

Internship Final Report: Part II

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Abstract

I have worked on two different departments of ABB. Firstly I was in the Dilovası fabric which produces transformers and transformer core. My project was to work on automatization of the machines and work on the overhaul of them. Secondly, I have worked on the Dudullu Fabric which designs and implements robotic systems for other companies. My project there was to create an android app that enables the user to control the robot from the phone and take data from it.

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Introduction

This report includes brief information about ABB and ABB Turkey. In the process of my internship, I have worked in two different departments of ABB Electric and I have been assigned to two projects. Both of these departments and projects will be explained in detail.

First part of the internship was in the fabric of ABB which is in Dilovası. This department produces transformers and transformer cores, moreover works on the overhaul of the machines that are used on this production. The area of transformer production is one of the most common factory field of work, especially in Turkey. This is why being able to examine transformer production and working on its overhaul was really important experience for me. In addition, error debugging of big factory machines and being able to understand their working principles will help me after school during my career.

In the second part of my internship, I have transferred to the Dudullu Fabric of ABB which works with ABB Robots. In this department, project of Robotic Systems are designed and generated for other companies, moreover service and overhaul of Robots and Robotic Systems are done. Since robots are used in every area of industry and in everyday life as well, doing my internship in a robotics factory was a big luck for me. In this part of my internship, I was able to compound both my software and mechanical knowledge. Moreover, I significantly increased my knowledge about Android and Java. In addition, I was able to work with different kinds of robots, which I will explain later in this report, learn how to use them and understand these robots working principle.

Company/Institution Background

ABB Elektrik Sanayi A.Ş.

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Dudullu Factory – Dudullu Organize Sanayi Bölgesi

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Dudullu: +90 216 528 22 00

Web Page: <https://new.abb.com/tr>

ABB (**ASEA Brown Boveri**) is a Swedish-Swiss multinational corporation. ABB took place form coming together of ASEA and BBC(Brown Boveri) firms in 1988 which were best known names of electrical engineering history in Europe. ABB employs 160.000 people around the world. ABB works for community, industry, transportation and infrastructure sectors and provides service on power network, electrification products, industrial automation and robots and motion areas.

ABB Turkey has production facility of 50.000 m2 on Istanbul, Kocaeli, Ankara, Izmir, Bursa and Adana with 1690 employee and exports to more than 70 countries. Starting from 1965, ABB Turkey has produced power transformers and supplied energy to 50 countries around the world.

ABB Turkey produces products such as motor drivers, transformers, Solar inverters and deliver robotic projects. An engineer from drivers' part told us that he opened the drivers used in Atatürk dam which needs very powerful motors and drivers. He told us that being able to activate that kind of system, moreover after activation the view of the dam makes an engineer feel so happy. This is the joy of working in this area.

Main competitors of ABB could be Schneider Electric since both firms are working on electrification and Siemens since both firms are big names in automation and electrification. In transformer production and Robotic systems, I can tell that ABB is the biggest company in Turkey and Europe as well.



Figure 1. ABB robot manipulator

Internship Project: Description and Analysis

Dilovası Fabric

This part of the ABB produces transformers and transformer cores. ABB presents whole kinds of power distribution transformers required in industrial, beneficial and commercial applications. ABB is the most capable transformer manufacturer around the world and produces liquid-filled and dry-type transformers. In addition offers service support for the products in whole life-cycle. A transformer is a system that provides electrical energy transformation between two or more circuit via electromagnetic induction. It is used on AC alternative current circuits. Transformers are used in electronic products in order to decrease the high voltage transmitted in the wires and make it usable for low voltage circuits. In addition, prevents the direct contact with the supply voltage. In sum, it provides us a suitable voltage and it is an obligation to use in every part of life. There are different kinds of transformers such as LMPT(large medium power transformer).

Three-phase transformer were produces in the department that I have worked. Transformers are created by wrapping copper wire around the transformer core. Transformer core is produced from sheet metal and covered with silicium. Aim of covering with silisium is to reduce the current loss during transmission. Schematic of a three-phase transformer is shown in the Figure 2. Below.

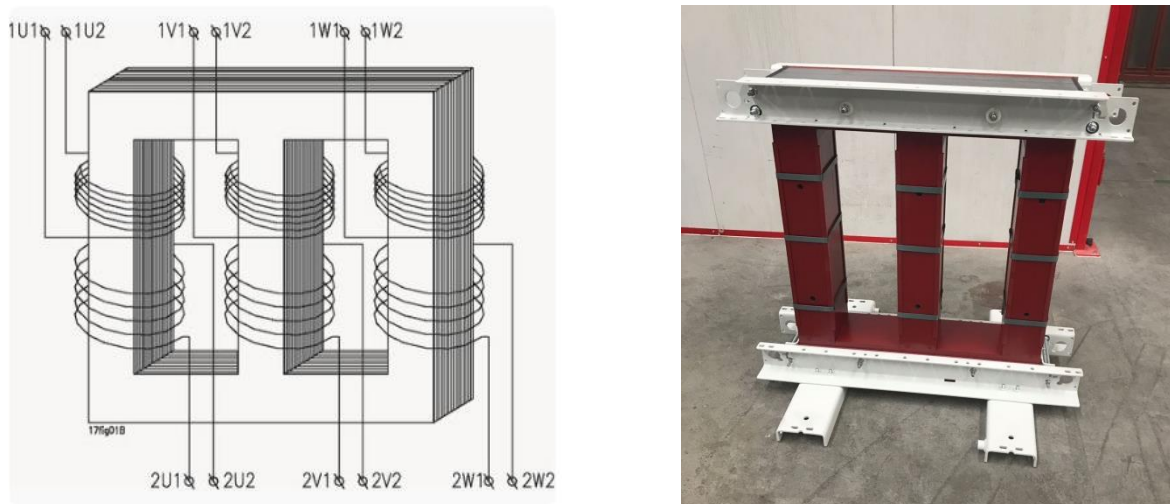


Figure 2. Transformer

The project assigned to me was to examine and work on the automatisisation of the PLC machines in order to carry out overhaul, save time, and reduce cost within the fabric. During my internship, I was able to examine the working principle of the machines that are used in transformation production. I have worked with engineers to checkout errors in machine and analyzed them. In the result of machine analysis, failure detection is done and overhaul for the machines are completed. Optional precautions for repeating errors performed. In addition, I was able to examine and understand the protocol of communication between sensors, switches etc. and PLC.

Different kinds of machines are used in the production of transformation cores. For example the machine shown in Figure 3. below is named Georg 100.



Figure 3. Georg 100

Its function is to slice the metal sheet. It divides the big sheet metals to little sheets. Smaller sheet metals are transferred to the machine named Georg 400 that I will explain later. During my internship, I was able to see failure detection for this machine. It had an error about collision of sheets. Firstly, we thought failure could be because of the error in sensor, however sensors were working properly. Secondly, we looked at encoder, wrong counting in encoder can cause collision in sheets. However encoder was working properly as well. The error was in the measuring disk. This disk is connected to the encoder and it counts sheets. All of the disks have their own radius and multiplying this radius with rotation gives the count. It takes the information about rotation from encoder. When we have cleaned the disk, or changed it with new one, error was fixed.

Another type of machine was Georg 400. This machine also has slicing tasks. It slices the smaller sheet that is coming from Georg 100 to the wanted shape. This shape is written in the program and sent to the machine. Georg 400 is used in the production of bottom and middle leg of the transformer core. In failure analysis of this machine, error part was the sensor. This

sensor was an inductive sensor which sense metal. Georg 400 machine is shown in Figure 4. below.



Figure 4. Georg 400

Figures 5. And 6. shown below is the interface for data storage. It takes the measurements of the sliced sheet metals and sends to the database in realtime. It has a server and send the collected information to the main server of ABB.



Figure 5. data storage



Figure 6. Data storage

Figure 7. shown below is the overhaul workplace. Repairation of pistons, valves and other mechanical devices are done in here.



Figure 7. Overhaul workplace

In addition, there is a device that heats the wires used in packaging. Its repairation is done in here, by changing the bobbins inside it. This machine is shown in Figure 8. below.



Figure 8. Packaging device

Another machine that is used in transformer production is Soenen. This machine does slicing in V shape. This V shape is cut from the middle of the transformer. This way, legs of

transformers are connected to each other. Frequently errors occur in this machine. For example, there was an error in hoarding of the sheets from this machine. It should put the pieces that it slice to a specific place however it were putting to wrong place. The general reason for this is burr coming to the lens of the sensor. So, sensor assumes sheet came when it sees burr. This error is fixed by cleaning the sensor regularly.



Figure 9. Soenen

Figure 10. shown below is packaged Transformation parts. This package is sent to the customer and customer assembles these parts and use.



Figure 10. Packaged transformer parts

Dudullu Fabric

In this department of ABB, Robotic Systems are designed, constituted and service and overhaul for these robotic systems are offered. Manipulator part of robots is not produced in Turkey. So engineers firstly talk with customer company about the system they need. Later they decide most proper manipulators, order it from main ABB fabric. In addition other components of the robot are decided such as grippers, conveyors etc. Before ordering all these equipment, design engineers design whole project virtually in RobotStudio environment.

RobotStudio is a graphical environment that ABB offers in order to design all the system in computer. Its advantage is that mechanical constraints and all reality including mass, singularity etc. can be added to system in order to see the most real scenario before constitution of the robotic system.

After designing the project, if customer accepts it, Robotic System is firstly produced in here Dudullu Fabric and later last corrections are done in customer fabric.

Figure 11. below shows robot manipulator, controller and other elements. Element 1. Is one of the robot manipulators that we have worked on. There is a gripper on it which holds a pen. Element 2. Is the controller which controls the robot. Controller includes drivers to direct the motors on joints. 1 driver is able to direct 2 joints. Controllers come with 3 drivers default and additional drivers can be included if needed. These additional drivers are called ADU(Additional Driver Unit). For example a 9 joint robot needs additional drivers because default controllers can control 6 joints at most. All connections are done in controller and CPU of the robot is on the controller as well.

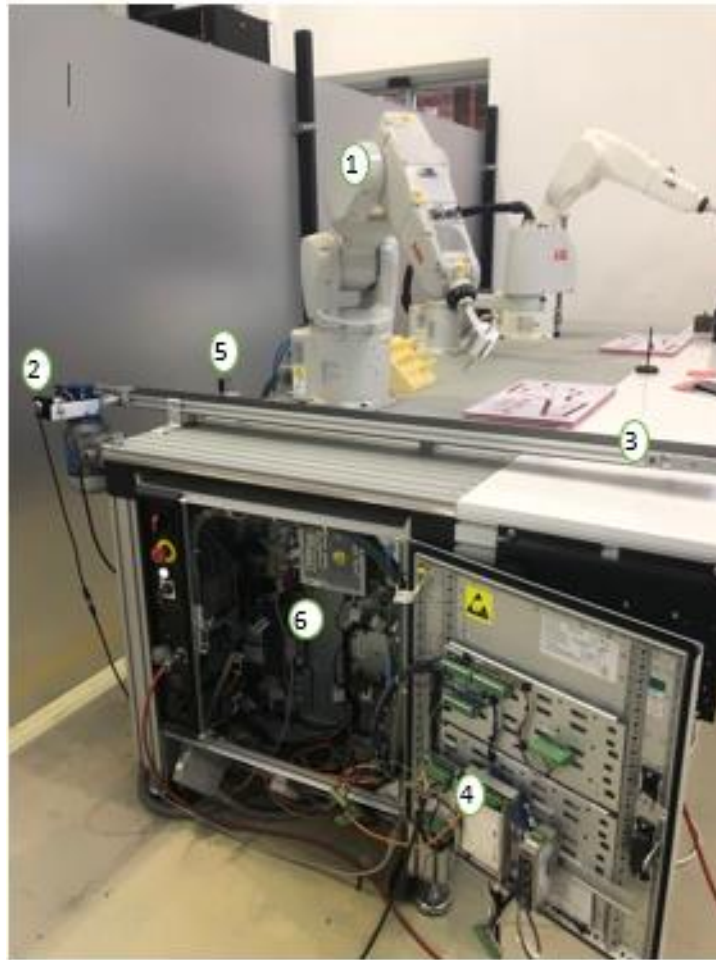


Figure 11. Robot manipulator

The manipulator can also be controlled via FlexPendant. This is an interface for the user of the robot. Necessary adjustments such as tool configurations, robot configuration, new tool introduction, conveyor and camera configurations, changes in the Rapid code etc. can be done using this pendant. For example a tool such as gripper should be introduced to all manipulators. Configuration for this tool should be done properly. There is a term called TCP(tool center point) and this introduces the system the center point of the tool, in order to make precise implementations. Controller, pendant, robot and computer connections are shown in Figure 12. below.

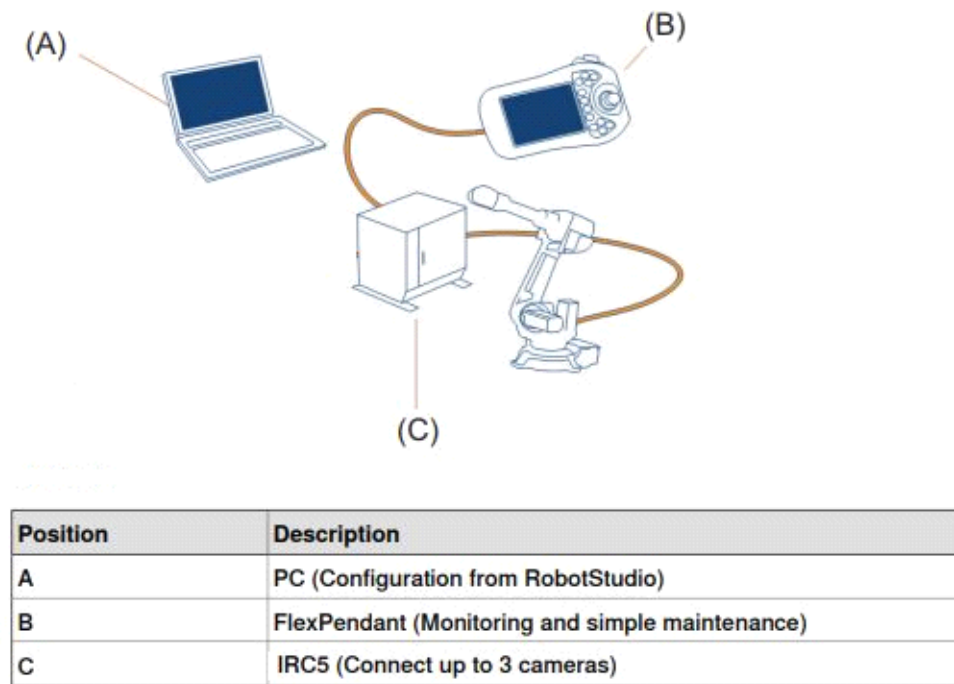


Figure 12. Robot parts and connections

An example of a Rapid code on FlexPendant is shown in Figure 13. Below.

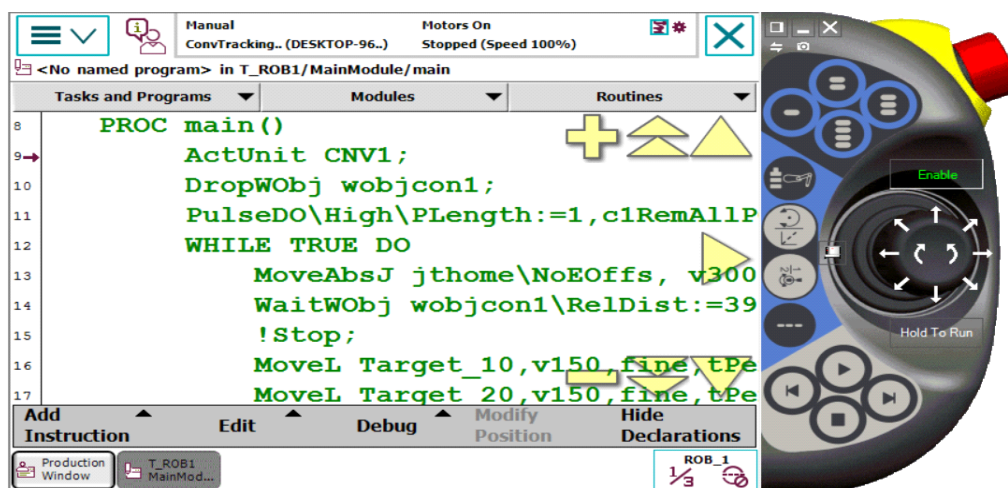


Figure 13. Rapid code in FlexPendant

The project assigned to me in Robotics department was to create an android app which communicates with a robot, direct the robot from the app and receive information data from it. Mobile app is written in Android Studio environment with java language. In RobotStudio

environment, code part is written in Rapid of RobotStudio and after connecting the computer to robot, this code is transferred to the robot. In sum, our main purpose was to communicate Android Studio and RobotStudio.

Connection between the computer and the controller is done with an Ethernet cable normally. However our purpose was to wirelessly communicate. We used TCP/IP socket communication on this purpose. The robot was the server and the android app was the client. This communication protocol helps us to communicate wirelessly however in order to make this communication, both devices should be using the same Network(Wi-Fi). In order to control the robot from another place which is using different network, we created a Web Server. We used SOAP protocol and http language on that purpose. We have created a database which contains user information such as id, password and email. In addition, we store data from the robot such as backup of the code in that database. This app is also able to control the robot. That means we will be able to move the robot from the phone when we finish. Since we have 1 more weeks, connections will be finished and implementation will be done until 21th of September.

From now on, we have created the database and web server. Rapid code from the RobotStudio is completed as well. After a few adjustments on Android Studio, we hope to success in communication. Later, we will implement the code on the robot manipulator.

In order to communicate with Android, the robot should have PC interface permission. Only the Yummy robot here has this permission, so we are working on this robot. Figure 14. below is Yummy.

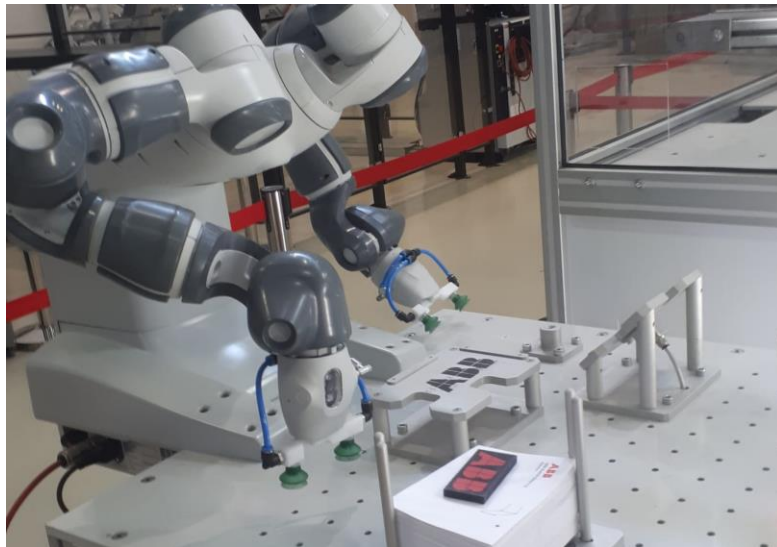


Figure 14. Yummy

Rapid code in RobotStudio:

```

MODULE MainModule
TASK PERS tooldata tool1:=[TRUE,[[80,0,100],[1,0,0,0]],0.9,[0,0,100],[
TASK PERS wobjdata wobj1:=[FALSE,TRUE,"",[[696.81,387.507,27.67],[0.002
TASK PERS wobjdata wobj2:=[FALSE,TRUE,"",[[696.81,452.5,27.67],[0.0025
TASK PERS wobjdata wobj3:=[FALSE,TRUE,"",[[696.81,387.507,27.6726],[0.0
VAR socketdev temp_socket;
VAR socketdev client_socket;
VAR string received_string;
VAR bool keep_listening:=TRUE;

PROC main()
  SocketCreate temp_socket;
  SocketBind temp_socket,"0.0.0.0",5000;
  SocketListen temp_socket;
  WHILE keep_listening DO
    ! Waiting for a connection request
    SocketAccept temp_socket,client_socket;
    ! Communication
    SocketReceive client_socket\Str:=received_string;
    TPWrite "Client wrote - "+received_string;
    received_string:="";
    SocketSend client_socket\Str:="Message acknowledged";
    ! Shutdown the connection
    SocketReceive client_socket\Str:=received_string;
    TPWrite "Client wrote - "+received_string;
    SocketSend client_socket\Str:="Shutdown acknowledged";
    SocketClose client_socket;
  ENDWHILE
  SocketClose temp_socket;
ENDPROC

!MoveL [[-167.22,523.52,-0.37],[0.00428332,-0.705354,-0.00898183,-0.708
ENDMODULE

```


Android studio main code to connect via via socket:

```
giris.setOnClickListener(new View.OnClickListener() {  
    @Override  
    public void onClick(View v) {  
        Database database2 = new Database( context: MainActivity.this);  
        database2.VerifEkle(user.getText().toString(), sifre.getText().toString());  
        String ip = "0.0.0.0";  
        int port = 5000;  
        Socket s = null;  
        try {  
            s = new Socket(ip, port);  
        } catch (IOException e) {  
            e.printStackTrace();  
        }  
        String str="hi guys";  
        OutputStreamWriter os= null;  
        try {  
            os = new OutputStreamWriter(s.getOutputStream());  
        } catch (IOException e) {  
            e.printStackTrace();  
        }  
        PrintWriter out=new PrintWriter(os);  
        try {  
            os.write(str);  
        } catch (IOException e) {  
            e.printStackTrace();  
        }  
    }  
}
```

Then I tried to make server on android based on server- client relationship with using TCP protocol.Aim of this to make connection with Android Studio and Robot Studio.

From Android part I create port with special port number 5000

```
static final int SocketServerPORT = 5000;
```

```

public class Database extends SQLiteOpenHelper {
    private static String DataBaseName = "Kayıtlar";
    private static final int version = 1;
    public final String KullaniciAdi = "id";
    public final String isim = "ad";
    public final String sifre = "sifre";
    public final String mail = "mail";
    public final String sifreagain = "sifretekrar";
    public final String Database_TABLE = "table";
    private String[] Sutunlar={"adi","sifre","sifretekrar","email"};

    public Database(Context context) {
        super(context, DataBaseName, null, version);
    }

    @Override
    public void onCreate(SQLiteDatabase db) {
        db.execSQL("CREATE TABLE Database_TABLE( KullaniciAdi,sifre,mail,sifreagain,isim)");
    }

    @Override
    public void onUpgrade(SQLiteDatabase db, int oldVersion, int newVersion) {
        db.execSQL("DROP TABLE IF EXISTS " + Database_TABLE);
        // create new tables
        onCreate(db);
    }
}

```

For the keeping user data ,add and remove user on database I had to make database classes in Android Studio.I have several choices but SQLite was suitable for my program.I used SQLiteHelper class.Another reason why I choice SQLite instead of SharedPreferences or another local databases is I have planned to use online WebServer class as SOAP in future to keeping or controlling data remote.First step I give name for my database class then I created database table which is defined as 'string' and called 'table'.Then I need to columns for my table also I define them.

My database classes have properties OF insert,remove and lists .I create two add functons which are called VeriEkle and NewVeriEkle.These functions check writable database then insert these data as I mentioned ad,sifree,email inset my table than insert database .

```

public void VeriEkle(String name, String password) {
    SQLiteDatabase db = this.getWritableDatabase();
    ContentValues cv = new ContentValues();
    cv.put(KullaniciAdi, name.trim());
    cv.put(sifre, password.trim());

    db.insert(Database_TABLE, nullColumnHack: null, cv);
    db.close();
}

public void NewVeriEkle(String ad, String sifree, String sifretekrar, String email) {
    SQLiteDatabase nwdb = this.getWritableDatabase();

    ContentValues nw = new ContentValues();

    nw.put(isim, ad.trim());
    nw.put(sifre, sifree.trim());
    nw.put(sifreagain, sifretekrar.trim());
    nw.put(mail, email.trim());
    nwdb.insert(Database_TABLE, nullColumnHack: null, nw);
}

```

As an another project, an ABB engineer wanted us to prepare a desktop application in order to organize overhaul data. This program was written in Visual Studio environment in C# language. This program takes the information of the machine that needs overhaul. This information is added in to the list. Then, program creates a Word file from those machines. In addition, it creates an excel file. Windows form application is used when writing program. Application looks like the Figure 15. given below. We have 5 buttons, one listview and textbox'es in order to take information from user.

[illegible]

Figure 15. ABB application general view

4 informations as Robot S/N, Malzeme kodu, adet and açıklama are taken from the user by writing them on textboxes. When pushed to LİSTEYE EKLE button, program adds the machine with these info to the list. Code for doing this is shown below:

```

int sayac = listView1.Items.Count;

listView1.Items.Add("");

listView1.Items[sayac].SubItems.Add(1.ToString());
listView1.Items[sayac].SubItems.Add(textBox1.Text);
listView1.Items[sayac].SubItems.Add(textBox2.Text);
listView1.Items[sayac].SubItems.Add(textBox3.Text);
listView1.Items[sayac].SubItems.Add(textBox4.Text);
l = l + 1;
}

foreach (Control item in this.Controls)
{
    if (item is System.Windows.Forms.TextBox)
    {
        System.Windows.Forms.TextBox tbox = (System.Windows.Forms.TextBox)item;
        tbox.Clear();
    }
}

```

In addition, chosen machine can be removed from the program using button LİSTEDEN SİL. This code:

```

listView1.SelectedItems[0].Remove();

int x;
for (x = 0; x < listView1.Items.Count; x++)
{
    listView1.Items[x].SubItems[1].Text = (x + 1).ToString();
}
l = x + 1;

```

Lastly, a wrong information may be put, so DEĞİŞTİR button is used in order to change the selected machine from list. Code for this part is below:

```

listView1.SelectedItems[0].SubItems[2].Text = textBox1.Text;
listView1.SelectedItems[0].SubItems[3].Text = textBox2.Text;
listView1.SelectedItems[0].SubItems[4].Text = textBox3.Text;
listView1.SelectedItems[0].SubItems[5].Text = textBox4.Text;

```

The most important part of the project was to create a word document from this listview. For the items on the listview, there are same number of pictures in a file in the computer that the user have created. When we push the WORD button, it asks us to choose the picture file. This

program creates a Word file which organizes machines and adds pictures of these machines in a manner. Machine number and explanation is written. Then picture comes. Lastly, under picture, number of machine and Robot S/N is written. Machine as wanted can be loaded to word document with this manner.

Code below show the folder choosing segment of the code for choosing picture folder.

```
//resimlerin olduđu dosyası seçmek için.  
FolderBrowserDialog Klasor = new FolderBrowserDialog();  
Klasor.Description = "Resim dosyasını seçiniz";  
Klasor.ShowDialog();  
KlasorYolu = Klasor.SelectedPath;//Resim dosyasının yolu
```

In the Figure 16. below, program is played, some machines are added to list and WORD button is pushed. When pushed to the Word button, it automatically asks for picture folder.

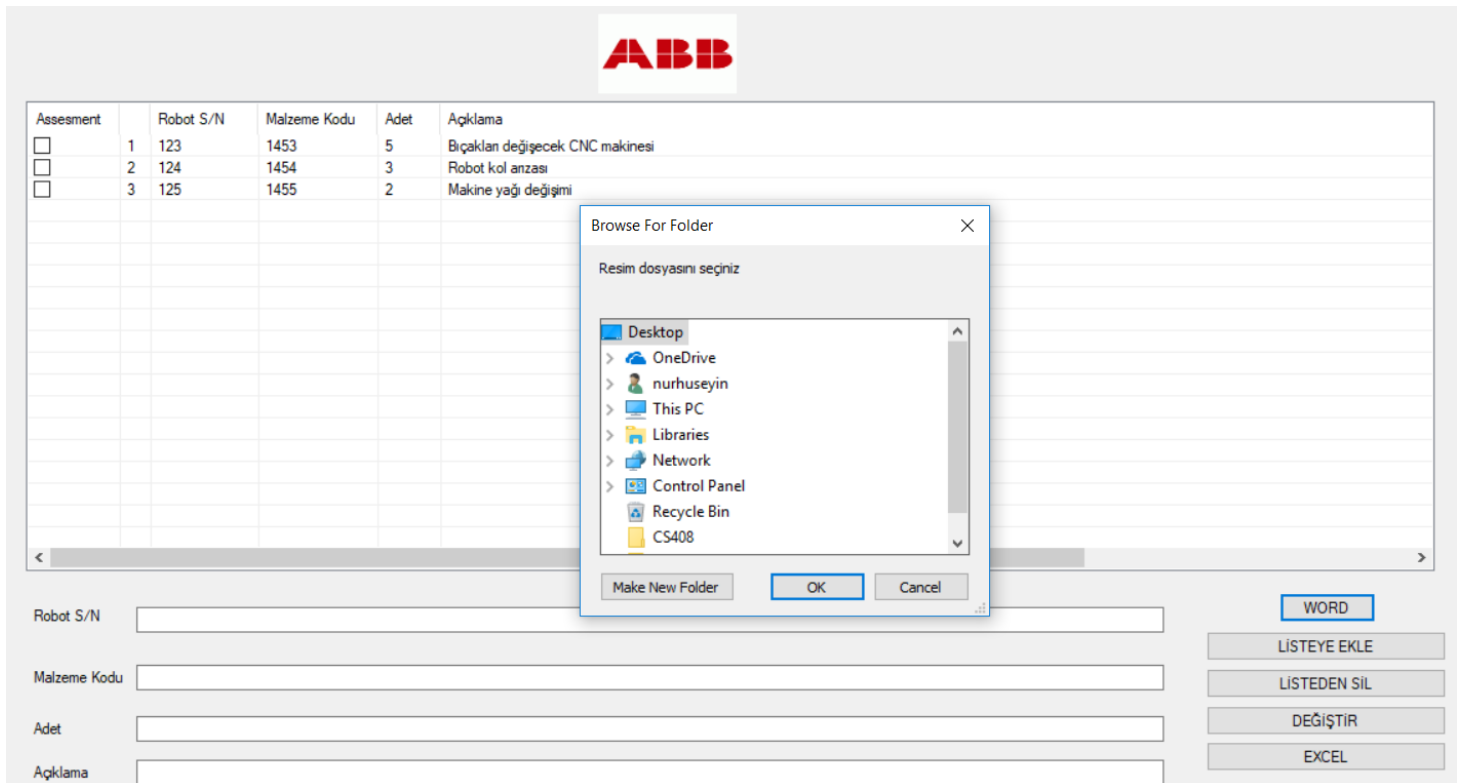


Figure 16. Working of WORD button

There are check boxes in the list. Those check boxes are put to regular excel file. When pushed to EXCEL button, if assessment check boxes are checked program puts the machine under assessment and if not checked program puts it under bakım. A created excel document is shown below.

Assesment	Robot S/N	Malzeme Kodu	Adet	Açıklama
<input type="checkbox"/>	1 123	1453	5	Bıçakları değişecek CNC makinesi
<input checked="" type="checkbox"/>	2 124	1454	3	Robot kol arızası
<input checked="" type="checkbox"/>	3 125	1455	2	Makine yağı değişimi

Figure 17. Excel example

In order to organize the Word file Spire.office library is used. This library is downloaded from internet and added as reference to the code. In addition, imported inside the code. Full code for the WORD button and word document creation is given below.

```
//resimlerin olduğu dosyası seçmek için.
FolderBrowserDialog Klasor = new FolderBrowserDialog();
Klasor.Description = "Resim dosyasını seçiniz";
Klasor.ShowDialog();
KlasorYolu = Klasor.SelectedPath;//Resim dosyasının yolu

//Boş bir word dosyası açar
Document document = new Document();

//ilk sayfayı ekledik
Section section = document.AddSection();
int k = 1;
for (int i = 0; i < listView1.Items.Count; i++)
{
    //ilk paragrafı oluşturdu. Açıklamayı buraya ekledik
    Paragraph p1 = section.AddParagraph();
```

```

p1.AppendText(k + ": " + listView1.Items[i].SubItems[5].Text);
//p1.ApplyStyle(BuiltInStyle.Heading1);
p1 = section.AddParagraph();

//ikinci paragrafı oluşturdum
Paragraph p2 = section.AddParagraph();
//Resmi ekle. k=resmin adı. 1,2,3,... şeklinde gidiyor
try
{
    string imagePath = KlasorYolu + @"\" + k + ".jpg";

    Bitmap p = new Bitmap(Image.FromFile(imagePath));
    DocPicture picture = p2.AppendPicture(p);
    //Resmin pozisyonunu ortalama
    p2.Format.HorizontalAlignment =
        Spire.Doc.Documents.HorizontalAlignment.Center;
    //resmin boyutunu ayarladık(resize). 150'i değiştirerek boyutu
    düzenlenebilir
    float a = picture.Height;
    picture.Height = 150;
    picture.Width = (picture.Width * picture.Height) / a;
}
catch { MessageBox.Show("Resim klasoru uygun değil! Oluşturulan belge
eksik olacak.", "Error"); }
//son paragraf resmin altına robot S/N ve adedi girilir
Paragraph p3 = section.AddParagraph();
p3.AppendText("Adet: " + listView1.Items[i].SubItems[4].Text + "(Robot
S/N: " + listView1.Items[i].SubItems[2].Text + " )");
p3.Format.HorizontalAlignment =
    Spire.Doc.Documents.HorizontalAlignment.Center;
p3 = section.AddParagraph();

k = k + 1;
}

try
{
    //Dosyayı kaydet
    string KlasorYolu2;
    FolderBrowserDialog Klasor2 = new FolderBrowserDialog();
    Klasor2.Description = "Kaydetme yerini seçiniz";
    Klasor2.ShowDialog();
    KlasorYolu2 = Klasor2.SelectedPath;

    document.SaveToFile(KlasorYolu2 + @"\ABB_rapor.docx",
FileFormat.Docx);
    //PDF için yorumu aç.
    //document.SaveToFile(KlasorYolu2 + @"\ABB_rapor.pdf",
FileFormat.PDF);

    DialogResult cevap = new DialogResult();
    cevap = MessageBox.Show("Belge oluşturuldu!", "Sonuç.",
    MessageBoxButtons.OK);
}
catch { MessageBox.Show("Oluşturma klasoru uygun değil! Belge
oluşturulamadı.", "Error"); }

```


In order to create and organize the excel file, Microsoft office library for C# is used. It is added to the references and imported in the code as well. Full code for creating and regulating excel document is given below.

```
Microsoft.Office.Interop.Excel.Application objexcel = new
Microsoft.Office.Interop.Excel.Application();
    objexcel.Visible = true;
    Microsoft.Office.Interop.Excel.Workbook objbook =
objexcel.Workbooks.Add(System.Reflection.Missing.Value);
    Microsoft.Office.Interop.Excel.Worksheet objSheet =
(Microsoft.Office.Interop.Excel.Worksheet)objbook.Worksheets.get_Item(1);
    Microsoft.Office.Interop.Excel.Range objRange;
    objRange = objSheet.get_Range("A1", System.Reflection.Missing.Value);
    objRange.set_Value(System.Reflection.Missing.Value, textBox1.Text);
    objexcel.Cells[1, 1] = "Assesment'a göre";
    objexcel.Cells[1, 6] = "Bakıma göre";
    objexcel.Cells[2, 1] = "Robot S/N";
    objexcel.Cells[2, 2] = "Malzeme Kodu";
    objexcel.Cells[2, 3] = "Adet";
    objexcel.Cells[2, 6] = "Robot S/N";
    objexcel.Cells[2, 7] = "Malzeme Kodu";
    objexcel.Cells[2, 8] = "Adet";
    int i = 3;
    int j = 1;
    int c = 3;
    int n = 6;
    foreach (ListViewItem item in listView1.Items)
    {
        if (item.Checked)
        {
            objSheet.Cells[i, j] = item.Text.ToString();
            int temp = 1;

            foreach (ListViewItem.ListViewSubItem subitem in item.SubItems)
            {
                if (temp > 2)
                {
                    if (j < 4)
                    {
                        objSheet.Cells[i, j] = subitem.Text.ToString();
                        j++;
                    }
                    temp++;
                }
                j = 1;
                i++;
            }
        }
        else
        {
            objSheet.Cells[c, n] = item.Text.ToString();
            int temp = 1;
            foreach (ListViewItem.ListViewSubItem subitem in item.SubItems)
            {
                if (temp > 2)
                {
                    if (n < 9)//Açıklamayı yazmamak için
                    {
                        objSheet.Cells[c, n] = subitem.Text.ToString();
                    }
                }
            }
        }
    }
}
```

```
        n++;  
    }  
    temp++;  
}  
n = 6;  
c++;
```

Recommendations

Working in a project such that I was able to improve both my mechanical and software skills was a big chance for me. I was able to understand connection, connection types and principles between mechanical devices and software. My recommendation for internships is to take notes in every part of the work. Asking everything to the people around such as engineers and workers helped me very much. In addition working in a specific project helped me to understand the subject I'm working on more neat and better. This is why after finishing the project assigned to me, I have asked engineers to give me another project.

Conclusion

ABB is a big and rooted company. I was able to examine transformers and their working principle. In addition, I have learned what are the most regular problems that occur in the machines and how to fix them. Moreover, I had chance to see robotic systems and how they are designed. I have worked with real robots and learned to communicate between different devices.

References

- [1].Figure 12. <https://robohub.org/ideahub-abb-launch-new-robotics-accelerator-programme/>
- [2].ABB, Application manual Controller software IRC5