Chapter 187

Development of a climate data collector and vibration in egg conveyors in commercial households

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ABSTRACT
The egg is a food with great prominence in Brazil because of its nutritional power and low cost. With the technological advances many farms choose to automate their whole production process, however, many times these technologies may interfere and favor losses during production, requiring adjustments to avoid these losses. Therefore, it is noteworthy that problems originating from vibrations and impacts during the automated egg transportation causing cracks in eggs, besides sun exposure, are one of the main factors that stand out in the production loss of eggs. With this in mind, the present project aimed to create a hardware prototype that collects data on weather conditions and vibration of commercial aviary belts and a firmware that can be embedded in the prototype to read the information collected by the hardware and record it in a memory card for later analysis of the collected data.

Keywords: Data collector, Egg, Automated transport.

1 INTRODUCTION

The egg is seen as a more nutritious and low-cost option for the human diet because it is a food rich in proteins and nutrients.

Eggshell quality has always been a major concern for laying poultry. According to FERNANDES (2012), The shell is primarily responsible for protecting against mechanical shocks, making it difficult for the egg to be infected by bacteria and pathogens.

According to the Associação Brasileira de Proteína Animal (ABPA, 2022), Brazil was responsible for producing around 54 billion eggs in the year 2021, with 99.54% of this production destined for the Brazilian domestic market.

According to the Government of the State of São Paulo (2019), about 30.9% of all national production is in the state, having the capacity to feed more than 60 million people per year.

PIZZOLANTE et al. (2011) state that in the poultry farming activity of laying hens, recent technological innovations are considered radical or incremental in the creation systems, and that the adoption of these technologies aims to reduce production costs by reducing processing time and labor.

According to NAZARENO (2012), nowadays it is observed that there are losses in the egg production line due to cracks and fissures during the automated displacement from production to the places of classification, packaging, and dispatch, caused by vibrations and impacts.

FERNANDES (2012), says that with the increase in temperature together with the high humidity, there is a gradual decrease in the quality of the eggshell, favoring losses during production.

The insertion of new technologies for the automation of processes in poultry laying may not always have favorable results, requiring the development of accessories that help to minimize losses during production.

2 JUSTIFICATION

It is considered that it is possible to prevent the loss of egg quality during the movement on a conveyor between the sectors of the farm with the implementation of a technology that collects and stores data referring to sudden changes in dry bulb temperature and relative humidity, vibrations and impacts identified during the conveyor belts. Therefore, it will be possible later to carry out an analysis of the collected data to identify and mitigate problems located in the path of the conveyor belts.

3 OBJECTIVES

The current research project aims to study and carry out the development of an autonomous data logger hardware prototype capable of collecting data regarding dry bulb temperature, relative air humidity and vibration, and the impacts of mats in laying aviaries. To jointly develop a firmware capable of being embedded in the hardware, allowing the reading of the temperature and relative humidity sensors, and the vibrations in three axes through the accelerometer. The firmware should also read the date and time of the records from a real-time clock and store the collected data on an internal solid-state memory card so that it can be exported for future analysis in supervisory software.

4 MATERIAL AND METHODS

At first, the works were based on the analysis of the literature in international and national databases of scientific articles, in this way, it was possible to have a deeper understanding of the problems of vibration and impacts, in addition to issues of climatic conditions. The literature analysis was also essential for understanding the development of hardware and firmware to obtain results in an egg production environment.

The development of the hardware initially took place by identifying the components that would compose the project. Therefore, the selected components were:

- Arduino UNO baseboard.
- DataLogger module with integrated RTC (Real Time Clock).
- DHT-11 sensor (Dry bulb temperature and relative humidity).

● MPU-6050 Sensor (Accelerometer and Gyroscope).

● Micro SD adapter.

● 9V battery.

● Battery 3V.

With the list of selected components, the block diagram was developed, in which its function is to facilitate the understanding and application of the project.

The project hardware was previously developed with the help of modeling and prototyping software provided by the Friends-of-Fritzing Foundation (FRITZING, 2022), to plan, simulate and define the connections of components on the acquisition and control development boards.

Later, with the prototype virtually developed, the DHT-11 and MPU-6050 sensors and their corresponding circuits were soldered on the Data Logger Module board with integrated RTC according to the virtual creation.

The project firmware was developed in the C++ programming language, from the Arduino IDE application available on the internet (ARDUINO, 2022), having the ability to collect data from climatic elements, together with vibration data from the three axes of the accelerometer. In addition to collecting data, the software is capable of recording the date and time of each reading and

record the data on a micro SD card in a .txt file, for later evaluations using data analysis software.

Using the Arduino IDE application, it was possible to embed the firmware on the AVR microcontroller chip of the hardware built through the computer's USB port connected to the data acquisition board.

With the development of the hardware and firmware, it was possible to carry out functional tests of the prototype built in the digital systems laboratory located on the premises of the Faculty of Engineering and Sciences, UNESP, Tupã-SP campus.

5 RESULTS AND DISCUSSION

The elaboration of the project was separated into six stages: selected components, development of the block diagram, development of modeling and prototyping, assembly of the prototype, development of the firmware, and tests.

5.1 SELECTED COMPONENTS

5.1.1 Base Plates

After a preliminary study, the prototyping and welding boards that would compose the design of a hardware prototype can be defined, so, as shown in Figure 1, it is possible to observe the selected baseboards.

Figure 1: Arduino Uno Tenstar Robot Board (a) and DataLogger Module with integrated RTC (b).

(a) (b)

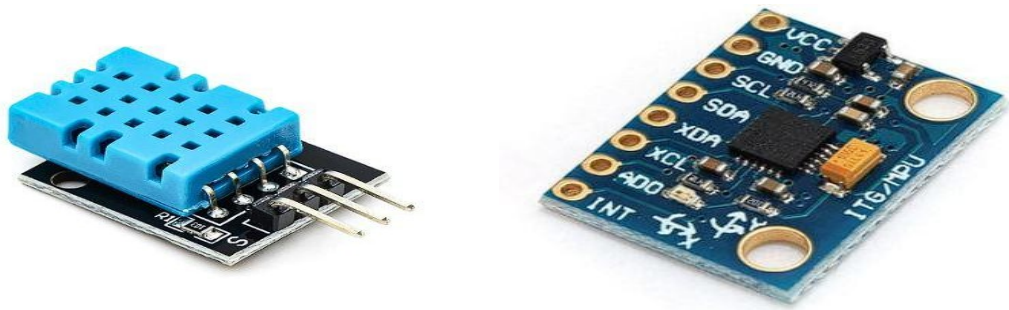
The Arduino Uno Tenstar Robot board has an Atmega328p microcontroller, developed by the company Atmel Corporation. This microcontroller features high performance with low power consumption, a supply voltage range from 2.7V to 5.5V, and 23 digital inputs and outputs.

The Datalogger Module with integrated RTC features an input for a micro SD card adapter, an integrated DS1307 real-time clock, an area for prototyping and soldering and the ability to be coupled to the Arduino Uno Tenstar Robot board.

5.1.2 Sensors

The selected sensors can be seen in Figure 2.

Figure 2: DHT-11 sensor (a) and MPU-6050 sensor (b).



(b) (b)

To measure the dry bulb temperature and relative humidity of the air, the DHT-11 sensor was chosen, with characteristics of low energy consumption and measurement accuracy of ± 5% concerning the relative humidity of the air and ± 2ºC for the temperature. The MPU-6050 sensor is responsible for measuring the vibrations and impacts in the three axes (x, y, and z) during transport by the aviary mats. Its features are low power consumption and I2C communication.

5.1.3 Micro SD Adapter, Battery, and Battery

As shown in Figure 3, it is possible to observe the components selected to receive the collected readings and power the prototype and the battery to attach to the real-time clock.

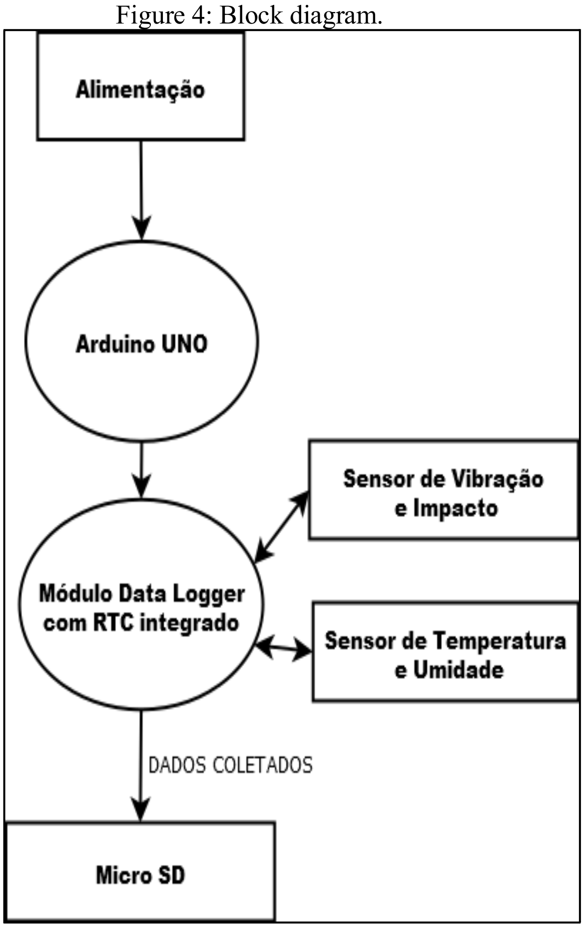
Figure 3: Micro SD adapter (a), 9V battery (b), and 3V battery (c).

(c) (b) (c)

5.2 DEVELOPMENT OF THE BLOCK DIAGRAM

The block diagram was developed to mitigate and assist the assembly of the prototype containing all selected components. You can view the diagram in Figure 4.

Figure 4: Block diagram.

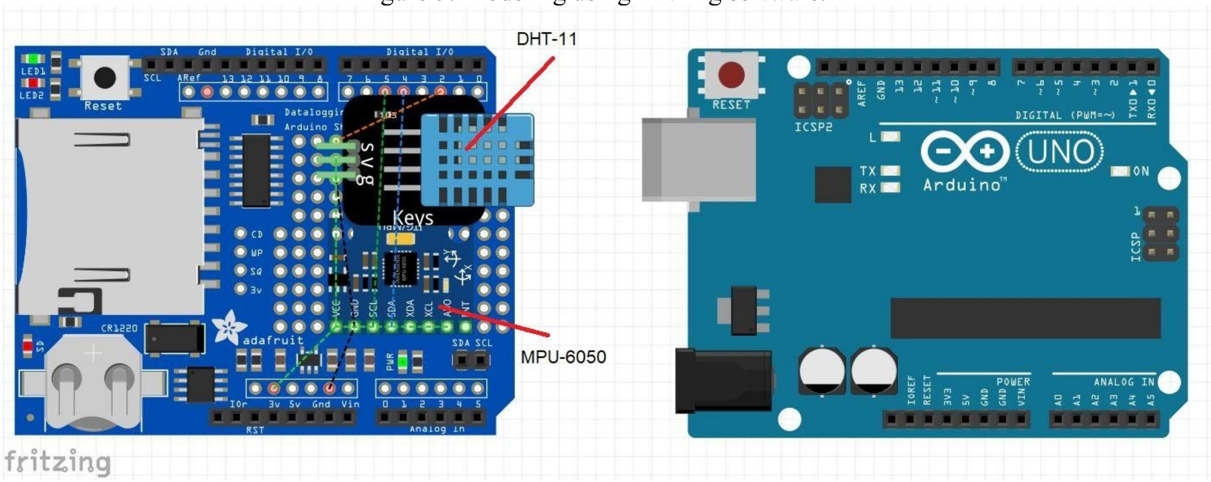


Therefore, from the block diagram, there was an understanding of how it would be necessary to handle the components in addition to effectively knowing their applications.

5.3 DEVELOPMENT OF MODELING AND PROTOTYPING

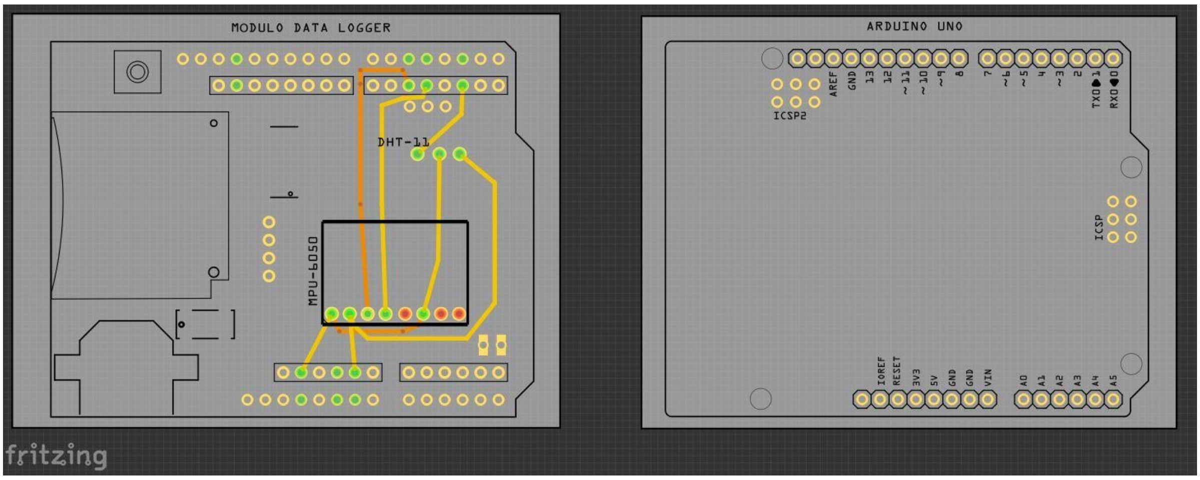
With the selected components and understanding of the application, it was developed from the software provided by Friends-of-Fritzing (FRITZING, 2022). In this way, it was possible to develop the breadboard with the elements of the project. Figure 5 represents the modeling of the plates together with the sensors coupled in the desired way.

Figure 5: Modeling using Fritzing software.



With the idealized modeling, the electrical layout of the components was carried out together with the routing and interconnection with the help of the Fritzing software. Figure 6 shows the PCB (Printed Circuit Board) of the project with the connections between the boards and the sensors.

Figure 6: Visualization of the PCB with the electrical circuit routings.

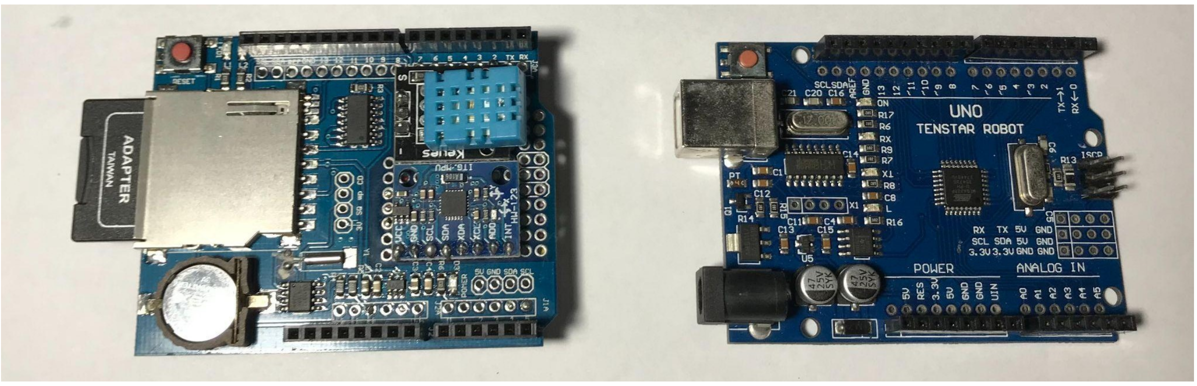


As seen in Figure 6, the sensors are supplied with a voltage of 3.3V, while the other routings are standardized from their respective datasheets.

5.4 PROTOTYPE ASSEMBLY

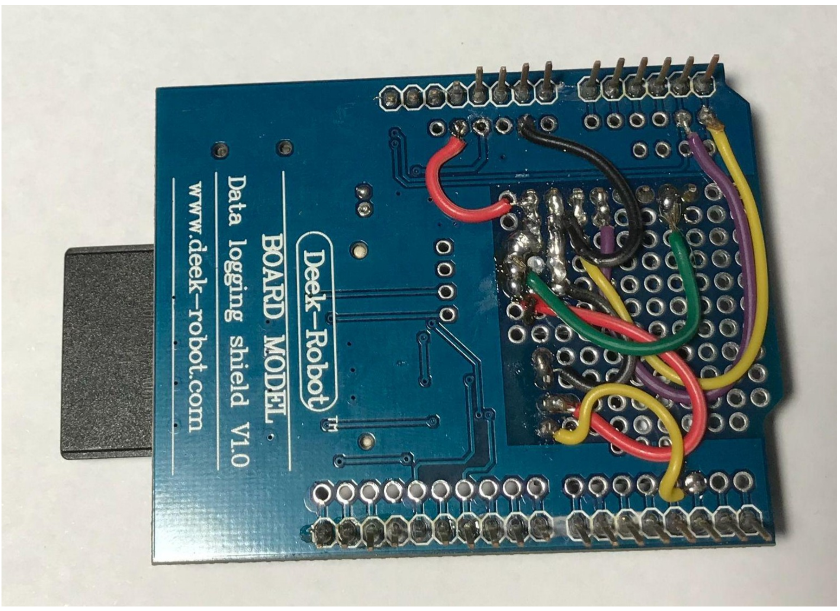
The assembly of the prototype took place by understanding all the items above that served as the basis for the construction of the proposed hardware. Figure 7 shows how the sensors were soldered on the DataLogger Module prototyping board with integrated RTC and the right side shows the Arduino UNO Tenstar Robot board.

Figure 7: DataLogger module with integrated RTC with soldered sensors and Arduino UNO Tenstar Robot baseboard.



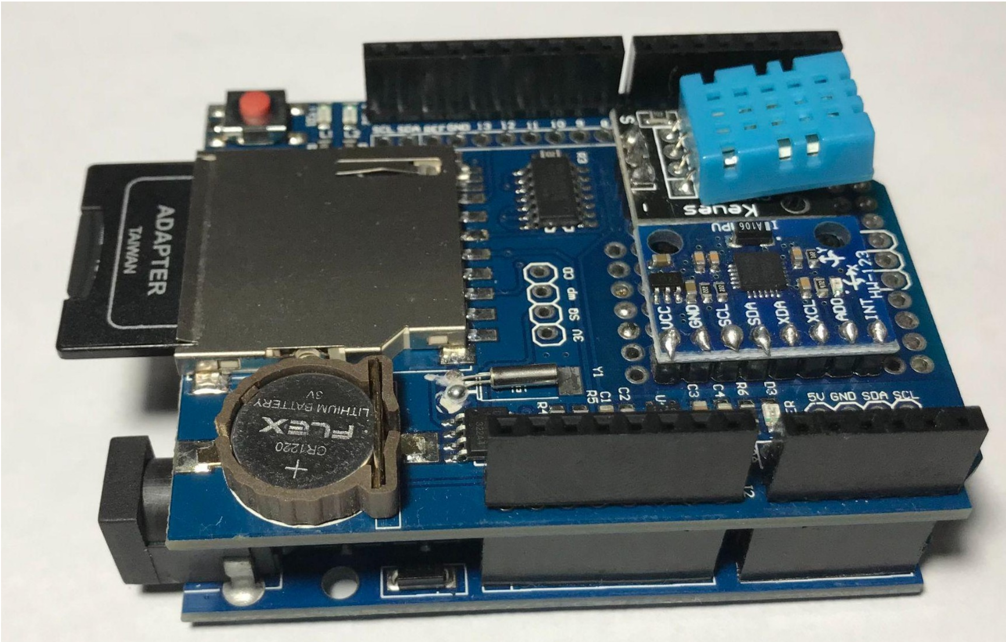
The soldering of the circuits of the respective sensors can be seen in Figure 8. All soldering was based on the previously developed PCB.

Figure 8: Electrical circuit of the sensors.



Finalizing the development of the prototype, it was necessary to attach the DataLogger Module board with integrated RTC to the Arduino UNO Tenstar Robot board. As the two boards are compatible, it was only necessary to connect the pins of the DataLogger Module with RTC integrated into the inputs available in the Arduino UNO Tenstar Robot. You can see the final prototype in Figure 9.

Figure 9: Finished prototype.



5.5 FIRMWARE DEVELOPMENT

The firmware designed to be embedded in the built hardware was made from the Arduino IDE tool available on the internet. The code construction phase was based on the project objectives.

Initially, the code performs a test to verify the existence or not of the micro SD card in the reading module, in addition to verifying the integrity of the card, verifying that it is active to carry out data collection.

After checking the micro SD card, the real-time adjustment of the RTC and the activation of the sensors were performed.

With all the components of the prototype working, the information collected by the respective sensors and by the RTC was read and stored in variables that helped in the information recording part.

It was idealized in the firmware to record all data collected on an SD card, where a .txt file was created on this card to carry out the record of all readings performed with the formatting of the data layout allowing future export and analysis.

Therefore, the collected data that were sent for recording on the micro SD card were the date, time, and day of the week, dry bulb temperature, relative humidity, and the three axes (x, y, and z) of the accelerometer.

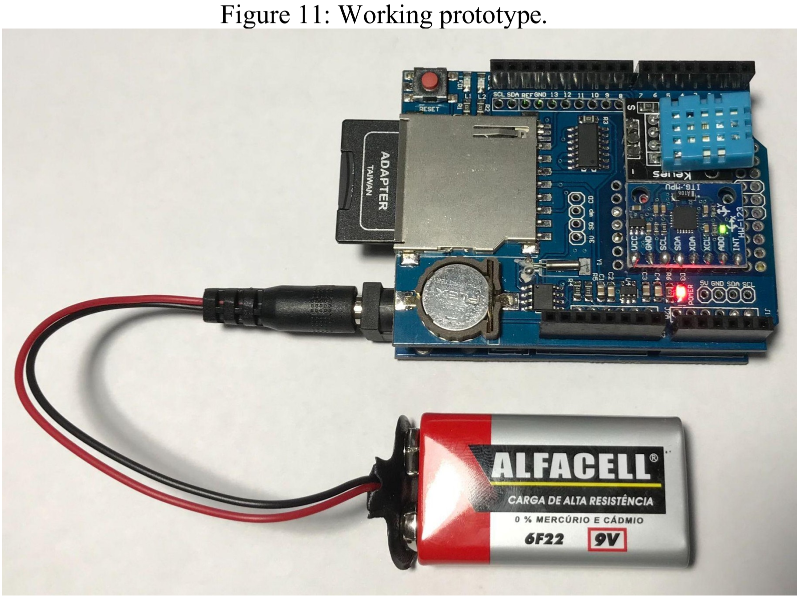
5.6 TESTS

With all parts of the project developed, it was tested and verified in the laboratory to validate the correct functioning of the hardware and firmware through the computer's USB port. You can appreciate the measurement results that were obtained from the serial monitor of the Arduino IDE software in Figure 10.

Figure 10: List of readings performed for the variables.

With the bench test, where the prototype was connected from the computer's USB port, the project was tested using a 9V battery. It is possible to observe the prototype coupled to the battery from Figure 11.

Figure 11: Working prototype.



After testing the prototype with the battery, it was seen whether there was an efficient record on the micro SD card of all collections carried out in a .txt file. The recording result can be seen in Figure 12.

Figure 12: .txt file generated with all collections performed.

DATALOG (1) - Bloco de Notas

Arquivo Editar Formatar Exibir Ajuda

Internal Clock Time:				Humidity(%)	Temperature(*C)	Eixo X	Eixo Y	Eixo Z
2022/10/25,	Tuesday,	15:56,	Measurements:,	34.00,	26.00,	-6712,	-2248,	15084
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	4184,	-11496,	12412
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	7948,	-3108,	9820
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	5020,	-4184,	13140
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	10224,	-5028,	14612
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	8904,	-9424,	-10904
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	4468,	-10072,	788
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	6060,	-7092,	-576
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	19036,	-10348,	4684
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	876,	-1456,	14140
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	-12936,	-76,	5932
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	1464,	-5228,	14604
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	25128,	-1552,	-19944
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	25.00,	9116,	-7444,	9516
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	25.00,	6960,	-592,	15328
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	25.00,	13884,	-10956,	2084
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	-1948,	-7104,	13284
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	13444,	-12516,	19464
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	10528,	-9872,	9708
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	6924,	-6600,	8976
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	5508,	-6828,	7016
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	4040,	-3072,	27392
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	3932,	-7348,	7308
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	-460,	-6232,	16824
2022/10/25,	Tuesday,	15:56,	Measurements:,	33.00,	26.00,	10472,	-7608,	14976
2022/10/25,	Tuesday,	15:56,	Measurements:,	32.00,	27.00,	6808,	-7464,	7368
2022/10/25,	Tuesday,	15:56,	Measurements:,	32.00,	27.00,	5428,	-8276,	13436
2022/10/25,	Tuesday,	15:57,	Measurements:,	32.00,	27.00,	9952,	-9500,	20732
2022/10/25,	Tuesday,	15:57,	Measurements:,	32.00,	27.00,	8384,	-9476,	8668
2022/10/25,	Tuesday,	15:57,	Measurements:,	32.00,	27.00,	-4544,	-5764,	11128
2022/10/25,	Tuesday,	15:57,	Measurements:,	32.00,	27.00,	10920,	8020,	-632
2022/10/25,	Tuesday,	15:57,	Measurements:,	32.00,	28.00,	12688,	11060,	4488
2022/10/25,	Tuesday,	15:57,	Measurements:,	32.00,	28.00,	10844,	11008,	6488
2022/10/25,	Tuesday,	15:57,	Measurements:,	32.00,	28.00,	5152,	7476,	12776
2022/10/25,	Tuesday,	15:57,	Measurements:,	32.00,	28.00,	9572,	11872,	6284
2022/10/25,	Tuesday,	15:57,	Measurements:,	32.00,	28.00,	14968,	4124,	1372

With the recording of the collected data, it will be possible to later perform the analysis of the data from software capable of identifying the critical points, thus helping the producer to reduce production losses.

6 CONCLUSION

Despite the difficulties encountered during the development of the project, it was concluded that it was possible to achieve all the objectives proposed for the development of the prototype. The developed project can collect climate and vibration data through low-cost components, but very efficiently, in addition to recording all the information collected for future data analysis.

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