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DETERMINING THE WEIGHT OF OIL EXTRACTED WITH A SCREW PRESS USING A STRAIN GAUGE SENSOR, HX711 MODULE, AND ARDUINO

This research presents an automated system for quantifying oil extracted from a screw press, leveraging a strain gauge sensor and HX711 module in synergy with the Arduino platform. This innovative setup measures the target mass of extracted oil, wherein the collected data is further processed by an Arduino microcontroller. User-defined measurement parameters, such as specific oil mass, dictate when the system terminates the screw press operation.

Hitting the set oil mass triggers the Arduino microcontroller to halt the press, allowing for the conservation of raw materials and energy, and consequently ensuring product quality consistency. Conversely, if the desired mass value remains unreached, the extraction continues until fulfillment of target outcomes. This approach optimizes press use, manifesting in maximum efficiency and selectivity in the production process. It demonstrates how such a control system can automate measurement and production supervision, thus fostering optimal screw press operation.

The article suggests the solution for integrating Arduino, HX711 module, and strain gauge sensor to measure the weight of the oil extracted through the screw press. The strain gauge and HX711 module were programmed within the Arduino Integrated Development Environment, enabling the accurate measurement of extracted oil mass and data transference to the Arduino controller. A housing bracket 3D model for the strain gauge and HX711 module within the existing screw press was also created using 3D modelling and subsequently printed and implemented. This aids reliable sensor fitting and ensures system stability for oil mass measurement.

This study demonstrates the potential for implementing this advancement within pre-existing press infrastructures with minimal changes. Our methodology offers prospective enhancements in quality and efficiency, notably within the oil production domain.

Keywords: Arduino, Oil Pressing, Automation, Control Systems, Smart Technology.

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ВИЗНАЧЕННЯ ВАГИ ВИЧАВЛЕНОЇ ОЛІЇ ШНЕКОВИМ ПРЕСОМ З ВИКОРИСТАННЯМ ТЕНЗОМЕТРИЧНОГО ДАТЧИКА, МОДУЛЯ HX711 ТА ARDUINO

У цьому дослідженні представлено автоматизовану систему кількісного визначення олії, видобутої з шнекового преса, використовуючи тензодатчик і модуль HX711 у взаємодії з платформою Arduino. Ця установка вимірює цільову масу видобутої олії, при цьому зібрані дані додатково обробляються мікроконтролером Arduino. Визначені користувачем параметри вимірювання, такі як маса олії, визначають, коли система завершує роботу шнекового преса.

Після досягнення встановленого значення маси вичавленої олії, мікроконтролер Arduino надсилає сигнал для зупинки пресу, що дозволяє уникнути перевитрати сировини та енергії. Такий підхід також забезпечує однорідність якості продукту, оскільки кожна партія вичавленої олії вимірюється. З іншого боку, якщо задане значення маси ще не досягнуто, процес вичавлення може продовжуватися до досягнення цільового результату. Це дозволяє оптимізувати використання пресу, забезпечуючи максимальну вибірковість і результативність у виробничому процесі. Така система керування дає можливість автоматизувати процес виміру та контролю виробництва, забезпечуючи ефективну роботу шнекового пресу.

Ключові слова: Arduino, Oil Pressing, Автоматизація, Системи керування, Розумні технології.

Staging problems

In many cases, measuring screw press oil can run into staging problems. This means that it is difficult to determine exactly when the oil extraction process should be stopped or continued to reach a certain mass of extracted oil. This problem arises due to the large number of factors that affect the pressing process, such as the type of raw material, its moisture content, temperature and press settings.

The solution to this problem lies in the development of a control system that will allow accurate measurement of the mass of the pressed oil and automatically control the operation of the press. Using the strain gauge, HX711 module and the Arduino IDE allows you to get accurate mass data in real time. After installing the sensor in the press body and programming the system, it is possible to set a certain weight value to be reached and automatically stop or continue the pressing process according to this value. This approach avoids staging problems and ensures efficient and automated extraction of oil from the screw press.

Analysis of recent sources

Arduino [1] is a multi-faceted platform that eases the creation of electronic projects by offering microcontrollers and a programming environment [2]. This remarkable tool empowers individuals, regardless of their lack of prior knowledge, to gain programming proficiency and nurture mastery in the fields of robotics and electronics.

Arduino is widely used in various fields including automation, robotics, IoT (Internet of Things) [3], medical technology, agriculture, and many more. It allows users to create devices that can interact with the real world, control different mechanisms, collect and analyze data.

The sheer simplicity and cost-effectiveness of Arduino have played a significant role in its widespread embrace by artistic souls, trailblazers, and scholars all across the globe. It opens up endless avenues for unleashing one's imagination and pushing the boundaries of electronic wizardry and coding prowess [4].

In this article [5] authors explain the creation of a prototype system for collecting data on the mass flow for pressing palm kernel seeds. The prototype successfully passed tests, showing a 5% error in load sensor calibration and 100% efficiency in communication between Bluetooth and Arduino. The system will help identify critical points for press maintenance and search for reasons for its decreased productivity.

The work [6] introduces a technique for creating a low-cost device called a tensiometer, which is used to measure the tension between a liquid and air at their interface. To construct this device, commonly used tools such as an analytical balance, an Arduino microcontroller, and a constant current are utilized. In addition, manufacturing techniques like CAD and 3D printing are employed. To facilitate the operation of the tensiometer, user-friendly software with a graphical user interface has been developed. The article also includes the source code of the software and CAD models that can be used to print the necessary components. Furthermore, the effectiveness of this proposed tensiometer has been demonstrated through experiments involving nanofluids. These studies have shown promising results when dealing with intricate systems. The study [7] reveals tension between values in the data from the Arduino.

This paper [8] investigates the creation of electronic weighing indicator designed to convert analogue measurements into digital format. The use of high-precision components and calibration allows for achieving high measurement accuracy. In this work [9] authors develop a weighing machine using Arduino and a load sensor, which can measure weight up to 20 kg. To achieve this, the HX711 IC and Arduino were utilized, where the load sensor converts weight into an electrical signal. Weight machines based on Arduino are easy to implement and cost-effective. After calibration, the system provides fairly accurate results.

Arduino enables the creation of new experiments in physical laboratories. Authors using Arduino and a load sensor to measure surface tension using the du Noüy method [10]. This is a simple and cost-effective for laboratories.

Presentation of the main material

The determination of weight is a relevant task for designing a screw press, as accurate weight measurement allows for effective control of the pressing process. Taking into account the requirements of efficiency and cost-effectiveness, it has been decided to use a strain gauge and HX711 module [11]. This combination not only ensures sufficient measurement accuracy but also affordability, making it the optimal choice for the project.

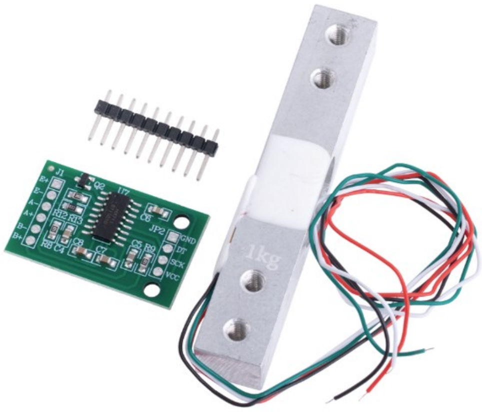

Fig. 1. Strain gauge and HX711 module [11]

The strain gauge and the HX711 module have the following parameters:

Features:

- 1kg straight bar load cell with HX711 amplifier module.
- Force variation output: Voltage signal.
- Operating voltage range: 2.6 to 5V.
- Operating temperature range: -20 to + 85 ℃.
- Power consumption (including power supply circuit): Typical operating current: <1.7mA, shutdown current: <1µA.
- Output data rate: 10Hz or 80Hz optional.
- Load cell size: 12.7 x 12.7 x 75mm.
- Load cell bar comes with 2 x M4 + 2 x M5 screw hole for mounting.
- The module uses 24-bit A/D converter chip HX711.
- The module has two analogue channel inputs, programmable gain of 128 integrated amplifier.
- The input circuit has the capability to be set up in a way that it can supply an electrical bridge voltage, such as pressure or load.
- Utilizes a communication method known as Two Wire, which involves the transmission of both clock and data signals.
- Compatible with Arduino.

The connection between the strain gauge and HX711 module with Arduino can be done as follows:

1. Connecting the load sensor to the HX711 module:

- Using four wires (or any other appropriate number), connect them to the corresponding outputs of the sensor (usually red and black wires for power, and two wires for signal transmission).
- The HX711 module has input terminals for connecting the sensor. They are labelled as A+ (positive input), A- (negative input), E+ (power), and E- (ground).

2. Connecting the HX711 module to Arduino:

- The HX711 module has two output terminals for connecting to the Arduino board. They are usually labelled as DT (Data) and SCK (Clock).
- These terminals should be connected to the corresponding digital pins on the Arduino board.

After the proper connection, Arduino can interact with the HX711 module, receiving data from the load sensor and processing them for further use, such as measuring the weight of objects in a screw press project.

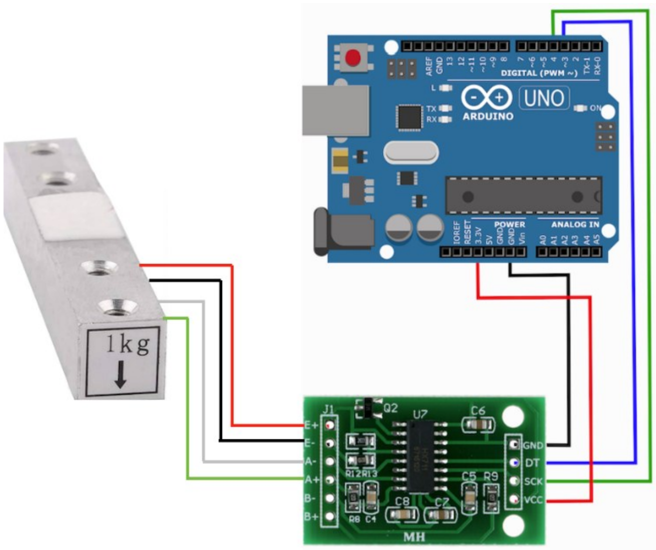

Fig. 2. Connection scheme between the strain gauge and HX711 module with Arduino

The appropriate program code was written to enable the interaction between Arduino and the HX711 module, strain gauge and screw press motor. Here is an example of Arduino code for reading data from the load sensor using the HX711 module. In this code, we utilize the HX711 library to simplify the data reading from the load sensor through the HX711 module.

```
void MassUpdate() {
  if (millis() - lastMassChangeTime >= 500) {
    // Read new mass value
    float newMass = scale.get_units(5);
    // Noise filter
    if (abs(currentMass - newMass) >= MASS_DRIFT_TOLERANCE) {
      currentMass = newMass;
      lastMassChangeTime = millis();
      motorStable = false;
    } else if (!motorStable && millis() - lastMassChangeTime >= STABLE_MASS_TIME) {
      // Mass stable during STABLE_MASS_TIME
      // Start reverse for motor stop
      performRevers();
      motorStable = true; } }}
```

As a result of the project, a bracket was created (fig. 3) for the strain gauge and successfully integrated into the screw press (fig. 4). This casing provides protection for the sensor from external factors such as moisture and dust, which can affect its functionality. The integration of the weight sensor into the screw press allows for accurate measurement of the extracted oil weight that passes through the press, thereby helping to effectively control and optimize the pressing process.

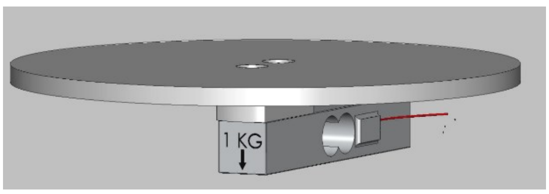

Fig. 3. Plate and strain gauge 3D model

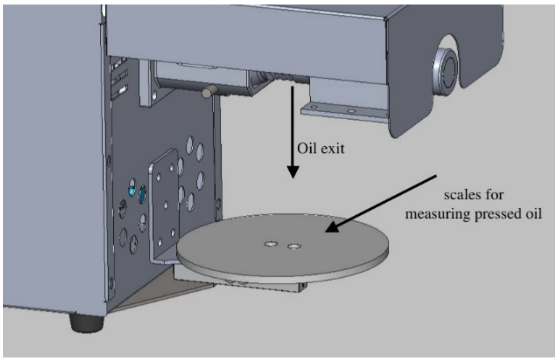

Fig. 4. Implementations of strain gauge HX711

Conclusions

The employment of the strain gauge sensor and HX711 module in combination with Arduino IDE for measuring the weight of the oil extracted by the screw press proves to be an effective and innovative approach. Within this article, a viable solution for incorporating Arduino, the HX711 module, and the strain gauge sensor for oil weight measurement was proposed. The development of program code facilitated this integration process. Furthermore, a 3D model of the structure was conceptualized and successfully implemented.

It was proved that integrating this control system into the existing press infrastructure would mean that this advancement may be implemented without significant alterations to existing production operations. These findings reveal potential for augmentations in production process quality and efficiency within the oil production sector.

In summary, this newly developed method for measuring the output of oil from a screw press brings forth fresh opportunities for enhancing productivity, quality assurance, and automation within the oilseed industry's production processes. This offers a promising blueprint for future research and technological advancements within the field.

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