ANDROID BASED ONLINE INDUCTION MOTOR TORQUE ANALYSIS AND CONTROL TOOL

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Abstract
  Engineering training theory and application to consists of two sections. Theoretical training as well as importance of application is quite big, but it is quite difficult to provide a separate set of experiments for each student in laboratory applications. For this reason the online laboratory systems are being developed. In this study, a real-time online control system for induction motor torque analysis was developed. Students can remotely perform torque analysis of induction motor via smartphones, tablets and media players with Android OS. The analysis is calculated by running a real induction motor at different frequency values and measuring the voltage and current values. Also at different frequencies, the student can view the motor speed, winding voltage, current and load status in real time. The results of the analysis are visualized by the prepared MATLAB application and transferred to the students. The student can record the results of the experiment on the device. Torque testing can be performed by connecting the students remotely from the laboratory.

Keywords: torque analysis, android, virtual laboratory, remote control,

INTRODUCTION

Laboratories in applied educational sciences constitute an important part of teaching. Students overcome the difficulties they have experienced in adapting the theoretical knowledge by doing laboratory experiment[1]. By the visualiation of obtained datas from experimental set is extremely easy to overcome difficulties. Also, in laboratories there hasn't no experimental set for most of student. In addition, each student does not have a separate set of experiments in the laboratory. For this reason, it takes a long time for all students to complete their laboratory activities. In order to solve these problems, remote laboratory applications are being developed, which allows the student to reinforce the theory at any time. In the literature, there are many studies about remote education and laboratory applications made in different areas[2-9].

These studies are usually done via a computer. With the rapid development of portable device technology, these applications can be adapted to smartphones and tablets. In this study, a remote access laboratory application was presented to analyze the torque values produced by three-phase asynchronous motors at different frequency values. The data obtained as a result of the torque analysis are delivered to the student with a report. The tool also allows the student to have free control of the asynchronous motor and can transmit many parameters in real time, such as the motor's operating voltage, current, load status, speed and load status.

HARDWARE

The experimental set consists of the server computer, asynchronous motor, frequency converter, control card and current-voltage measurement cards. The experimenta al is shown in Fig.1.
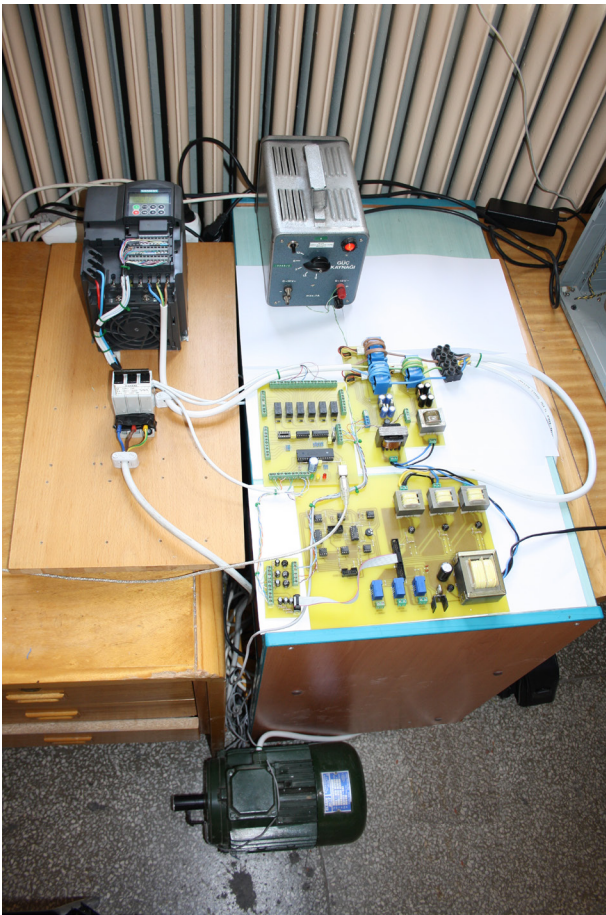
Fig. 1. *Experimental set*

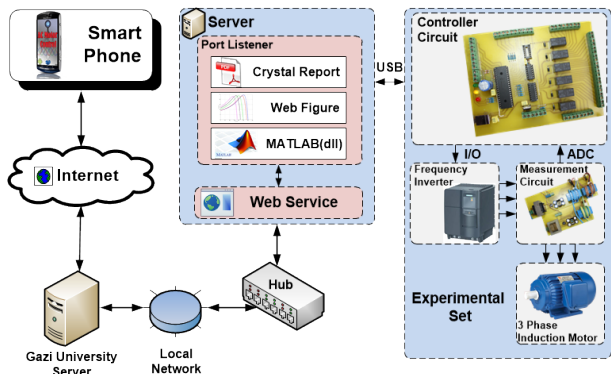Experimental set control structure is presented Fig. 2.

Fig. 2. *Experimental set control structure*

Control card is connected to server via USB port and controls frequency converter via pinout. Additionally, it measures voltage and current values using measurement circuit.

SOFTWARE

The designed study consists of 4 main software parts. These are the software designed for the Android device, a web service application that provides internet access to the device, a microcontroller application that provides port listening application that provides connection with the experiment set and experimental set control application. The block diagram of the software infrastructure is shown in Fig. 3.
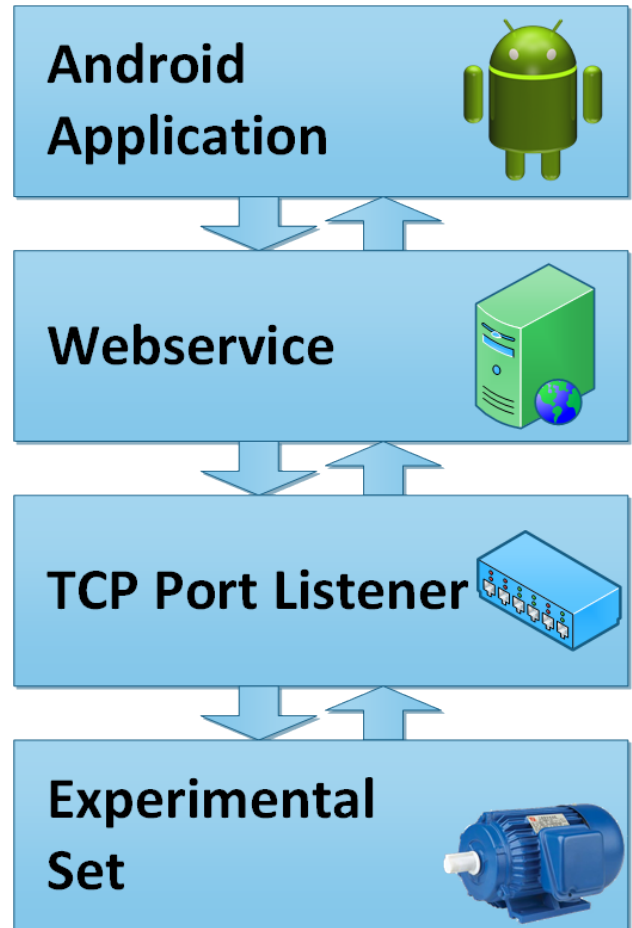

Fig. 3. *Software infrastructure block diagram*

ANDROID APPLICATION

The designed experimental set uses a smartphone with an Android operating system to interact with the user. It is intended to be compatible with Android API 23 (6.0.1) and lower versions for the purpose of supporting the work by multiple devices. Developed Android application splash screen is shown in Fig. 4(a). After the application launch is completed, the user's experiment set menu is displayed as presented in Fig.4(b).
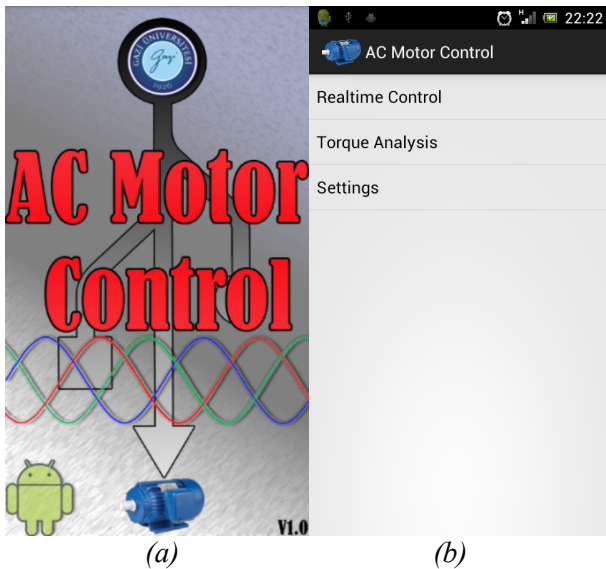
Fig. 4. *(a) Application splash screen, (b) experiment set menü*

In the application, there are 2 different experimental studies depending on the user selection. The flow chart of the Android application required to control experimental work is shown in Fig. 5.
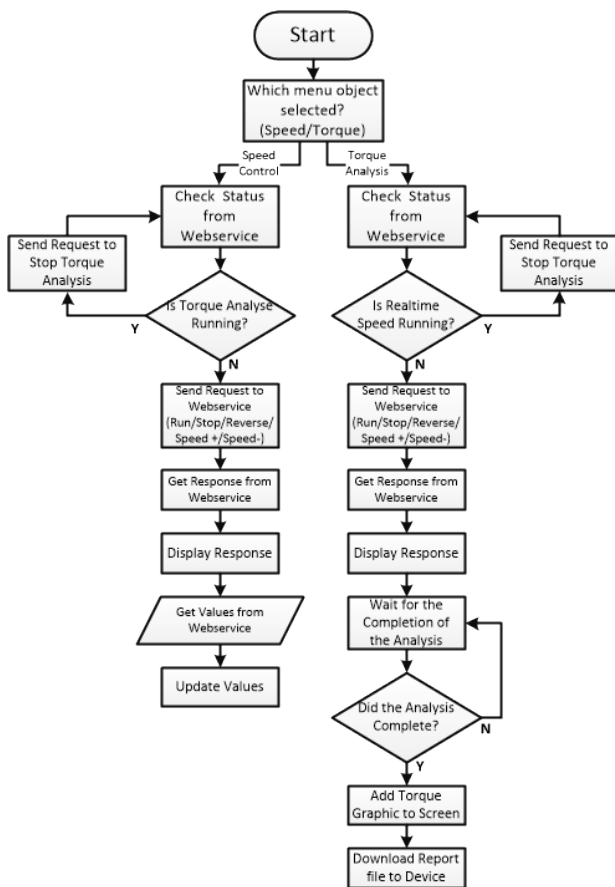

Fig. 5. *Android application flow chart*

In the first option, there is a working mode in which the user can provide speed and direction control of the asynchronous motor and also monitor the motor parameters in real time. Fig. 6 shows the real-time control application screen.
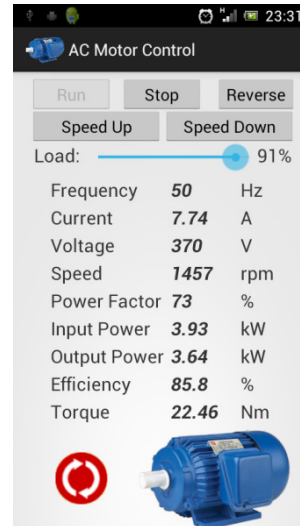

Fig. 6. *Real time control application screen*

In the real-time control application, the user must touch the "Run" button to start the asynchronous motor. With the button is touched, the mobile device sends the command to the server computer to run the web service application via the internet connection. When the command transmission is completed, the asynchronous motor starts to work and the motor parameters are measured by the control card and sent back to the mobile device. By taking all the parameters in the real time control screen and updates 5 sec intervals. The rotation direction of the asynchronous motor is displayed visually on the screen throughout the engine run time.

With the engine running, the "Stop" and "Reverse" buttons on the control screen become active. The user touches the "Stop" button and sends the command to the experimental set to stop the engine. In addition, the direction of rotation of the motor when the engine is running can be changed by touching the "Reverse" button.

Torque analysis is which working mode the second part of the application, is started by selecting the "Torque Analysis" menu item. Torque analysis start screen is shown in Fig.7.
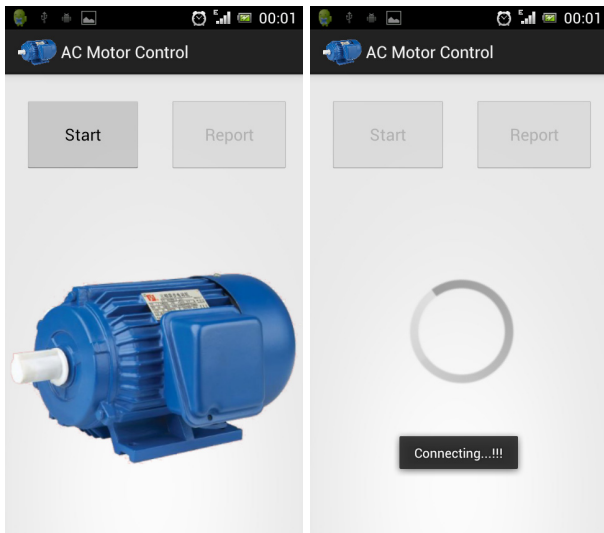
Fig. 7. Torque analysis start screen

The torque analysis process by touching the "Start Analysis" button sends the necessary commands to the web service application to initiate the analysis to the port listening application. The analysis process is completed by the port listening application and the results are transferred to the mobile device via web service application. The analysis processing structure is given in detail in the port listening application section. Upon completion of the analysis process, the "Report" button on the screen becomes active. With the button, the torque analysis experiment can be downloaded to the mobile device as the resulting PDF document. Experimental results can be documented and archived by this way.

WEB SERVICE APPLICATION

A web service application is designed with the aim of providing an internet connection between the Android device and the experimental set. The application is prepared using Microsoft .NET 4.0. This application evaluates the commands from the mobile device and adjusts the predetermined application port. The command from the Android application is sent to the port listening software using the set port. A transmission information is sent from the port listening application in order to ensure that the transmitted command is transmitted to the port listening software. Motor command is provided and the engine parameters are provided in the port listening application. With command transmission, motor operation is

provided and motor parameters are provided in the port listening application.

The obtained data is updated on Android application screen and real time monitoring is realized. The flow diagram of the web service application is shown in Fig.8.
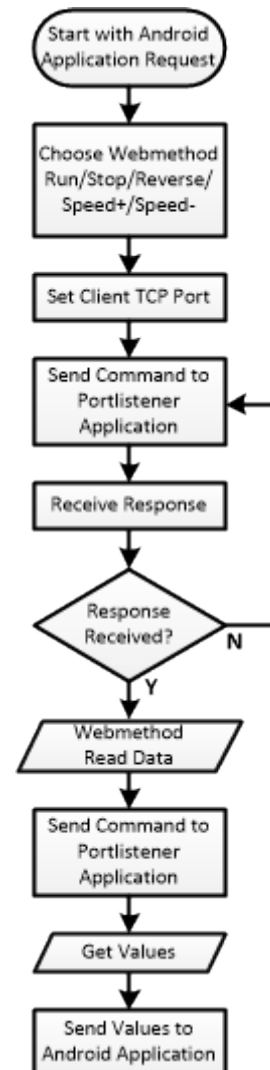

Fig. 8. Flow chart of the web service application

PORT LISTENING APPLICATION

Connection between web service application and experiment set is realized through port listening application. Depending on the incoming command, two different application flow controls are used. The port listening application flow diagram is shown in Fig. 9.

One of these, the flow of real-time speed, direction control, and processing required for parameter tracing operation. When the real-time control operation command is transmitted by the web service application, the experimental set detects whether the micro

controller application is to start / stop / change direction. Depending on the selected command, the necessary commands are sent to the test set application to obtain the parameters required for the monitoring operation.

Fig. 9. Port dinleme uygulaması akış diyagramı

The parameters obtained are transmitted to the web service application and sent to the Android application.

Second part of the application is the process flow necessary for the torque analysis process. In this process, the analysis is started for the torque analysis with start command sent by the web service application.

At the beginning of the analysis, the asynchronous motor is operated at a frequency of 50 Hz. All parameters are stored in the micro controller memory in the process of motor acceleration and maximum speed reach. Data for this frequency value is transmitted to the port listening application. After transferring the data, the frequency value of the applied voltage to the motor is reduced by 5 Hz. Depending on the re-tuned frequency value, the parameters are recovered and transferred to the port listening application. The process of obtaining the parameters ends with the motor decreasing to the frequency value of 25 Hz. All the data obtained when this frequency value is reached are recorded.

The result of the analysis, stored datas are sent to the .NET library, which is created using the MATLAB Builder for NE toolbox. The transmitted data are used in the torque calculation process for each frequency value using a mathematical model. Torque-speed graph is obtained in MATLAB environment by performing torque analysis process. The chart is saved to the server and transferred to the android application via web service application. After this process, the chart is added to a report draft prepared using Crystal Report Service. The torque calculation using MATLAB is added to the report via the same service in the process. This report file prepared with report service is saved as PDF document and transferred to Android application. The torque analysis result screen is shown in Fig.10.
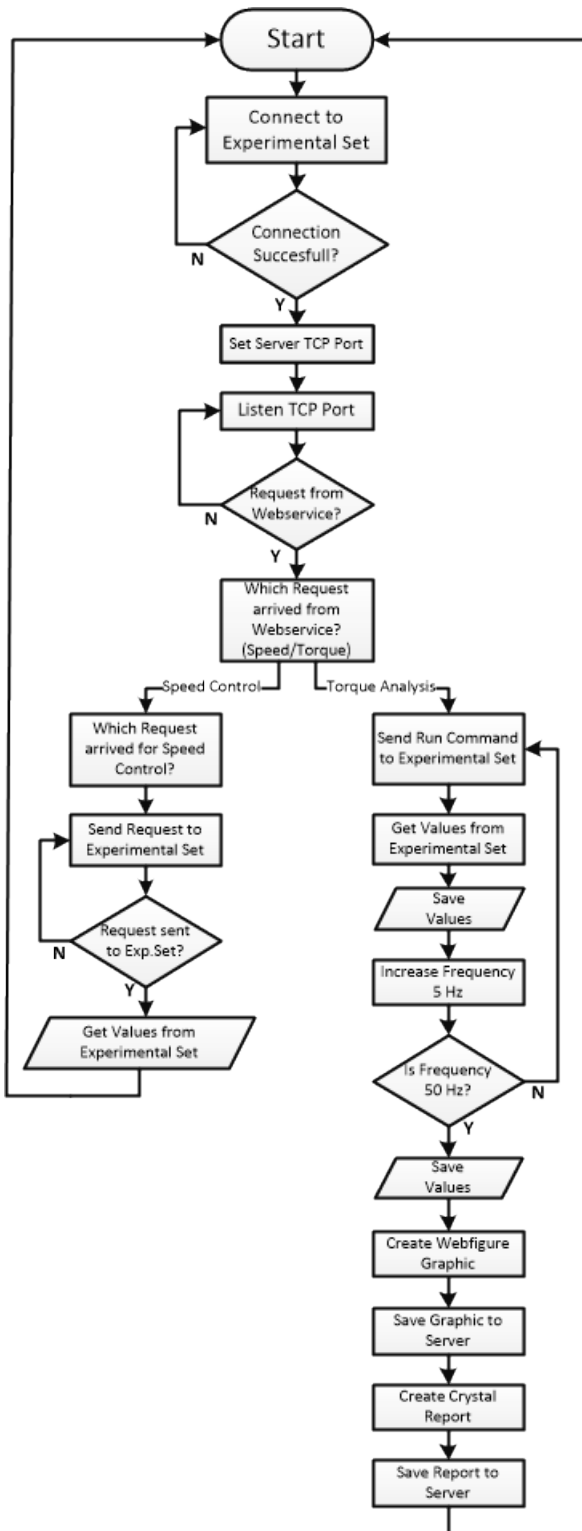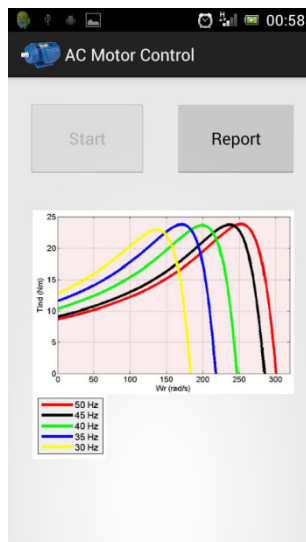
Fig. 10. *Torque analysis result screen*

CONCLUSION

As a result of the study, a real-time remote laboratory has developed for students who do not have enough facilities. The remote laboratory is based on the Android OS and has the possibility of being accessed easily. In this way, a remote asynchronous motor torque analysis experiment set is prepared. Experimental study results have been transferred to the user with the generated reports.

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