VOL. 18, NO. 7, APRIL 2023 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences


www.arpnjournals.com

# REMOTE CONTROL AND MONITORING SYSTEM FOR AC MOTORS

Faiber Robayo Betancourt
Departamento de Ingeniería Electrónica, Facultad de Ingeniería, Universidad Surcolombiana, Neiva, Huila, Colombia
E-Mail: faiber.robayo@usco.edu.co

**ABSTRACT**

This article presents a remote monitoring and control system for an AC motor using a mobile device. A tool for registering and visualizing motor speed is developed through LabVIEW which is easy to access and understand. Its design is detailed using a block diagram, on which the implemented hardware devices are described. The programming stages of both the server and the mobile are also described. Motor control is performed by comparing the revolutions per minute (RPM) delivered by the motor and those desired by the remote operator. As a result, the data shows efficient tracking at the reference speed with low error.

**Keywords:** control, AC motor, monitoring, RPM, LabVIEW.

Manuscript Received 20 January 2021; Revised 19 May 2023; Published 30 May 2023

## 1. INTRODUCTION

The technological advances of the last decades have favored the automation of processes in industries. Many of these industries still carry out operations manually through operators, and the information is handled through analog instruments. One of the best-adapted systems to the industry's remote process monitoring needs is SCADA systems (Supervisory Control and Data Acquisition) (Corrales, 2007). Thanks to these systems, it is possible to control and supervise industrial processes remotely. Also, it facilitates feedback in real time with field devices. With this system's implementation, the industry has further optimized its processes in different areas, making them more efficient and improving operator safety.

Due to the high costs of implementing these systems, low-cost systems make them available to industries that do not have adequate technological development. It is intended that enterprises better control the different processes made, such as monitoring temperatures, motor speed, and liquid level, and more efficiently. Important related projects have been developed, such as access and remote control of a thermal system using LabVIEW and Moodle. A virtual learning space is created to design the user interface that allows remote monitoring of temperature (Bolívar *et al.*, 2018). Likewise, developing an interface for the remote control of motors using an embedded device was created with a Raspberry PI working as the main component (Arias and Pérez, 2015).

In the present work, the monitoring and control are carried out on an AC motor; LabVIEW (National Instruments, 2019) is proposed, which provides more efficient management of the system and a user-friendly interface. Likewise, a good alternative for remote monitoring is mobile devices use to achieve easy access to remote terminals due to the excellent coverage.

## 2. MATERIALS AND METHODS

The proposed system has the function of remotely monitoring and controlling the RPM of an AC motor. The system's design and implementation are divided into six stages, which are shown in Figure-1.

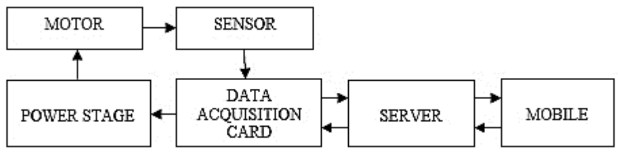


**Figure-1.** Block diagram of the proposed system.

### 2.1 RPM Measurement

The UGN 3503 (Allegro MicroSystems, 2019) reference Hall effect sensor used to sense speed is shown in Figure-2. This sensor generates a pulse every time it passes near a magnetic field, which is used to know the motor RPM. The sensor does not need any particular circuit for its connection, merely the power and the output. This sensor's output is connected to the data acquisition card and is processed through programming to determine the motor's speed.

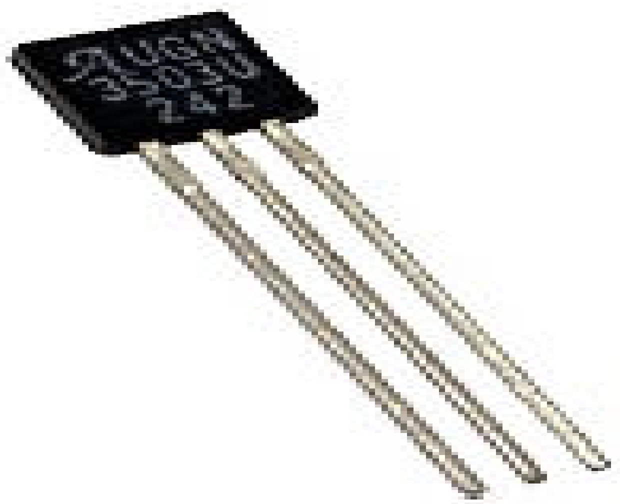

**Figure-2.** Hall effect sensor.

### 2.2 Acquisition System

ARPN Journal of Engineering and Applied Sciences



The data acquisition system is based on a USB-6009 card (National Instruments, 2019), shown in Figure-3. Analog input is used to acquire data coming from the Hall effect sensor. Furthermore, an analog output is configured to the power management stage to do the respective control.

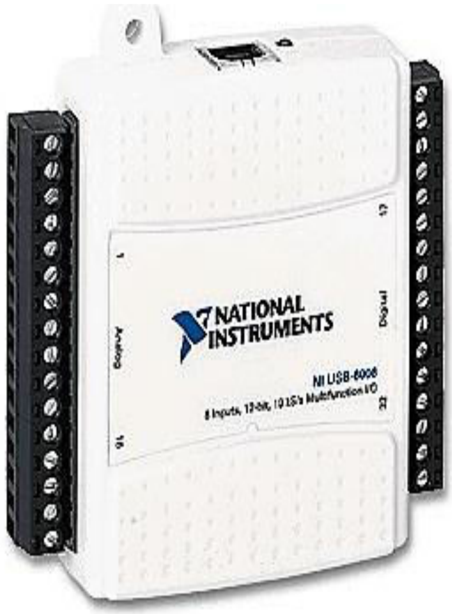


**Figure-3.** Data acquisition card.

**2.3 Server**

After data acquisition, the information is sent to the server by USB connection. The server is responsible for communicating between the mobile device and the motor; besides, it stores the input variable's data and performs its respective control. The server program is made with LabVIEW.

**2.4 Mobile Device**

LabVIEW mobile is used for mobile programming, making all the necessary modifications to run the mobile device's file.

**2.5 Control and Power Stage**

The speed variation is used in the power stage. It allows the control stage to be performed directly by the variator because it implements its control system internally. It is only necessary to send the RPM information required by the system, and the variator adjusts the motor speed until the speed needed for the mobile is obtained. For the project development, the AF-300 E11 variator shown in Figure-4 is used (Fuji Electric, 2019).


**Figure-4.** Speed variator.

**3. RESULTS AND DISCUSSIONS**

**3.1 Server Programming**

The server display window is shown in Figure-5. In this graph, the motor's RPM and the pulses generated at the Hall effect sensor input are shown. The RPM requested by the mobile (RPM control) and the motor rotor RPM (corrected variable) are illustrated. The control objective is that the requested RPM and the obtained RPM are equal. However, this isn't easy to achieve due to the resolution of devices such as the data acquisition card.

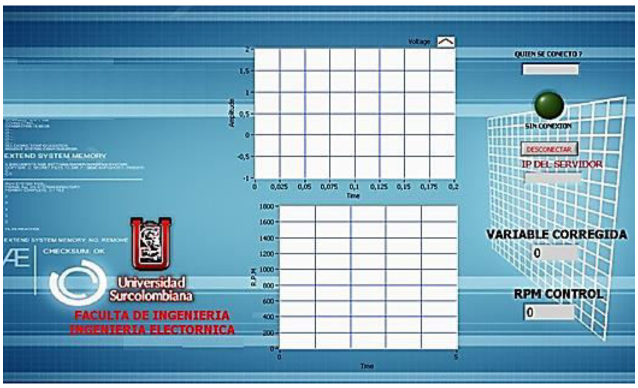


**Figure-5.** The server interface.

LabVIEW software is used for server and mobile programming. The server has different stages which are shown in Figure-6.

As soon as the input signal is acquired, it must be conditioned so that the program can read it; then, its

VOL. 18, NO. 7, APRIL 2023 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences



respective correction is made due to the signal's nature. Later, this information is sent to the mobile and is stored to have a record in memory. In addition to the stages described above, there is also one where the mobile signal is received and sent to the power stage responsible for carrying out the respective control. The programming on the mobile phone only receives the server's information and sends the operator's RPM

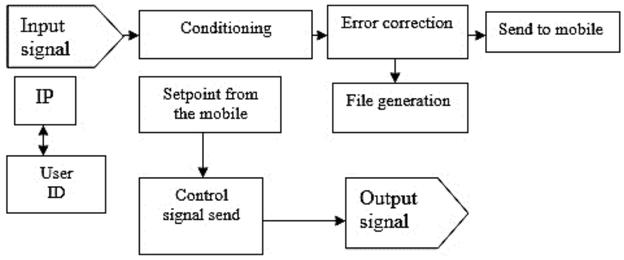


**Figure-6.** Server programming diagram.

### 3.1.1 Signal conditioning

The signal sent by the Hall effect sensor through the data acquisition card is taken at this stage. It is then conditioned and displayed on the front panel as a pulse wave caused by the Hall effect sensor. In this process, the motor's RPM is found, and a local variable is created, as illustrated in Figure-7.

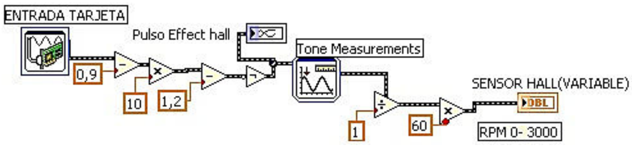


**Figure-7.** Signal conditioning.

### 3.1.2 Error correction

Due to stray electromagnetic fields generated when the motor is stopped and the magnet is close to the sensor, an error voltage is generated, and false RPM appears. Furthermore, conditioning is performed to avoid exceeding the maximum speed for which the motor was built. After making this correction, the front panel data is displayed as a "corrected variable," as shown in Figure-8.

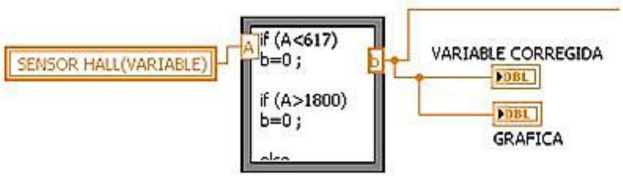


**Figure-8.** Correction of errors in the measurement.

### 3.1.3 Sending to mobile

In this stage, the information is sent to the mobile, besides, a signal adaptation so that the sending is made successfully is carried out as shown in Figure-9.

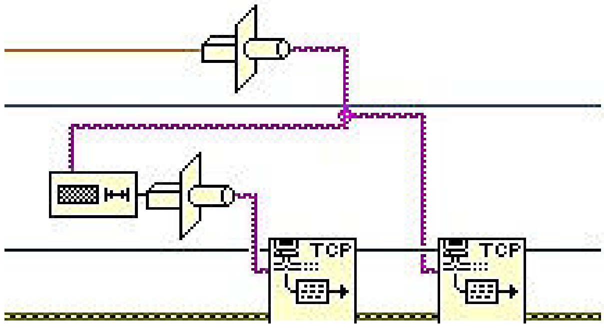


**Figure-9.** Sent to mobile.

### 3.1.4 File generation

In this stage illustrated in Figure-10, the corrected variable is taken as input, and a .txt file is written with information on the time, date, and RPM.

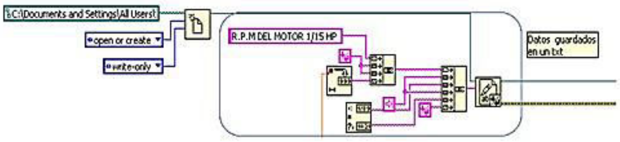


**Figure-10.** File Generation.

### 3.1.5 IP

At this stage, the server IP in the control panel to connect with the mobile device is supplied.

### 3.1.6 Setpoint from mobile

The setpoint data from the mobile are taken. When the setpoint is received, the respective reading and visualization on the front panel are carried out, which are named "RPM control." After this process, the reading of the data from the acquisition card begins (Figure-11).

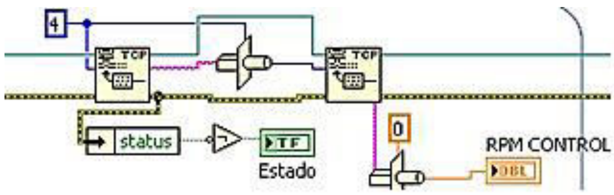


**Figure-11.** Setpoint from the mobile.

### 3.1.7 Sending of the control signal

In this stage, the RPM information required by the mobile towards the acquisition card is sent, as shown in Figure-12. After that, this information is sent to the speed variator and thus makes the respective control.

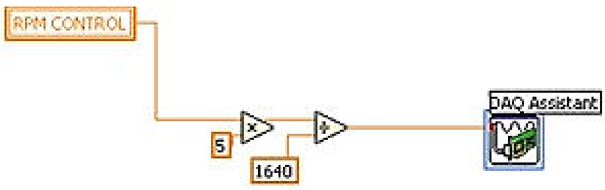


**Figure-12.** Sending of the control signal.

VOL. 18, NO. 7, APRIL 2023 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

### 3.2 Mobile Programming

The mobile is connected to the internet to access the connection with the server. Mobile programming is more straightforward than the server since it is only required to enter the server IP address and then send the RPM needed to start the system. The mobile receives the RPM information that the motor has from the server and displays them in its respective interface, as shown in Figure-13.


**Figure-13.** Mobile display interface.

It is essential to highlight that mobile data are conditioned to be viewed in the graphical interface mentioned above. Another critical aspect being considered is that the transmission speed depends on the communication quality that the mobile has with the server.

The general programming of the mobile is shown in Figure-14, and the explanation is detailed below.

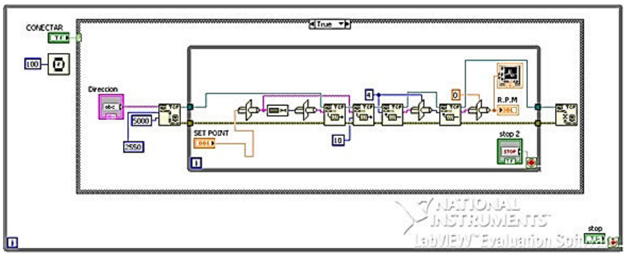


**Figure-14.** Mobile programming code.

#### 3.2.1 Server IP

In this stage, the server's IP address is entered into the mobile to connect them.

#### 3.2.2 Sending of set point

Now, the required RPMs are sent from the mobile to the server.

#### 3.2.3 Data acquisition from the server

In this phase, the motor speed acquisition (corrected variable) from the server is performed.

#### 3.2.4 RPM display

The motor speed is plotted and displayed on the mobile through the interface described before in Figure-13.

### 3.3 System Operation Test

The implemented system is shown in Figure-15. After the server's program is started, its IP address is taken and entered into the mobile to start the connection. Meanwhile, the program remains in standby mode until the device establishes the connection. Then, the RPM that is required to begin the process is sent by the mobile. The server takes that reference, and the variator is transmitted through the data acquisition card to start the motor and adjust the RPM to the required value from the mobile. During this process, the Hall effect sensor's pulses are taken and sent to the server through the data acquisition card. Finally, the signal is graphed both on the server and the mobile device. The number of revolutions per minute is displayed, then the revolutions information per minute is stored in a text file along with the date. In case to change the RPM reference, it is enough to change them from the mobile, and the procedure of sending data to the variator is repeated so that it modifies said variable and the process continues. In case it is required to turn off the motor, just set zero RPM.


**Figure-15.** Data acquisition and control stage.

To be compared, the RPM data requested through the mobile device and the RPM read from the motor are presented in Table-1. As observed, the data shows efficient tracking at the reference speed with low error.

**Table-1.** RPM requested Vs. RPM obtained.

| RPM requested | RPM obtained |
|---|---|
| 500 | 473 |
| 600 | 586 |
| 700 | 695 |
| 800 | 807 |
| 900 | 915 |
| 1000 | 1019 |
| 1100 | 1115 |
| 1200 | 1189 |
| 1300 | 1308 |
| 1400 | 1431 |
| 1500 | 1540 |
| 1600 | 1613 |
| 1640 | 1635 |

## 4. CONCLUSIONS

With the project's development, it was possible to implement a remote monitoring and control tool for an AC motor from a mobile device.

The implementation of this project provides an essential contribution to the construction of low-cost SCADA systems for small and medium-sized companies that want to automate their processes, improve production, and update their facilities in terms of technology.

Implementing a speed variator as a power management system offers more safety and efficiency due to the possibility of making modifications to this stage quickly according to the operating requirements.

LabVIEW has been developed to record and visualize motor speed tools; This tool is easily accessible and easy to understand.

## REFERENCES

Allegro Microsystems. 2019. Sensor de Efecto Hall UGN 3503 [On-line]. Available in: https://html.alldatasheet.com/html-pdf/55100/ALLEGRO/UGN3503/246/1/UGN3503.html.

Arias A. C. and Pérez L.E. 2015. Desarrollo de una interfaz para control remoto de motores usando un dispositivo embebido. Trabajo final para la obtención del título: Ingeniero en Ciencias Computacionales. Espol.Fiec, Guayaquil. 59p.

Bolívar Marín F., Sendoya-Losada D. F., Robayo Betancourt F. 2018. Access and remote control of a thermal system using labVIEW and Moodle. ARPN Journal of Engineering and Applied Sciences. 13(01): 321-324.

Corrales L. 2007. Interfaces de Comunicación Industrial. Departamento de Automatización y Control Industrial, Escuela Politécnica Nacional, Quito, Ecuador.

Fuji Electric. 2019. Variador de velocidad AF-300 E11 [On-line]. Available at: http://www.fujielectric.com.

National Instruments. 2019. Tarjeta adquisición de datos USB-6009 [On-line]. Available in: https://www.ni.com/es-co/support/model.usb-6009.html.

National Instruments. 2019. Entorno NI LabVIEW [On-line]. Available in: https://www.ni.com/es-co/support/model.usb-6009.html.