SMARTAGRODRY:IOT-ENABLEDPRECISIONTEMPERATURE AND HUMIDITY CONTROL FOR OPTIMIZED HARVESTING

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ABSTRACT

This project introduces a Raspberry Pi Pico-controlled Temperature-Controlled Harvester, offering an innovative solution for grain drying by automating and optimizing the process. Traditional grain drying methods are labor-intensive and imprecise, often leading to inconsistent results. The proposed system leverages Raspberry Pi Pico microcontroller technology to regulate temperature, ensuring efficient and uniform drying while preventing over-drying or under-drying. Integrated temperature sensors continuously monitor and maintain optimal conditions, while a fan system adjusts airflow based on real-time data. This adaptability enhances drying efficiency and grain quality. The user-friendly interface allows farmers to set specific drying parameters, providing a customized and automated solution. Additionally, the system is designed for energy efficiency, reducing resource consumption and making it a cost-effective and sustainable alternative to conventional drying methods. By optimizing the drying process, this innovation helps reduce post-harvest losses, improve grain quality, and enhance overall agricultural productivity. With its precision, automation, and adaptability, the Raspberry Pi Pico-controlled harvester addresses the evolving needs of modern farming, offering a reliable and efficient approach to grain drying.

Keywords: IoT, Temperature Control, Humidity Control, Agriculture, Harvesting System, Raspberry Pi Pico, Microcontroller, Grain Drying, Precision, Automation.

1. INTRODUCTION

Traditional grain drying methods, such as sun drying, face significant inefficiencies and reliability issues due to their dependence on unpredictable weather conditions like rain and wind, increasing the risk of spoilage and yield loss. Additionally, the manual labor required for sun drying makes the process time-consuming and labor-intensive, reducing overall efficiency. To overcome these challenges, the agricultural sector is increasingly adopting automated drying systems that enhance precision and reliability. One such innovative solution is the Raspberry Pi Pico-controlled temperature-controlled harvester, which optimizes the drying process through automation. Thissystemregulatestemperature and humidity levels, ensuringconsistent and efficient grain drying while minimizing spoilage risks. Equipped with sensors to monitor environmental conditions, the harvester makes real-time adjustments, adapting to varying climates for improved drying efficiency. The integrationofaRaspberryPiPicomicrocontrollerallowsprecisecontrol overthedryingenvironment, reducing dependency on manual intervention and enhancing operational effectiveness. Furthermore, this system offers an energy-efficient alternative, cutting down on resource consumption while ensuring superior grain quality. With a user-friendly interface, farmers can customize drying parameters, making the process more accessible and adaptable to different grain types and conditions. The Raspberry Pi Pico-controlled & temperature-controlled harvester represents a sophisticated technological solution, integrating an array of sensors and actuators that operate autonomously to monitor and regulate the temperature and humidity within the grain drying environment. This automation not only expeditesthedrying processbut alsoservesas apreventativemeasure against the risksofspoilage.Keycomponentsofthiscutting-edgesystemencompasstheRaspberryPiPico microcontroller, temperature and humidity sensors, a heater for temperature adjustment, and a fan designed to facilitate air circulation within the drying environment.

PROBLEMSTATEMENT:

Traditional grain drying methods utilized in agriculture are marked by inherent inefficiencies and imprecise control, resulting in suboptimal outcomes for farmers. The labour- intensive nature of these conventionaltechniquesnotonlydemandsconsiderablemanualeffortbutalsoleadstoinconsistencies in the drying process, negatively impacting the quality of harvested grains. Moreover, the lack of precision in regulating drying conditions often results in over-drying or under-drying, further diminishing the overall quality and market value of the grains.

The existing challenges necessitate a paradigm shift towards innovative solutions that address the limitations of traditional grain drying methods. There is a critical need for a system that can automate and optimize the grain drying process, offering efficient and consistent results. The inadequacies of current approaches underscore the urgency to leverage advanced technologies to enhance the overall quality of the drying environment, ensuring optimal conditions for preserving grain quality.

Farmers currently lack access to a reliable, cost-effective, and sustainable grain drying solution that alignswiththemodernrequirementsofagriculturalpractices.Theabsenceofasystematicapproachto temperature control and real-time monitoring leaves farmers vulnerable to environmental variations, leading to unpredictable and often undesirable outcomes in grain drying.

In light of these challenges, the proposed Raspberry pi Pico-controlled Temperature-Controlled Harvester emerges as a compelling solution. It aims to revolutionize grain drying practices by introducing precision, automation, and adaptability to environmental conditions. This project seeks to address the pressing issues faced by farmers in the drying process, providing a technologically advanced system that optimizes resource consumption, reduces post-harvest losses, and enhances the overall efficiency of grain drying in contemporary agricultural settings.

2.LITERATUREREVIEW

N. Sreedhar Reddy : Efficient drying from any mobile paddy dryer would result in the superior quality of the product within a desirable time. Dryer was evaluated using 5332.5 kg of freshly harvested paddy at 21.01% moisture content (w.b). The air velocity at top layer was found to vary from 0.50 to 0.33 m/s at loading condition and 1.7 to 0.6 m/s at no-load condition. The moisture content, the coefficient of uniformity (Cu) and moisture ratio at bottom of the drying chamber were observed to vary from 21.03 to 13.44% (w.b), 91.47 to 98.32%, and 0.928 to 0.085 respectivelyduring the start to the end of the drying. The temperature of the drying chamber at bottom and top layers were found to vary from 35.57 to 32.47°C and 40.63 to 32.47°C, respectively. The relative humidity values at the bottom and top layers were 95.87 to 94.27% and 72.40 to 93.43%, respectively during drying. At the end of drying after 4.5 h, the final moisture was estimated to be 15.23%(w.b).**[1]**

Kumara Reddy Rao: Paddy is one of the largest consuming foods with the subsequent increase of food growing. Especially in rural areas, there is an accompanying need for preservation method. Though the steam driers are available and they all are having capacities of more than 20 tonnes. this much of quantity small scale farmers are didn't get. Then, they will go for natural drying by sun. they are fully depending on sun light, this will be get difficulty to farmers in rainy season.While drying in fields or Road side, domestic animals disturb the spreaded Grains, this will be difficult task especially in rural area. During the rainy season nofarmer have a chance to spread the gains in the fields because of, the rain water will be stored in the field area. Also, not every former have a much space under shedsto store the grains tillraingets over. Also, sun drying have somedisadvantages likeslowdrying process. In sun drying process for some time farmer have to turn or stir the grains. This paper is the comprehensive work done with the aim of reducing the cost of drying and also for practical demonstration of some of the theoretical knowledge acquired. It was discovered that the drier is efficient since the heat leakage was found to be very low. Kacheru, Goutham. **[2]**

Aditya Jain: This paper presents the design and development of an automatic solar powered grain dryer used to remove the moisture content from grains, post harvesting. The drying is achieved by allowing the heat from heat chamber to flow on to the conveyor belt with the help of exhaust fans present in the heat chamber. The grains are layered evenly on the conveyer belts upon which the heated air is passed to extract the moisture from the grains. Arduino Uno (ATmega328P) along with the appropriate sensors are used to monitor and control the moisture content, speed of the motor and temperature of the heating chamber. Based on the moisture content present in the grains, the sensor sends the control signal to the controller. Thus, the speed of the conveyer belt is adjusted accordingly to maintain required moisture content in the grains, which is ideally required for storage. The prototype of the system is developed and powered using solar photovoltaic energy generated from 10W solar panel in conjunction with buck-boost converter and charge controller. The results shows a good response in removing the initial moisture content from 30% to 14% from the grains without altering their nutrition values.**[3]**

Dr. I. A. Khan: Thisprojectintenttodesignanddevelopthe concept ofthedomesticgraindryer which used to remove the moisture content from grain. The drying is achieved by allowing the heat from heat chamber to flow though the treys placed in dryer cabinet with the help of exhaust fan present in the heat chamber. The grains are layered evenly in the trays through which the heated air is passedtoextractthemoisturefromthegrains.Theappropriatesensorsareusedtomonitorandcontrol themoisture content and air temperature ofthe cabinet. Based onthe inside temperature presentin the cabinet, the sensor sends the control signal to the controller. Thus, the constant desired temperature is maintained using control system.**[4]**

R. YADOLLAHINIA: Because of the importance of rice cracking in milling process, precision control of drying conditions is important. For this purpose, it is necessary to determine drying kinetics and obtainthemoisturechange duringthedryingprocess. Inthis paper,design, fabricationandtesting of an automated thin-layer dryer is presented. Experiments on the drying kinetics of rice paddy(Fajr cv.)wereconductedatfivedryingairtemperatures,rangingfrom30to70,infourairvelocities,ranging from 0.25 to1.0 msCo-1and three replicas (60 runs altogether) with initial moisture content of 25% (d.b.) at the start of all runs. During drying, the mass loss was measured continuously. Experimental curves of the drying rate versus time grouped by air temperature showed the strong dependence of drying rate with temperature revealed that: (a) drying rate increased whenair temperature increased and (b) moisture transfer occurred during the falling rate period of drying. However, when the curves of moisture ratio verses time were grouped by air velocity, very weak dependence of moisture ratio with velocity was observed. Increase In ai rve l ocity f r om 0.25 to 1 ms-1had little effect on the drying period paddy. Drying curves obtained from the experimental data, fitted to eight thinlayermodelsandcomparedwith three statistical parameters,showed thattwoterms model can predict moisture change with greater accuracy than other models.**[5]**

M. Olaniyan: Rice (Oryza sativa) is an important food crop which belongs to the Gramineae(grass) family. It is an excellent source of carbohydrates, vitamins (such as vitamin D), minerals (such as thiamine, iron, riboflavin and calcium), fibre and other nutrients that are valuable for human growth andhealth.Asastaplefoodformorethan60percentoftheworldpopulation,rice is low infat and salt and contains no cholesterol, preservatives or additives that are injurious to human health. Dryingis one of the most important processes involved in the postharvest handling and processing of rice - other processes include threshing, parboiling, post-drying milling, cleaning, polishing and packaging. Kacheru, Goutham. **[6]**

Johannes P. Angula: Solar energy is one of the renewable energy sources which is abundant and pollution free. Over the years it has grown rapidly in the field of agriculture for the purpose of food preservation. The use of solar energy to dry agricultural products can be achieved using three techniques,namely, direct solar drying,indirect solar drying, andmixed-mode solar drying. Drying of agricultural products is usually modelled as either thin layer or deep bed layer. Various researchers have conducted numerous experiments and simulations to study and model the performance output of solar dryers in terms of the outlet temperature, type of heat collector, drying air velocity, drying period, and moisture removal rate.**[7]**

WILSON KWAKU KALLAI:A low-cost, 250kg to 1-tonne capacity continuous-flow mixing grain dryer (LSU type) was designed and developed. The dryer consists of three main parts: 1) the drying chamber made of inverted V-shaped ducts, to which the plenum inlet is connected; 2) the blower, with a 750 W(1 hp) electricmotor and centrifugal fan which provides the drying air; 3) 1 kW electric heater, 4) discharge rollers powered by a 3kW electric gearmotor with a 37.5:1 reduction gearbox. Trials conducted between April and June, 2011 showed that paddy rice, at initial moisture content(MC)of19.7%-26.6%driedto11.8%-13.5%respectively.Sundryingwasalsocarriedoutas control.Thedryingperiodforthemechanicaldryingrangedfrom4.8-5.7handthatforsundryingwas 5h. The moisture reduction rate ranged form 1.16-2.41%/h for the mechanical drying and 2.18% for sun drying. Milling recovery and head rice yield from mechanical drying were better than for sun drying. The heat efficiencies of drying the four consignments ranged from 36.40%-62.70%. Although power consumption was not measured, the operating cost would reduce if a biomass (rice husk)burner is used instead of electrical energy.**[8]**

4.PROPOSEDSYSTEM

In this innovative project, a functional model of a temperature-controlled harvester has been meticulously crafted, incorporating a variety of essential components to optimize the grain drying process. The system is equipped with a suite of key elements, including a temperature sensor,humidity sensor, mode switches for both heating and engine temperature control, an Raspberry PiPico microcontroller, an LCD display, a DC fan, and an AC heater.

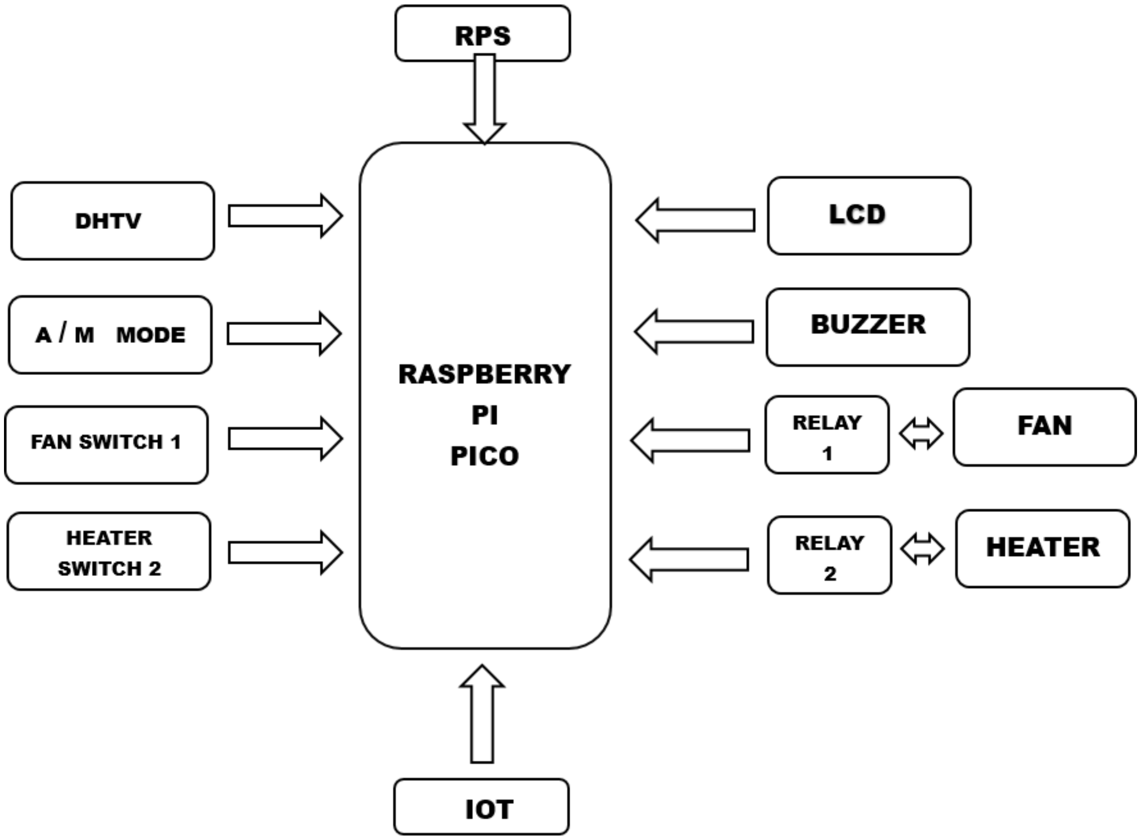
The functionality of the harvester is enhanced by the strategic placement of a humidity sensor within the grains chamber. This sensor diligently monitors the humidity levels in the grains and transmits real-time data to the Raspberry Pi Pico microcontroller. Upon sensing the need for drying, the controller promptly activates the AC heater, initiating the drying process. As the grains reach the desired dryness level, the humidity decreases, prompting the controller to deactivate the heater, ensuring optimal grain quality.

Recognizing the potential overheating of the harvester's engine during the drying process, a temperature sensor is thoughtfully positioned near the engine. In the event of engine overheating, the system triggers the activation of a DC fan. This proactive measure serves to safeguard the harvester's engine, preventing potential damage due to excessive heat.

Theintroductionofmodeswitchesaddsalayerofversatilitytothesystem.Theseswitchesallowfora seamlesstransitionbetweenauto-modeandmanualmodefortheheater.Thisfeatureprovidesusers with the flexibility to manually control the heating process when necessary, offering a practical solution for specific operational scenarios.

In summary, this temperature-controlled harvester model demonstrates a comprehensive and intelligent approach to grain drying. By integrating sensors, switches, and an Raspberry Pi Pico microcontroller, the system ensures precise control over the drying environment, promotingefficiency, and safeguarding the harvester's engine. The inclusion of manual control options enhances user adaptability, making this model a practical and effective solution for optimizing the grain drying process in agricultural settings.

BLOCKDIAGRAM:



WORKING:

Inthissystemtherearetotallyfour Sections/Modules

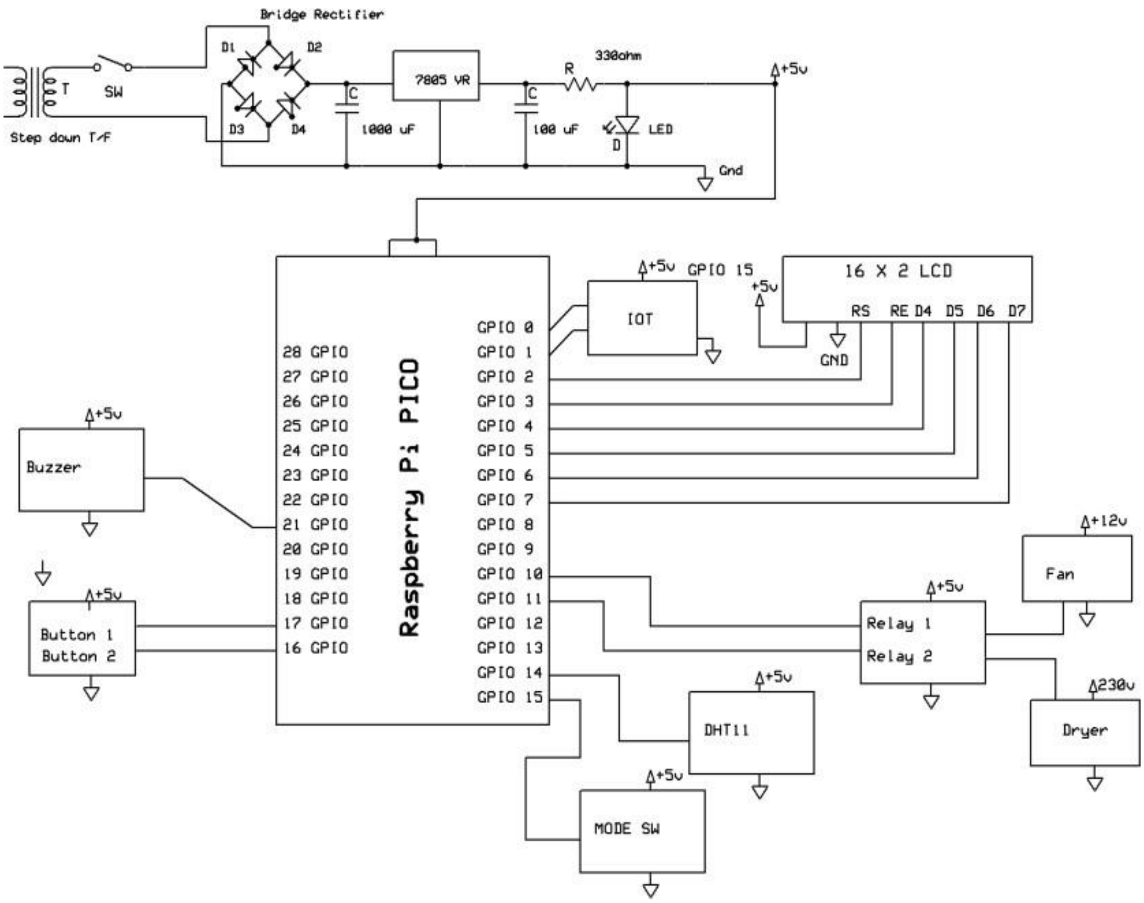
1) Regulatedpowersupply(RPS)
2) InputSection
3) OutputSection

4) RaspberrypipicoMirco Controller

The RPS module converts the 230 volts into 5V of dc. The 5v of power supply goes to allcomponentsinthesystem.TheInputoftheproject isTemperatureandHumiditysensor,modeswitch, manual switches. The Temperature and Humidity sensor (DH11) is used to sense the wet percentage of Grains/Beans in the drum. The mode switch is used for switching the modes either manually or automatically, and two manual switches are provided in the circuit i.e, fan and heater switches by manual mode of operation.

The output module has LCD, Buzzer, IOT, Relay-1 is attached with DC fan and Relay2 is attached with heater. The IOTserver can send the data and display the data in web server app. In Raspberry pi pico microcontroller contains the software programming code in embedded C. The main purpose of the microcontroller is to process the data and then controlling the data. Once we should on the kit, we need to reset the kit because to connect wifi to IOTserver. The kit is reset and then the LED displays “Temperature Control Harvester”.After we configure to IOT server by using an web application.

Once the mobile data of your mobile is ON and connect your hotspot to the circuit, so that it can access internet for uploading the data of temperature and humidity levels of the grains in web application. The DH11 sensor sense the temperature and humidity levels in the grains and displays it on LCD. In Automatic mode the microcontroller receives the data from the sensor and performs the operation of grain drying. We can also operate this circuit by using the manual mode function. And finally the grains are ready for packing and selling.



APPLICATIONS:

Precision Agriculture: By monitoring temperature and humidity levels in real-time, farmers can optimize crop growth conditions, ensuring that plants receive the necessary environmental parameters for optimal growth.

Crop Management: Farmers can remotely monitor and adjust temperature and humidity levels to prevent crop stress or disease outbreaks, leading to healthier and higher-yielding crops.

Greenhouse Management: IoT sensors can be used to regulate temperature and humidity levels inside greenhouses, ensuring that crops are protected from extreme weather conditions and providinga controlled environment for year-round cultivation.

Crop Storage and Preservation: IoT devices can also be employed to monitor temperature and humidity levels in storage facilities to prevent spoilage and maintain the quality of harvested crops.

Energy Efficiency: By automatically adjusting environmental parameters based on real-time data,IoTsystems can optimize energy usage in agricultural operations, leading to cost savings and reduced environmental impact.

Remote Monitoring and Management: Farmers can monitor and control the temperature and humidity levels of their agricultural operations remotely using smartphones or computers, allowingfor timely interventions and adjustments.

Data Analytics and Decision Making: IoT systems collect vast amounts of data on environmental conditions, which can be analyzed to gain insights into crop performance, optimize resource allocation, and make informed decisions for future agricultural practices.

Integration with Other Systems: IoT-based agriculture systems can be integrated with other smart technologies such as irrigation systems, weather forecasting, and crop management software, creating a comprehensive and interconnected agricultural ecosystem.

ADVANTAGES:

PrecisionControl: IoTtechnologyenablesprecisemonitoringandcontroloftemperatureand humidity levels, allowing farmers to create optimal growing conditions for crops.

Increased Yields: By maintaining optimal environmental conditions, IoT systems can help increase crop yields and improve the quality of harvested produce.

Resource Efficiency: Efficient use of water, energy, and other resources is possible with IoT-basedsystems, as they enable targeted and automated adjustments based on real-time data.

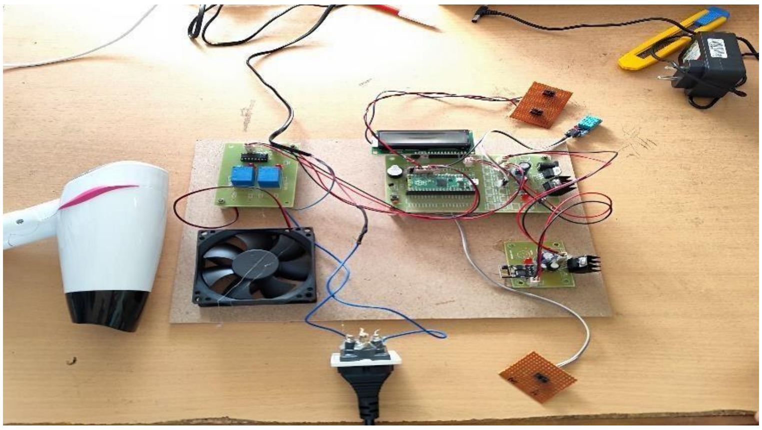
Remote Monitoring and Management: Farmers canremotely monitor andmanage their agricultural operations, reducing the need for physical presence and enabling timely interventions.

Data-drivenDecisionMaking: IoTsystemscollectandanalyzelargeamountsofdata,providing valuable insights for informed decision-making and better crop management practices.

ReducedLaborCosts: Automationofmonitoringandcontroltaskscanhelpreducelaborcosts associated with traditional agriculture practices.

Environmental Sustainability: Byoptimizingresourceusageandreducingwaste,IoT-basedsystems contribute to environmental sustainability in agriculture.

4. RESULTS



Herethe circuit isturned ON by givingtheregulatedpower supplyof 12v whichis convertedto 5vdc current. The LED is the indication for 5v current so, if there is 5v current then automatically the LED glows. The generated 5v dc current passes to every hardware component in the circuit.

When we hit the reset button after providing the regulated power supply, the LED display “Temperature Control Harvester” the output may be seen in the following image after wehave connected the IOT module via a wifi Connection.

The LED displays the Temperature and humidity levels and mode switches on LED by sensingthegrain humidity values. We can see inthe above placed picture how the values are represented.

S.No	Temperature	Humidity	Date
1	41	41	2024-02-16 12:27:46
2	43	36	2024-02-16 12:27:26
3	45	34	2024-02-16 12:27:06
4	47	36	2024-02-16 12:26:46
5	42	45	2024-02-16 12:26:26
6	34	90	2024-02-16 12:25:29
7	34	90	2024-02-16 12:25:09
8	32	91	2024-02-16 12:21:35
9	31	90	2024-02-16 12:21:15
10	41	40	2024-02-16 10:55:12
11	43	36	2024-02-16 10:54:51
12	44	34	2024-02-16 10:54:31
13	48	29	2024-02-16 10:53:51
14	48	30	2024-02-16 10:53:31
15	34	90	2024-02-16 10:52:51
16	34	90	2024-02-16 10:52:31
17	35	90	2024-02-16 10:48:16
18	33	92	2024-02-16 10:44:02
19	33	92	2024-02-16 10:43:42
20	33	92	2024-02-16 10:43:22

Heretheimagedisplaystheoutputofmicrocontroller.TheHighhumiditygrainsaretobe normalized by the help of heater and data is stored in the web.

5. CONCLUSION

Inconclusion,thedevelopmentoftheRaspberrypiepicoTemperature-ControlledHarvesterrepresents asignificantstridetowardsaddressingtheshortcomingsoftraditionalgraindryingmethods.The project successfully tackles the labour-intensive and imprecise nature of conventional techniques by introducing a comprehensive, automated, and optimized solution. Leveraging the capabilities of Raspberry pie picomicrocontroller technology, the system ensures efficient and consistent graindrying while significantly enhancing the quality of the harvested grains.

The incorporation of temperature control mechanisms, monitored by sensors within the harvester, stands out as a pivotal feature. This not only regulates the drying environment but also prevents common issues such as over-drying or under-drying of the grains. The real-time adjustmentsfacilitated by the Raspberry pie pico controller further underscore the system's adaptability to varying environmental conditions, ensuring optimal drying parameters.

The synergy of key components, including temperature sensors, a fan system, and the Raspberry pie pico microcontroller, operates seamlessly to achieve precise temperature control. The user-friendly interface empowers farmers to customize drying parameters, offering a tailored and automatedsolution that minimizes manual intervention.

Moreover, the project places a strong emphasis on energy efficiency, designed to minimize resource consumption during the grain drying process. This, coupled with the reliability and cost-effectiveness of the Raspberrypiepico-controlled Temperature-Controlled Harvester, positions it as a sustainable solution aligned with the evolving needs of modern agricultural practices.

In essence, this innovative technology promises a reliable, cost-effective, and sustainable approach to grain drying, addressing critical aspects such as improved grain quality, reduced post-harvest losses, and increased overall efficiency in the agricultural sector. As a transformative solution, the Raspberry pie pico-controlled Temperature-Controlled Harvester holds the potential to significantly impact and enhance the practices of grain cultivation, contributing to a more resilient and productive agricultural landscape.

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