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INSTALLATION FOR MONITORING, CONTROL AND REMOTE DIAGNOSIS OF WOODBREAKER WITH DRIVING FROM LAPTOP OR SMART PHONE

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Abstract: The paper presents the installation of monitoring, control and remote diagnosis of a woodbreaker as well as the way to improve its operation using the actuation by means of a converter, with speed adjustment and anti–locking system. The solution developed by INOE 2000 together with the partner company CORNER PROD has proposed to carry out a monitoring with warning system and recording the parameters in the type of operation in order to prevent the appearance of problems in operation, which is actually the necessary torque, why the peaks torque appear. The equipment can be integrated into a fully automatic system.
Keywords: woodbreaker, intelligent drive, automation, biomass

1. INTRODUCTION

In recent years, the increase in the technical and technological level has had a strong impact on all branches of industry. At the same time, mass production imposed the maximum reduction of the operating costs of machinery, production lines. (Lacatusu P., Ionel M., et.al, 2021).
In general, at low power, at this moment the problem is solved by oversizing the engines and reducers, but in the conditions in which it is necessary to use engines with premium efficiency to decrease the energy consumption, the oversizing approach is a matter of the past, especially as the energy is expensive and optimize these drives. (Narayan, S, 2005).
The lack of equipment with tools for biomass breakage, whether we burn it or process it primarily, in the household, is very acute. Researching the current situation of the market, we found that there is room for improvement which meets the needs of users (Stojanovic, N. et al. 2018).
With the development of hydrostatic action technology, wood–breaking machines for fire driven by hydraulic force were also created. Three variants of machines for splitting wood are manufactured in the world. Splitting consists in the penetration of a wedge into the wood in the direction of the fibers. The widely used maintenance strategies are periodic, corrective maintenance and predictive maintenance. Periodic maintenance is based on maintenance schedules given by the manufacturer with periodical revisions, changes of parts and consumables. Periodic maintenance imposes important operating costs given by the downtime, the change of some subassemblies and consumables before reaching the necessary wear due to the operating conditions, or the failure of the equipment between the revision periods due to the exceeding of some technological limits in operation. Meeting the needs of reliable equipment with active assisted operations based on intelligent supervision (Hassan, M.M. et al., 2020) is a priority for researchers.

2. MATERIALS AND METHODS

The solution developed by INOE 2000 together with the partner company CORNER PROD has proposed to make a woodbreaker with three–phase electric motor, is part of the field of low power industrial or domestic equipment, designed to break firewoods in order to use them for burning in stoves for heating spaces or food preparation. It consists, according to the technical drawing, of a stick 1, equipped with two wheels and a set of lifting arms 8 for transport. On the stick are located: hydraulic group 7, log lifting platform 6, breaker cylinder 2 with pushing plate 3, log lift cylinder 5, knife 4 with indexing system 9, hydraulic manifold for cylinder burglar 10, hydraulic manifold for lifting cylinder 11 and knife lifting lever 12.
The prototype without lift executed within the project is shown in Figure 2. The logs are taken from the ground by pushing on platform 6 which is raised to the working level by hydraulic cylinder 5 by operating the control lever of the manifold 11. From here, a log is manually transferred in the light of the baton to the right of the pusher plate 3 equipped with anti–slip spikes, the breaker knife 4 is manually positioned in the optimal central position, by means of the lever 12 and the indexing system 8.

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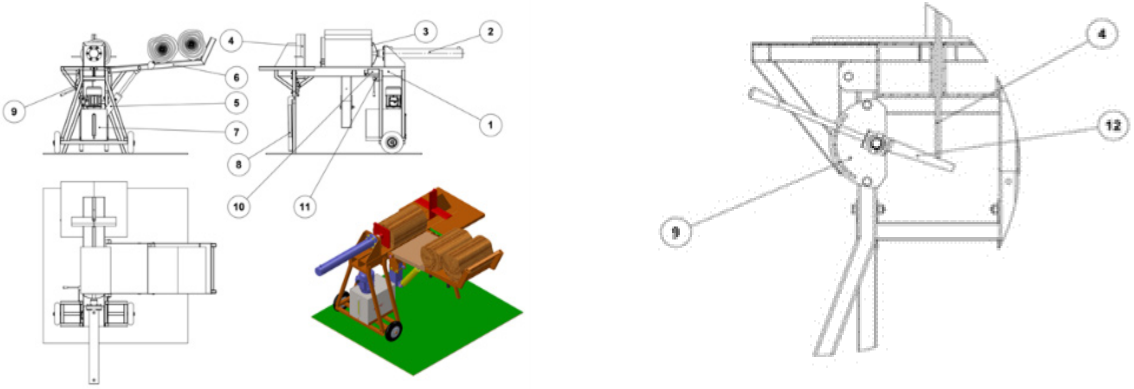

Figure 1 – The constructive solution of the woodbreaker

Figure 2 – Prototype of the woodbreaker

From the lever of the hydraulic manifold 10 the advance of the breaker cylinder 2 pushing the logger through the pusher plate 3 towards the breaking knife 4 is controlled with a force of up to 7 tf sufficient for any type of wood. After cracking the wood, it is ordered through the manifold 10 to withdraw the cylinder rod and the pushing board while the work area is freed from the broken wood. Then the process of positioning the log and knife is resumed and the activity of breaking wood continues. The manual mechanism for indexing the position of the burst knife is composed of lever 12, spherically articulated on the indexing system 8, which acts by direct contact portcutite 4. Changing the position is done by operating the 12 lever to the side and removing the locking spur from one position and inserting it to another position, up or down. Establishing the optimal position of the knife eliminates in large part the unwanted tangential forces created due to the detachment of the hub from the cracking axis.

3. ARCHITECTURE OF THE MONITORING SYSTEM

The online monitoring system designed and implemented allows continuous monitoring of the monitored engine consumption as well as of the temperature in three points. The architecture of the system has three main components:

- Sensor system
- Communication network
- Data processing module

Sensor system

The sensors used in this application are wifi communication sensors produced by Shelly Cloud Bulgaria. In this application are used two sensors. The sensors used are intelligent sensors based on SoC microcontrollers, system on a chip, from express if's ESP8266 family. These sensors run an application that allows them to have a WEB interface for configuration and monitoring. ESP8266 systems have also implemented a TCP/IP stack and hardware needed to connect to a WiFi network in the 2.4 GHz band. At this level of system development, two types of electrical and temperature sensors are used.

Electrical sensors

The electrical sensor is Shelly 3EM that allows to measure the voltage in the three–phase network and the current consumed by each phase of the motor. The sensor acquires all these six sizes with a cadence of one measurement per minute. The whole sensor does the calculations to indicate the power consumed on each phase and the power factor.

Thermal sensors

The thermal sensor is Shelly 1 with temperature measurement mode that allows the purchase of three temperatures, in three points with semiconductor sensors of type 18S20 in housings with ip67 degree of protection. Temperatures are read with a cadence of one measurement per minute.

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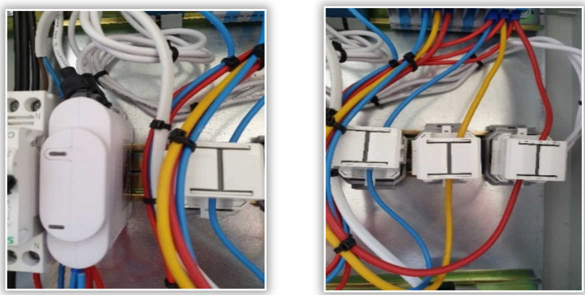
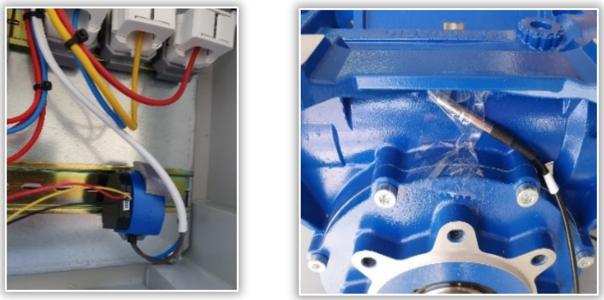


Electrical size transducer   Current transformers 120A

Figure 3 – Electrical sensors



Temperature transducer   Temperature transducer

Figure 4 – Thermal sensors

Communication network

The communication network used in the application is a local WiFi network, used only by the components of the application. The network is controlled by the Microtik Hap Lite RB941 Access Point rotor that ensures the management of network functions:

- Authentication of clients on the WiFi network Alocarea automata de adrese in rețeaua locala prin protocolul DHCP
- Network Address Translation function to be able to connect the local network to the internet
- Firewall function to protect the internal network from attacks from the internet
- Port forwarding function to make available resources from the local network to the Internet to allow access to data collected and processed by the system from the Internet

Figure 5 – Control module

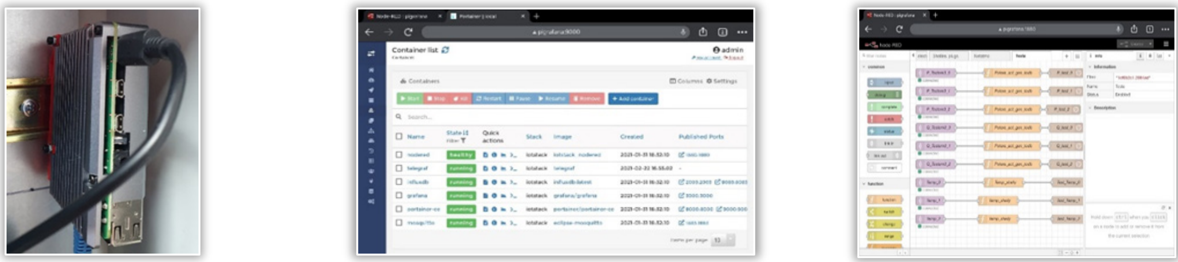
All sensors connect to the WiFi network and automatically receive IP addresses from the Microtik router. pplying the Internet of Things (IoT) can improve the efficiency of technology for monitoring the operation of agricultural equipment (Pi, J. et al., 2021)

Data processing module

The data processing module is implemented with a Raspberry Pi 4 with 4GB of RAM that provides all the necessary functions for the application:

- data collection
- storage
- data processing

The Raspberry Pi runs the Raspbian operating system together with the applications necessary to ensure the above functions.



The Processing Computer Raspbarry Pi 4   Application with portainer CE container management web interface   Node–Red graphical application

Figure 6 – Data processing module

In order to ensure an easy replication of the system, a solution for using docker containers with the necessary applications was chosen. Under these conditions, only a compose file for the Docker Compose application is required for the replication of the application. The compounding file that was written specifically for this application has the YAML format. It allows downloading from the internet the necessary

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Docker containers and tying them to ensure the operation of the application. The management of the installed containers can be done through the web interface of the Portainer–CE application.

Data collection function

The data collection function allows you to retrieve data from sensors with the cadence of one measurement per minute. Each sensor is programmed once a minute to transmit the data measured by the MQTT protocol. The MQTT protocol is in the Publish/Subscribe protocol that allows the acquired data to be automatically distributed to the processing storage applications.

In order to use the MQTT protocol, it is necessary to use a Broker that takes the data published by the sensors and transmits it to the applications that have subscribed for the receipt of the respective data. The MQTT broker is provided by the Mosquitto opensource application running in a Docker container (***https://www.loaderplans.com/log–splitter). Within the data collection function is also the Node–Red opensource application that allows graphically making and running NodeJS applications.

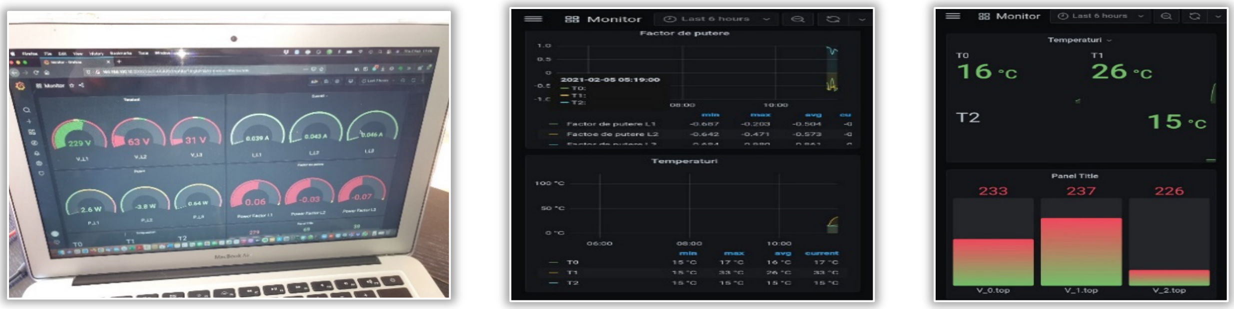
The function of the Node Red module is to connect to the MQTT Broker and primarily process the data received from the sensors in order to be stored in a database. The module implemented in Node Red also ensures the automatic transmission of alerts by e–mail in case of exceeding some values measured by the sensors.

Storage function

The storage function is provided by an InfluxDB time database that retrieves the data processed primarily by the Node–Red module applies them a timestamp and stores them. InfluxDB also runs in a Docker container and stores the data on the 64GB SD card in the Raspberry Pi. The InfluxDB database is of opensource type with a high similarity to SQL type databases.

Most of the data processing function is provided by the Grafana opensource application. Grafana is connected to the InfluxDB database, retrieves the data and displays it based on "dashboard" specifically programmed for this application in public web pages. The Grafana application can be programmed to give warnings and alarms when exceeding specified thresholds for the measured data. The data in the InfluxDb database can be processed through specific mediation functions, maximum storage, minimum.

In order to test the prototype of the intelligent drive installation used in the woodbreaker from the experimental model, the validated tests for the experimental model were repeated and the data and the damage warnings were transmitted to the computer and mobile phone.



Tested system

Various data display panels

Figure 7 – Storage function

Monitoring module

Various data display panels

Figure 8 – Monitoring module

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Figure 9 – Measurements of current, voltage, powers, power factor

The data is automatically recorded every 5 sec and is transmitted wirelessly by the monitoring module located near the woodbreaker to the control module connected to the central computer for interpreting the data and establishing the decisions to be taken

4. CONCLUSIONS

The monitoring system allows the acquisition and recording of the main electrical parameters and temperatures from a main motor assembly, their storage in a temporal database and their graphic display at the same time with the alarm of exceeding some predetermined value.

The realized system monitors the action behavior throughout the duration of use and follows the following parameters:

- The current absorbed on each phase of the motor;
- The absorbed power on each phase;
- The voltage on each phase;
- The power factor on each phase;

The temperature recorded in correlation with the other parameters in 3 strategic points on the engine and on the reducer (a sensor is also used to measure the ambient temperature)

It has been proven that one can improve the operation of the motoreducer by operating it by means of a converter, with speed adjustment and anti–lock system, but without a monitoring with warning system and recording the parameters in the type of operation it is not known where the problems arise from, what is actually the momentary moment, why the peaks appear, how long the peaks last. It is necessary a predictive maintenance and eventually the integration into a fully automatic system.(Matache, G., Barbu, V et al. 2021).

The same problems are encountered in other types of equipment that uses biomass, such as conveyors, especially where the personnel using the installations do not check and do not comply with the conditions listed in the technical book, but where they cannot be checked if the normal operating conditions have been observed.

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