

ANDROID APPLICATION USED IN DIAGNOSTIC SYSTEM OF ENGINEERING DEVICES AND MACHINES

Artur Gawlik, Damian Brewczyński

*Cracow University of Technology
Faculty of Mechanical Engineering
Jana Pawla II Av. 37, 31-864 Krakow, Poland
tel.: +48 12 3743352, +48 12 3743406, fax: +48 12 3743215
e-mail: artur.gawlik@mech.pk.edu.pl
damian.brewczynski@mech.pk.edu.pl*

Konrad Bobowski

*Aritex
e-mail: konrad.bobowski@wp.pl*

Abstract

Users of machines and engineering devices force continuous improvement of their functionality and efficiency while reducing energy consumption. For this purpose, numerous sensors are installed in the machines in both drive systems and execution systems. Sensors are a source of information for control units and also allow reading parameters during diagnostic tests. The diagnostician should have the appropriate interface and knowledge of the operating principles of the tested machine. In order to facilitate the implementation of the diagnostic process even by less experienced service personnel, it is proposed to use a diagnostic interface based on the application developed in the Android system, which main element is a QR code scanner. The system uses MATLAB-Simulink, database and PHP script to work properly. This system allows performing a diagnostic test and identifying potential causes of device failure. The system has friendly interface where is implemented many useful things like graphs and visualization of device movement. The application reads the nominal operating parameters stored in the QR code of the machine and displays the next steps necessary to assess the technical condition of the object. On the basis of a comparison of registered and nominal machine parameters, the application indicates possible fault locations. The implementation of the database on an external server allows the application to run anywhere on android devices that have access to the internet. Through the registration process, it is possible to create a database of employees who have access to the system. The diagnostic system for storing all information, such as employee data or current sensor measurement values uses the MySQL database. Preliminary tests of the application carried out during diagnostics of the hydraulic and mechanical system of the building manipulator confirmed the functionality of the developed system.

Keywords: *QR code scanner, diagnostic interface, MySQL database, hydraulic manipulator*

1. Introduction

Diagnostic systems are systems used to assess the technical condition of the device. This kind of systems cans monitoring in real-time main operating parameters of mechanism or mobile machines [1, 2]. This kind of system can operate non-stop or can be activate after alarm occurs and during periodic technical inspection. Based on the results obtained, the user is able to make the appropriate diagnosis, and then take action to remove the failure. The use of the diagnostic system improves and speeds up the diagnosis process, while allowing reducing the amount of funds and time needed to carry out this process.

Mobile applications are now widely used by most users of mobile devices. The number of these applications is constantly growing, and the sudden development in this subject came with the release by Google, the ability to create android applications for all users of this system. This move

resulted in the creation of a large number of useful applications, the use of which seems to be unlimited [7].

Nowadays, the popularity of using QR codes is also growing. They are used on online banners, billboards, and more and more often on business cards, in the press and labels of various products. The construction of the code itself allows its placement, and at the same times its reading on items moving quickly relative to the scanner. In Poland, the awareness of QR technology is still very low, and the use of the code itself is limited to few areas.

This article presents the design of a machine diagnostics system using the elements mentioned above. The diagnostic system application is based on the Android system and its main element is a QR code scanner. The use of this element together with the friendly interface of the application itself, further improves the user's work with the diagnostic system.

2. Diagnostic system elements

Android system

A distinguishing feature of the Android system is its openness. It does not have any restrictions from the publisher, and application developers can use free fragments of source codes to facilitate the implementation of additional device functions to their own applications. Another advantage of Android is its pleasant and intuitive interface, which can be modified according to the individual needs of the operator.

Using the appropriate SDK module allows to create applications for any version of Android. The tools included in the SDK Tools allow you to run and test applications on a virtual device, which significantly simplifies the creation process. Working with a virtual device is very useful because the developer is able to check the operation of his program on any device without the need to purchase it.

Communication

Communication between the sensor and the android application requires MATLAB and Simulink programs. The diagram of sending information from the displacement sensor to the android application is illustrated in Fig. 1. The sensor signal values, via an analogue/digital card, are sent to the Target PC. Next, the Host PC connects to the Target PC through the created network, and then reads the signal values of the sensor in the MATLAB-Simulink program, using the xPC Target module. This acquisition system allows collecting measured values from different kinds of sensors without and delay, as well as it can be used to control drive systems of the tested mechanism.

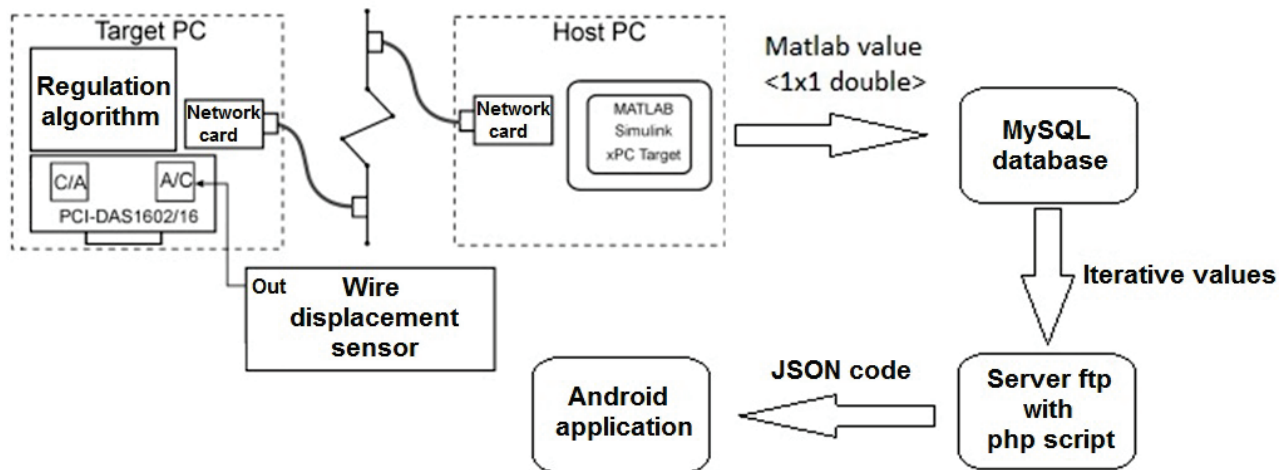


Fig. 1. Diagram of signal transfer from sensors to Android application

Written script working in the MATLAB environment, transfers the signal values to the MySQL database, from which they are directly downloaded to the PHP scripting, located on the ftp server. This script converts the received results into JSON code, which is processed in the next step by android applications. The JSON code includes the values of cylinder extension, pressure on the piston side together with the ID that defines it.

A well-configured ODBC interface will not be able to access the database until the correct setting of remote MySQL access on the host page [5]. In order to obtain a proper connection, the IP of the computer on which the MATLAB script is processed should be added. MATLAB script using the ODBC interface connects to the database and then sends an established amount (number of iterations) of the sensor signal values obtained.

After running the script, the exec command empties the “real time” table, and then the script starts executing the “for” loop. In the “for” loop, the current sensor signal value (get signal) is retrieved, which in the next step is sent by the MATLAB to the "real time" table using the fast insert command. The script saves up to 11 lines of the signal, and each line added in succession removes the first. This limitation allows optimizing the signal flow and minimizing the risk of stopping the application due to the too large amount of stored data in the database. Each sent sensor signal has its own ID number, which, along with time, increases incrementally. Based on the ID value, the time is simulated.

On the ftp server, there is script PHP that reads the results stored in the database continuously. Script connects to the database through the MySQL module, then retrieves the results (SELECT ... FROM ...) and writes them in the array form. In this way, the results are processed into the text of the JSON code, which, using the echo json_encode function can be read by the diagnostic application [6].

Scanner QR code

The diagnostic system application uses a QR code to obtain the required parameters to perform the diagnostic test. (Fig. 2)

The QR code is generated via an online code generator that replaces a string of digits stored in the text format into a QR image. The first two digits specify the device number, and the next ones assign the values of the parameters needed to perform the test. The adopted design solutions allow the system user to quickly and conveniently perform a test of the selected device. The diagnostic process has been improved by using a QR code scanner that automatically selects the device by reading first two digits of QR code.

1	2	3	4	5	6	7	8																	
0	1	0	6	0	0	3	0	0	0	7	0	0	2	0	0	0	6	0	0	3	0	1	4	0

1. Device number
2. Maximum extension of the actuator 1. [mm]
3. Minimum extension of the actuator 1. [mm]
4. Maximum extension of the actuator 2. [mm]
5. Minimum extension of the actuator 2. [mm]
6. Piston diameter [mm]
7. Piston rod diameter [mm]
8. Maximum hydraulic pressure in the system



Fig. 2. A string of numbers defining the number and parameters of the device and corresponding QR code

3. Stand tests

Preliminary tests were made on hydraulic manipulator driven by water hydraulic system [3]. The work medium is tap water without any chemical agents. Two cylinders can work separately or simultaneously. This kind of hydraulic circuit can operate at a maximum pressure value of 14 MPa

and different value of cylinders velocity controlled by proportional flow control valve. At key points of the mechanical and hydraulic system of the manipulator, linear displacement transducers and pressure transducers were installed.



Fig. 3. Object of diagnostic test and corresponding view of mechanism on application screen

After launching the application on the Android device, the user performs the following steps, such as logging in or registration and scanning the QR code from the device under test. The read information allows going to specific screens that provide tips and a description of the steps necessary to verify the correct operation of the tested object. On the smartphone screen, the user can observe the real-time motion animation of the manipulators links.

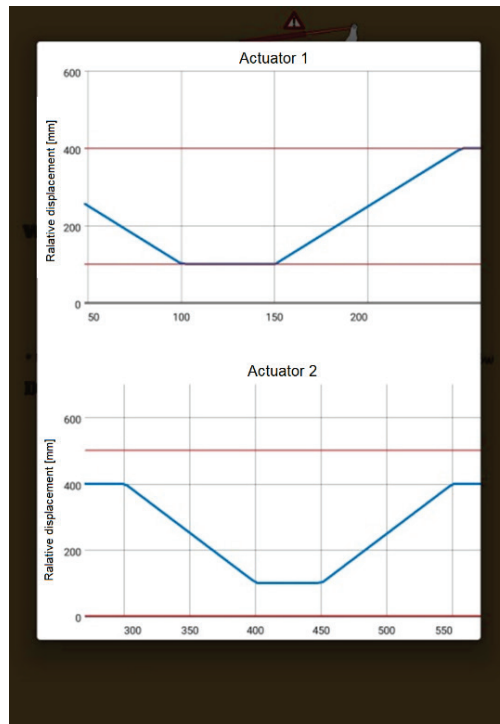


Fig. 4. Test results of the manipulator actuators; application screen shot with charts of cylinders stroke as a function of time

In case of exceeding the limit, operating parameters of the object (stored in the QR code) an alarm is displayed. An example of an alert for the arm mechanism of the manipulator is shown in Fig. 4a. In this situation, the application informs that the system is not working properly and indicates the potential causes of errors for individual mechanisms. Database is created based on the previous diagnostician experience with tested object or directly from computer simulations. Current application version is created in Polish language only.

The diagnostic system has the option of creating charts from data obtained during the test (Fig. 4b). Generating charts is done by calling the graph window with the “charts” button, on the basis of which the system user can analyse the movement of individual actuators. The red colour lines indicate the limit parameters, and the blue colour curves represent the position of the actuator that changes over time.

In this article was presented a project of diagnostic system which is used to diagnose technical devices such as machines, manipulators and others mechanism which work in stationary mode.

Diagnostic devices are the systems used to get the information about technical condition of the machines and particular circuits. With all information about technical properties of the devices, the diagnostician is able to make an appropriate diagnosis and then is able take action to remove the failure. The use of the diagnostic system streamlines and speeds up the diagnosis process itself, while allowing reducing the amount of spending time to carry out this process.

In this article, the project was designed for android application. The created system uses MATLAB-Simulink, database and PHP script to work properly. This system allows performing a diagnostic test and identifying potential causes of device failure. The system has friendly interface where is implemented many useful things like graphs or visualization of device movement.

The implementation of the database on an external server allows the application to run anywhere on android devices that have access to the internet. Through the registration process, it is possible to create a database of employees who have access to the system.

The diagnostic system application uses a QR code to obtain the required parameters to perform the diagnostic test. The QR code is generated via an online code generator that replaces a string of digits stored in the text format into a QR image. The adopted design solutions allow the system user to quickly and conveniently perform a test of the selected device. The user created his own data storage system for the QR code, allowing it to be expanded with additional devices and parameters.

4. Conclusion

Despite the optimization of signal transmission sensor – android application, we could not avoid the delay occurring during this transmission. The use of the ODBC interface has reduced the data transmission delay between MATLAB to database. It results from the use of the PHP script, which generates JSON code approximately every 1.5 seconds. The solution to this problem may be changing the database to a real-time database such as Firebase. This problem can also be solved by changing communication between the sensor and android application.

References

- [1] Ballaire, F., Muller, S., *Dynamic Weighing with a Front Loader*, Proceedings of the 71st International Conference on Agricultural Engineering – Land Technik, pp. 413-418, Hannover 2013.
- [2] Gawlik, A., Kucybała, P., *Dynamic weighing system used in excavator*, Journal of KONES Powertrain and Transport, Vol. 24, No. 4, pp. 31-38, 2017.
- [3] Gawlik, A., Sobczyk, A., *Theoretical and experimental investigation of hydraulic manipulator position control*, Proceedings of 3-rd FPNI – PhD Symposium on Fluid Power, pp. 195-203, Terrassa 2004.

- [4] Hohensee, B., *Developing apps using Android Studio*, Publishing House Babelcube, U.S. 2014.
- [5] Lis, M., *MySQL Darmowa baza danych*, Wydawnictwo HELION, Gliwice 2006.
- [6] Lis, M., *SQL*, Wydawnictwo HELION, Gliwice 2007.
- [7] Sang, C., Uddin, M., Sung, B., Sungho, K., Joon, S., *A smartphone-based optical platform for colorimetric analysis of microfluidic device*, *Sensors and Actuators B: Chemical*, Vol. 239, pp. 52-59, 2017.

Manuscript received 06 June 2018; approved for printing 07 September 2018