 0;
                                                tempTypeOffl = imread('temp off l.jpg');
%Led On Code
ledallon = [2;1;0;0;3];
                                                sevensegmentallon = [2;0;0;1;3];
fwrite(s,ledallon);
                                                fwrite(s, sevensegmentallon);
pause(2);
                                                pause(4);
takephoto('temp_on',1);
                                                takephoto('temp sevensegment',5);
tempTypeOn = imread('temp on.jpg');
                                                sevensegmentpic = imread('temp sevensegment.jpg');
tempTypeOn(:,:,3) = 0;
```





In the second part, the three images are subtracted from the image when it is off, so that the background will be totally deleted from the new photo which will leave us with the LEDs. By using SUBTRACT function, we got figure **Fig.**4.5. Then we apply the function that change the properties of the image to become grayscale which is in figure **Fig.**4.6, so we can use the centroiding function that will specify the spot of light according to a specific threshold.

The threshold is specified to be bigger than 200 for a pixel for each layer because as it is shown in **Fig.**4.5, we might have different LEDs color. So, in the code, the image is divided to (Red,Green,Blue) layer and checked separately.



The code that's used to proceed those steps is shown below.





The for loop that's shown in **Code**.4.3 is marking the centroid of the 7 segments LEDs with a red star, and for the other LEDs, we made a different part of the code that saves the coordinates of each centroid point and then marking them with a blue star which is shown in **Code**.4.4,so that all the LEDs will be shown in one final photo for authenticity as shown in **Fig.**4.7. In addition to that, **Fig.**4.7 shows that even sloped photos won't be a problem as well.







Regarding the 7 segments LEDs, it wasn't easy to detect each segment and to mark each one of them, so we added extra filtering to the image after cropping each segment so that the holes between each segment will be clear and enough to specify each one with its mark and its centroid.

In other words, we added some adjusting functions to the code, so it can clear the small unnecessary light in the background. **Fig.**4.8 shows one of the 7 segments after applying the filtering and adjusting to the image.



Fig.4.8. (*) star symbol refers to the centroid of each segments.

5.THIRD WEEK

5.1- Building the GUI (Graphical User Interface)

After finishing the part that's related to the code, it was necessary to build a GUI that will make our code useful and easier to use for the workers who are our users of the project. Moreover, it was an essential point to add a part of the GUI that will allow the user to add a new model of the panels other than the one that we were working on. The interface mainly consists of two parts: testing and adding new model. Also, we used Turkish as the main language in the interface since all the users are Turkish speakers, but it has the feature of using different language as well.

Fig.5.1 shows the opening page of the GUI which include the company logo with the two buttons which indicate new test (on the left) and adding new model (on the right).



Fig.5.1

5.1.1 – New Model

As it was shown in **Fig.**5.1, when you press the new model button it goes you to a different window where you can add specific details related to your unit or your panel board. As it is shown in **Fig.**5.2, which is Adding New Model window, there are four essential information about the model should be filled in their boxes.

Model \rightarrow The model's name or number

- LED \rightarrow Number of LEDs
- Button \rightarrow Number of push buttons
- Saat \rightarrow Number of 7 segments LEDs

New			- 🗆 ×	
Model	LED	Button	Saat	
	Kaydet	Çıkış		

Fig.5.2

After adding the specified information, you have the choice either to cancel or to save the data.

5.1.2 – Database

I mentioned earlier while explaining the process of testing and applying image processing that inside the code, it compares the information that it receives from the test to a predefined data. From this point, we build a database to be used as a reference for any other test, and the database file is connected directly to the Adding New Model window so whenever we press save, it saves the data in a file referred by the name of the model as shown in **Fig.**5.3.



```
function pushbutton4 Callback(hObject, eventdata, handles)
% hObject
           handle to pushbutton4 (see GCBO)
 eventdata reserved - to be defined in a future version of MATLAB
 handles
            structure with handles and user data (see GUIDATA)
modelname = get(handles.editl,'String');
led = get(handles.edit2,'String');
sevensegment = get(handles.edit3,'String');
buttonno = get(handles.edit5,'String');
fileID = fopen('modelname.txt','A');
fprintf(fileID,modelname);
fprintf(fileID,',');
fprintf(fileID,led);
fprintf(fileID,',');
fprintf(fileID, sevensegment);
fprintf(fileID,',');
fprintf(fileID,buttonno);
fprintf(fileID, '\n');
fclose(fileID);
f
 = msgbox('Kaydedildi');
```

Code.5.1

Code.5.1 is showing the part that's related to building database file where we specified the variables which each one of them correspond to the boxes that mentioned earlier. Then it will be stored in the way that **Fig.**5.3 shows.

5.1.3 – Testing Part

Now after having a reference model with all the related data saved in the database file, we can go and apply the testing part to analyze and compare the information and to decide if the unit that has been tested passed the LED functioning test or not.

The window of the testing part consists of big screen that shows what the camera can see which I will explain later how we connected our webcam to the GUI. Also, there are multiple buttons used to operate according to the choice of the user as shown in **Fig.**5.4.

Do The Test (Test Et) \rightarrow The button on the left

New Test (Yeni Test) \rightarrow The button in the middle

Exit (Çekiş) \rightarrow The button on the right

And going to the most important part of this window is the slider which shows the devices that you have which are saved to use the specified model as a reference. In **Code**.5.2, it shows how through the testing process, it takes the saved values from the database of our reference model.

Test						- X	
Test							
			eco or				
	_						
Modeli Seç E9 Testi Geçen S	Sayısı	 Static Text 	Test Et	Yeni Test		Çıkış	
Testi Geçeme	eyen Sayısı	Static Text	Dokunmatık	BEKLE	LED	BEKLE	
			Durum	BEKLE			
Fig. 5.4							
	axis of %A is global %Getti fileII A = te fclose %Initi set(ha % Upda axes(h %Start TurnOr guidat	off dummy vari l A; ing Data fr D = fopen(' extscan(fil e(fileID); iating popu andles.popu ate handles handles.axe t Live vide hLiveVideo(ta(hObject,	able for getting d om Database database.txt'); eID,'%s %s %s %s', pmenu pmenul,'String',A{ structure s1); o handles) handles);	atabase 'Delimiter', 1});	',');		

Code.5.2

We added also extra feature for more productivity and accuracy which is a counter that counts how many panels passed the test and how many failed and it shows the results next to each word that refers to the corresponding part of the test.

6.FOURTH WEEK

6.1 – Button Functioning Test

In the last week, we were left with the button functioning test which is the part where we need to check the capacitors of each buttons in the panel if they are working or not. The idea behind this test to be automatic was simple, which we used a metallic piece that will apply a pressure on the panel and the internal chip is connected to the microcontroller that will receive a signal from each capacitor, and as before, it will count the number of working buttons and compare it with a reference value of the model. You can see in **Fig.**6.1 the microcontroller and the metallic piece.



Fig.6.1

After that, we connected our hydraulic motor with the metallic piece, so that it will be as a compressor device which will compress the metallic piece to the panel. In addition to that, we wrote a code that will send a signal to the motor to operate according to our requirement so that we connected it with the microcontroller as well. **Code**.6.1 is the code which it controls and sends order to the motor to operate, and for collecting the capacitors signal, **Code**.6.2 shows this process. Also, to count the number of working buttons, we wrote a code that uses the previous part to specify how many buttons are working to compare with our reference as shown in **Code**.6.3.

```
%Motor Code
motoron = [2;0;1;0;3];
fwrite(s,motoron);
pause(3);
```

```
motoroff = [2;0;0;0;3];
fwrite(s,motoroff);
pause(3);
```





Code.6.2

Code.6.3

6.2 - Building the Prototype

In the end of all that work, we came to build our prototype, so we collected the components and connected them, so it became visible and clear for the engineers.



Fig.6.2

As shown in **Fig.**6.2, we used a wooden base to adhere the components with it. The motor is connected to a constricted air through blue pipe, and what makes the motor operates is the transformer that's being controlled by the microcontroller which has the process code. For the camera to detect the panel's LEDs and avoid all the other materials in front of it, it was put in a higher spot.

I went to the laboratory to check our panel and to see how it works with the dish washer machine as shown in **Fig.**6.3. Furthermore, **Fig.**6.4 shows the time when we were building our prototype and connecting the cables.



Fig.6.3

Fig.6.4

6.3 – Challenges

In this project, we faced two main problems, which is the ambient light and the camera vision.

Since our project was image processing and machine vision, we went through some specification to predict perfect photos of the panel to test. **Fig.**6.5 shows one of the taken photos to test and after subtracting function, the new image as shown in **Fig.**6.6, shows the ambient light which makes copious number of spots of light that are counted in our detection. To solve this problem, we added a filter on the surface of camera's lens as shown in **Fig.**4.1, and to cancel the background lights; we put very black plate in the back, so it absorbs any reflection.



Fig.6.5





The second problem was detecting the 7 segment LEDs with the edges between each segment. Simply, because of the intensity of light, it was difficult for the camera to detect the edges, so the addition that happened previously decreased the difficulty but still it wasn't enough, so we changed the camera setting to increase the concentricity on the 7 segments LEDs when the code is working on that part. So, the result, after changing the setting and fixing it, is as shown in **Fig.**6.7.





Fig.6.7

6.4 – Presenting the Project

In the last two days, we presented our project to the department manager and our supervisor with a group of engineers. Also, we suggested some improvement that can be added to our prototype to make it more efficient such as:

- Using professional camera or multiple camera.
- Designing additive part for connect power automatically without any need for a worker to connected with the supplier.
- Automatic sticker stamping to identify the working and non-working units.

In this link you can find how is the worker are checking the panel manually in a different part of the factory from where we tested:

https://www.youtube.com/watch?v=ks1-JqwwzRk&feature=youtu.be

In this link, you will find a video that shows the whole process of testing the units:

https://www.youtube.com/watch?v=Q14jr8YirEc

7-CONCLUSION

Overall, I had a new experiance of working in a very known company in turkey which is Arçelik, and I did a project that made an effect to the production line. Me and my partner were working on that project for the 20 days of the internship and it was focused on improving the test process of the button panels to switch it from manual to automatic process and to reduce the time that it takes to finish the test. We had a dish washer buttons panel to use and test our project on it. So, we used MATLAB language to code our project which made it easier to implement and use. We started with building our knowledge and background about the project that we wanted to do after suggesting the engineers to do it and we learnt the basics of using the new coding language.

Our prototype consists of a hydraulic motor that's attached to a metallic piece to act like a compressor and the motor takes the energy that gets normalized after passing through the transformer which is connected to the microcontroller. Moreover, there is our panel that we want to test which is connected as well to microcontroller and facing to an HD Webcam.

The function of the project is simple and can be split up in two main tasks, the Buttons Function Test and the LEDs Function Test. After building a GUI that simplified the test task to be only pressing keys, the test start after pressing do the test on the interface which will go to the code to compile it and what it do is sending commands to the camera to take 3 photos of the image which they get filtered and processed to give a final image that includes only the LEDs labeled with a star to indicate how many of them in the image and compare it to the reference information which is predefined to specify either it passed the first test or not. Then it proceed to the next task which is finding if the interior capacitors of the buttons are working or not by sending an order to the motor to push the metallic piece which in return it apply a pressure on the panel, so that the capacitors will be constricted and through the connection between the panel and the microcontroller we observe the change in voltage of the capacitors and count how many of them is giving changing signal to specify if it passed the second test or not. Comprehensively, if the unit didn't pass the previous 2 tests, then it will be thrown away and marked as failed unit. Later on, we presented the project to the department and explained its function which abridges my work in that 20 days.

References

[1] Arçelik webpage, History. Sited from : http://www.arcelikas.com/page/76/History

[2] MathWorks, File Exchange, 29 Sep. Image Manipulation Toolbox.

[3] MathWorks, Documentation, 2017. Centroid Function.