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Fabrication of Smart Storage and Dispensing Machine for Food Grains using Sensors

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Abstract: ***India is a country with a booming population and limited resources. 40 % of food grains are being wasted annually out of the world's production due to factors like improper post-harvest management, lack of storage spaces, storage facilities, handling and distribution of food grains, etc.***
Thus an effective solution is required to bridge the gap between surplus production and hunger. The objective of our project is to develop methods for retaining the quality of food grains under a controlled environment for effective storage and distribution. Automation using sensors helps to prevent illegal racketing with data collection, monitor storage conditions like temperature and humidity levels, and eliminate man-to-man contact. When dispensed, the level and quantity of the grains can also be recorded. Thus, this machine is better than the existing manual methods of distribution as it acknowledges fair distribution and quality preservation.
Keywords**: *Smart storage, proper distribution, sensors, post harvest losses, grain quality***

I. INTRODUCTION

According to FCI, even though storage structures such as Covered Area Plinth (CAP), godowns, etc with 877.37 lakh tonnes storage capacity are available for food grains, most of them are being wasted annually due to post-harvest losses and improper management. Pest infestations and rodents are yet another reason that cause change in odor, reduction of grain weight, nutritional value of stored grain, hence, reducing the quality and quantity of the grains.
Bulk storage in godowns offers little protection against insect infestation and can't be made gas-tight to permit fumigation. As a result, tight environmental conditions for food grain storage and distribution are required.
In India, food grains are distributed either through private markets or majorly through the public
Distribution system (PDS), to ensure an equitable distribution of food. (Neetu Abey George and Fiona H. McKay, 2019). The commodity stored in gunny bags are prone to post-harvest losses as it cannot sustain climatic change, and high humidity. Proper monitoring of temperature, and humidity ensures optimal preservation of food grain quality.
The 'Fabrication of Smart Storage and Dispensing Machine for Food Grains using Sensors' is a modern concept that ensures preservation of the quality of food grains in distribution points by proper monitoring of storage conditions, preventing illegal racketing, and collection of data.

II. OBJECTIVES

A. Retainment of the quality of food grains
B. Controlled environmental condition
C. Effective storage and distribution
D. Collection of data
E. Prevention of illegal racketing
F. Complete automation that eliminates man-to-man contact

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III. MATERIALS AND METHODOLOGY

Table 1: Component Requirements for the machine

S.NO	COMPONENT	SPECIFICATION
1	TEMPERATURE AND HUMIDITY SENSOR	DHT11
2	LOAD CELL SENSOR	HX71I
3	ULTRASONIC SENSOR	HC-SR04
4	KEYPAD	Matrix
5	LCD DISPLAY	65.4 X 28.2 (mm)
6	MICRO-CONTROLLER	PIC16F882
7	AC POWER SUPPLY	220 V 60Hz
8	BUZZER	12 V
9	LOAD CELL- TRANSDUCER	40 kg
10	PCB RELAY	JQC-3F (T73)

A. Temperature and Humidity Sensor

The DHT11 humidity and temperature sensor has a 5-percent RH accuracy and can measure relative humidity between 20 and 90 percent RH within a temperature range of 0 to 50°C. Temperature is also monitored with a precision of 2°C in the range of 0 to 50°C. With an 8-bit resolution, both values are returned.with 8-bit resolution. (Warren W. Gay 2014)

The temperature and humidity sensor monitors and detects the temperature and humidity inside the machine.

B. Load cell

The load cell, also referred to as a transducer, converts mechanical energy (weight) into an electrical signal. The magnitude of the electrical output is proportional to the amount of force applied. When pressure is applied to the strain gauge in the Load cells, it deforms. Because of its effective resistance, the strain gauge changes as it deforms, by creating electrical signals.
The load cell weighs up to 40kg of load. (Tossaphon and Jaysricha, 2018) A load cell sensor is used for weighing the appropriate quantity of grains before dispensing and makes sure that the accurate quantity of grains reaches the consumers without weight tampering.

C. Hx711 Load Cell amplifier Module

The Hx711 Load cell amplifier module is a 24 high-precision analogue to digital converter that amplifies low electric output from load cells, amplifies and transforms the low electric output of the load cell derived from mechanical energy (weight), and converts it to digital form. To generate the weight, the digital form is sent to the Arduino UNO.
When the load cell amplifier is linked to the microcontroller, the microcontroller will read changes in the load cell's resistance after some calibrations. As a result, weight measurements are extremely precise.(Tossaphon and Jaysricha, 2018)

D. Ultrasonic Sensors

The HC-SR04 ultrasonic sensor, like bats, employs SONAR to estimate the distance of an object. From 2 cm to 400 cm (1” to 13 feet), it provides outstanding non-contact range detection with high precision and reliable readings in an easy-to-use design. An ultrasonic transmitter and receiver module are included. (Mutava Mutinda and Paul Kamweru, 2020) It detects the level of grains inside the machine.

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E. Liquid-Crystal Display (LCD)

A liquid-crystal display (LCD) is a flat-panel display or other electronically modified optical device that uses liquid crystals and polarizers to manipulate light. (Mutava Mutinda and Paul Kamweru, 2020)

The LCD in the Smart Storage and Dispensing machine displays :

1) Temperature and Humidity

2) Amount of grains left (in kgs).

F. Relay

A relay is a switch that is controlled by electricity. A magnetic field is created by current flowing through the coil of the relay, which attracts a lever and switches the switch contacts in the machine. Relays feature two switch positions and are double throw switches since the coil current can be on or off.

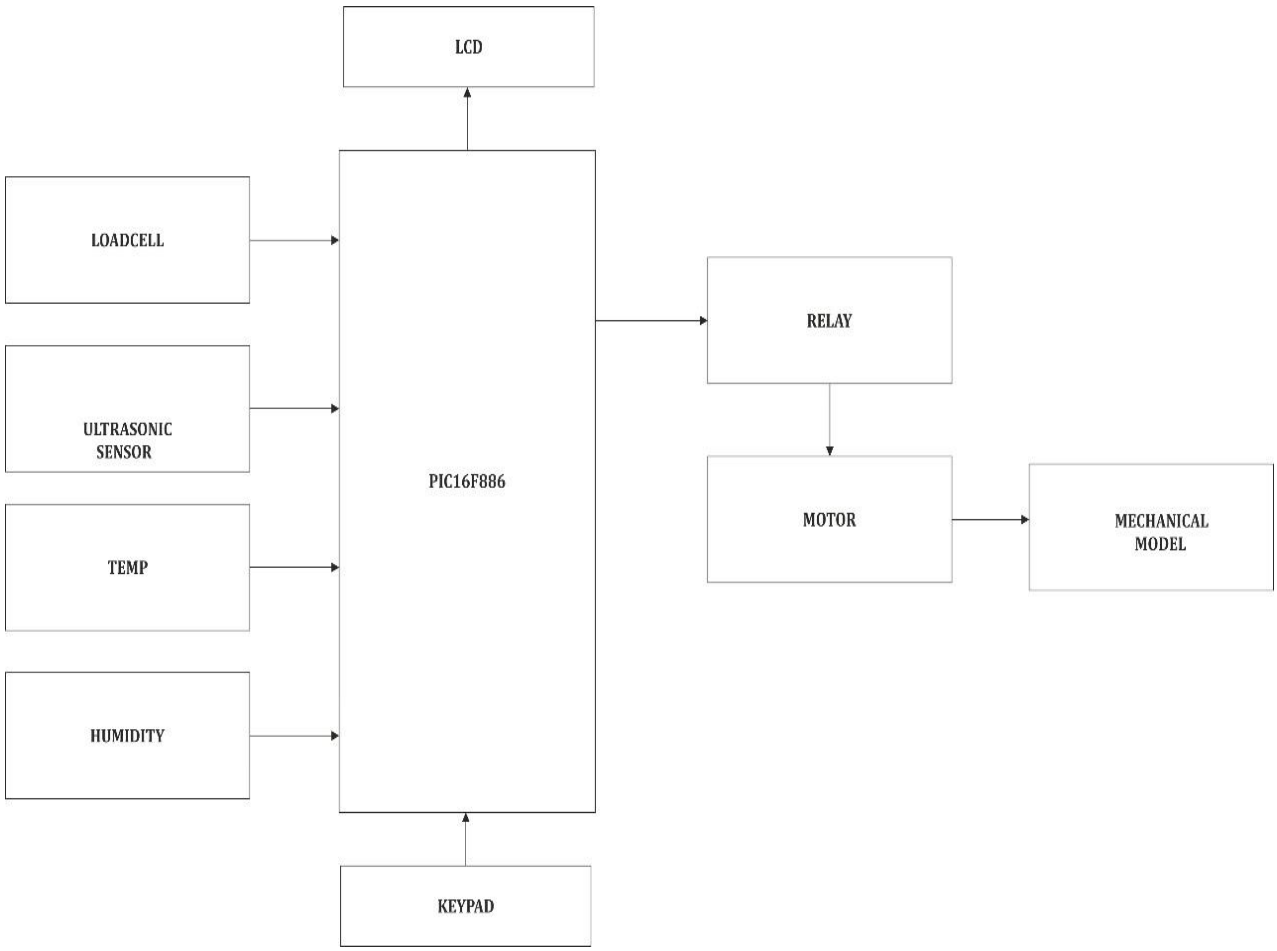
G. Buzzer

The buzzer is an electronic echo sounder with an integration structure that denotes the reduction of grains in the machine below the critical level.

H. Microcontroller

Microcontrollers are compressed microcomputers used to control embedded systems and carry out the programmed tasks.

IV. BLOCK DIAGRAM



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V. WORKING

1) *Step 1*: The grains are loaded into the Smart Storage and Dispensing machine through the feed hopper into the storage bin with capacity 10 kg.
2) *Step 2*: The LCD displays the real time information such as the humidity, temperature and the current weight of the grains accurately.
3) *Step 3*: The keypad is used to enter the amount of grains to be procured such that the exact quantity is dispensed through the dispensing slab.



Fig 1: Fabrication of Smart Storage and Dispensing Machine for Food Grains



Fig 2: Internal Components of the Machine



Fig 3: Front view of the Machine

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VI. RESULTS AND DISCUSSIONS

Food inadequacy is the most important problem seen throughout the country. There is always a gap between meeting people's basic needs and the production. Even though grains are produced in huge amounts, due to improper storage and handling, tons and tons of grains are wasted. This wastage of food leads to a huge economic crisis and in India, this loss is approximately estimated to be 92,000 crores per year, majorly in post-harvest losses. Hence, it's clear that agricultural inadequacy is mainly due to post-harvest losses rather than productivity. To prevent this, better storage environments and advanced distribution systems are required, such that people get food of good quality. For this, the activities like adulteration, improper handling, etc, must be checked and prevented. To ensure checks on these problems all the data related to the distribution, stocks must be maintained at distribution points like ration shops. A smart solution is required to prevent any malpractice in our Public Distribution System (PDS) and for efficient quality protection in any grain distribution points. The trials were made for three consecutive days in April with 5 kgs of respective samples, which are - rice and wheat. Rice and wheat are the most commonly used food grains and hence their trial revealed the real-life storage testing and monitoring of the parameters like temperature, and relative humidity. The grains stored showed no signs of damage during the period of storage and all the respective parameters were indicated clearly on the device. Further, the exact amount of grains given as input is dispensed along with the indication of the weight of grains left in the storage bin. Hence, this type of smart storage and dispensing concept is the required solution to tackle weight tampering, improper distribution, and monitor storage conditions of food grains at the same time. This complete automation is especially suitable for situations demanding social distancing without compromising on quality aspects.

Table 2: Analysis of Temperature and Relative Humidity for Rice

Sample: Rice Trial period: (13.03.2021 – 15.03.2021)

S.NO	WEIGHT (kg)	TEMPERATURE (°C)	RELATIVE HUMIDITY (%)
1	5	32	65
2	5	33	65
3	5	32	64

Table 3: Analysis of Temperature and Relative Humidity for Wheat

Sample: Wheat Trial Period: (07.04.2021 – 09.04.2021)

S.NO	WEIGHT (kg)	TEMPERATURE (°C)	RELATIVE HUMIDITY (%)
1	5	33	65
2	5	33	64
3	5	32	64

The grains were stored in the smart storage and dispensing machine and the conditions of the environment and the parameters that affect food grain quality were determined accurately by the device. The change in temperature, relative humidity as well as total weight of grains stored in the bin was indicated by the smart device. With the dispensing, the current grain quantity in the bin was rapidly updated on the screen. Hence, this reduces any chance of error in weighing, the quantity left in the bin, and knowing the real-time storage conditions.

VII. CONCLUSION

The smart storage and dispensing machine is an alternative to the traditional concepts of storage and manual distribution techniques. The quality of grains is kept preserved and the data about the environment helps in better monitoring, especially when used in locations with high humidity. As the weighing and dispensing is automatic, it prevents illegal racketing of food grains in distribution points, hence ensuring the protection of quality and quantity. The mode of procurement is based on digital payment and the entire process requires no man-to-man contact. This is a much-needed solution especially during the tough times of the Covid-19 pandemic where contactless purchasing of the staple food grains would be a convenient alternative.

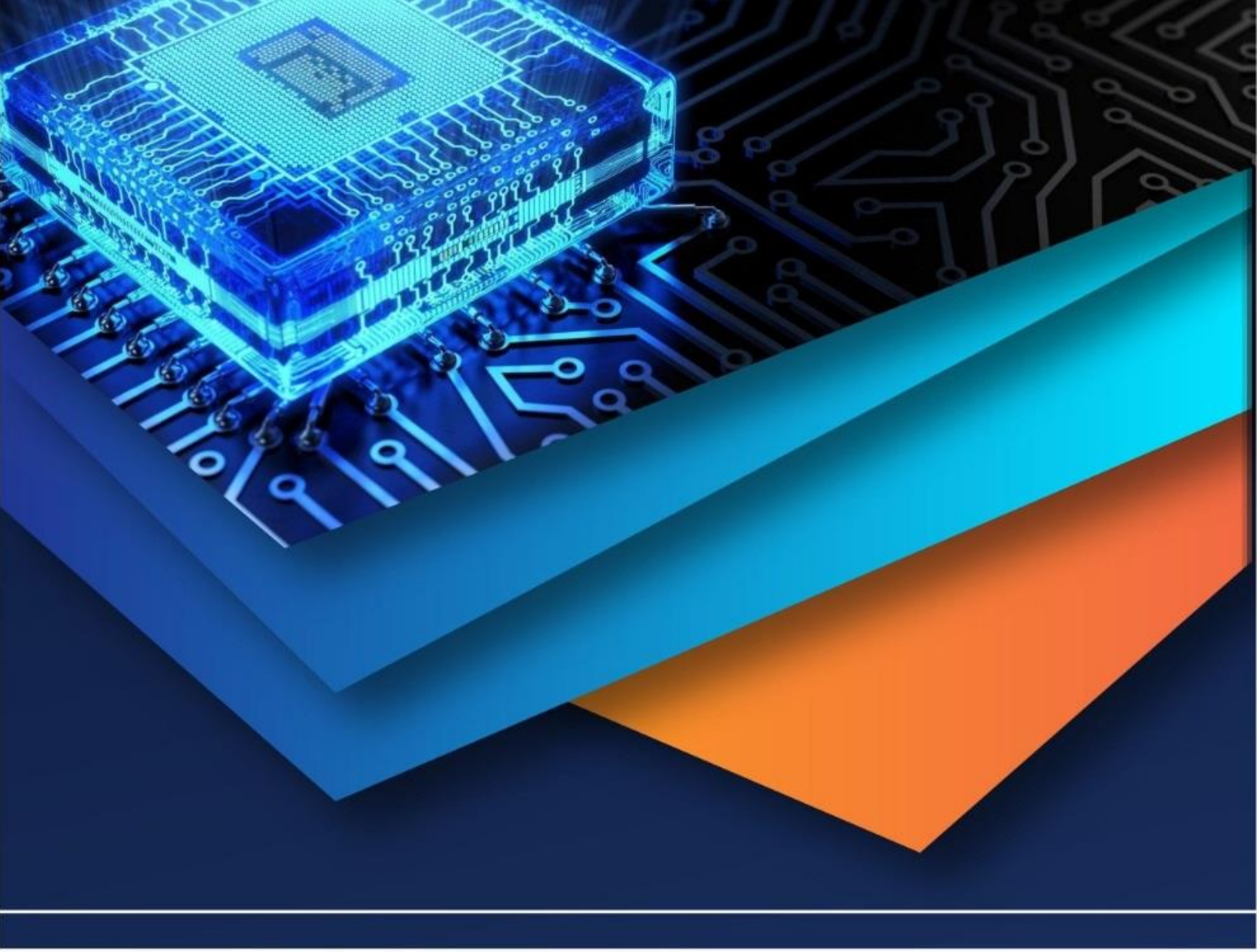
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Based on the trials and the features, 'Smart storage and dispensing machine for food grains using sensors', is the effective solution to improve the traditional handling of food grains prone to rodents, pests, and deterioration of quality during storage. The data about the number of grains dispensed will help in the acquisition of data related to consumer demands and supply chain errors to be rectified. This will allow transparent distribution of grains through the PDS system, ensuring the protection of grain quality as it is not prone to pests or rodents, and helps in maintaining data concerning the quantity of grain handled. Hence, the fair distribution of grains to the customers is ensured, the quality of the food grains is in check, and it is better than the existing manual methods of distribution.

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