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A Novel Dates Palm Processing and Packaging Management System based on IoT and Deep Learning Approaches

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ABSTRACT:

The demand for dates is on the rise, and countries like India are producing them in large quantities. However, the manual process of processing and packaging dates can be time-consuming and requires a lot of human labor. Additionally, the temperature during the processing of dates is critical, as improper temperature can harm the fruit. To store dates for a extended time deprived of any harm, they need to be packed in airtight packets, which is currently done manually. In this research, we suggest an well-organized and programmed method by means of the newest machineries to reduce the need for human labor and improve the accuracy of the process. The proposed model is a prototype that uses internet of things (IOT) methods for easy one-to-one care and control through a smartphone app. It is also furnished with various instruments to automate the method and purposes. Our research shows that this system has the potential to revolutionize the field of involuntary dates dispensation and wrapping. One of the main benefits of the proposed system is its ability to reduce the reliance on human labor, which can be in short supply in the dates industry. By automating the process and using advanced technologies, the system can improve efficiency and accuracy, leading to better quality dates and reduced waste. Additionally, the incorporation of various sensors and actuators allows the system to perform a wide range of functions and processes automatically, further reducing the need for human intervention.

Keywords: Internet of Things, Dates, Packing and processing management

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1. INTRODUCTION

Dates are a popular and nutritious fruit that are grown and consumed around the world. They are an important part of many cultural and traditional diets, and have a wide range of health benefits. In recent years, the demand for dates has increased significantly, leading to an increase in their production [1]. However, the process of processing and packaging dates can

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be time-consuming and labor-intensive, and is often done manually. This can lead to errors and waste, and can also be a barrier to the growth of the dates industry [2].

To address these issues, we propose a novel dates palm processing and packaging management system based on internet of things (IoT) and deep learning approaches. This system aims to improve the efficiency, accuracy, and convenience of the dates processing and packaging process, and has the potential to revolutionize the industry [3]. In this research, we will discuss the current state of the dates industry and the challenges it faces, and present our proposed solution. We will also review the existing literature on IoT and deep learning approaches in the context of dates processing and packaging, and discuss how our system builds upon and contributes to this literature [4], [5]. The dates industry is a significant contributor to the economy of many countries, including Oman, Saudi Arabia, and the United Arab Emirates. According to the Food and Agriculture Organization of the United Nations, the global production of dates reached 20.2 million tons in 2018, with the Middle East being the largest producer. However, the process of processing and packaging dates can be labor-intensive and prone to errors, which can lead to waste and reduced quality.

One approach to addressing these challenges is the use of IoT and deep learning techniques. IoT refers to the interconnectedness of physical devices, such as sensors and actuators, through the internet, allowing for remote monitoring and control. Deep learning is a type of machine learning that uses artificial neural networks to process and analyze large amounts of data. These techniques have the potential to improve the efficiency and accuracy of the dates processing and packaging process, and have been applied in a variety of industries, including agriculture, manufacturing, and logistics [6]–[8].

In the context of dates processing and packaging, several studies have explored the use of IoT and deep learning approaches. For example, In one research the authors examined the use of IoT and machine learning techniques to improve the quality and efficiency of dates sorting and grading [9], [10]. The study found that the use of these techniques led to a significant reduction in errors and waste, and an increase in the overall quality of the dates. Another study investigated the use of IoT and deep learning techniques to optimize the irrigation of date palm trees. The study found that the use of these techniques resulted in improved water use efficiency and crop yields [11], [12].

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While these studies demonstrate the potential of IoT and deep learning approaches in the dates industry, there is still a need for further research in this area. In particular, there is a lack of studies that examine the integration of these techniques in a comprehensive system for dates processing and packaging. Our proposed system aims to fill this gap by presenting a novel approach that combines IoT and deep learning techniques to improve the efficiency, accuracy, and convenience of the dates processing and packaging process [13], [14].

2. Methodology of the research

The planned internet of things (IOT) enabled smart scheme for dates processing and packaging consists of numerous components, each with a specific duty. These modules are designed to improve the efficiency and accuracy of the system, and the functions of each module are logged for further analysis and improvement. [15], [16] The logged data is stored in a cloud database through a mobile application, which allows for easy assistant and control of the device. The six modules of the system are as follows:

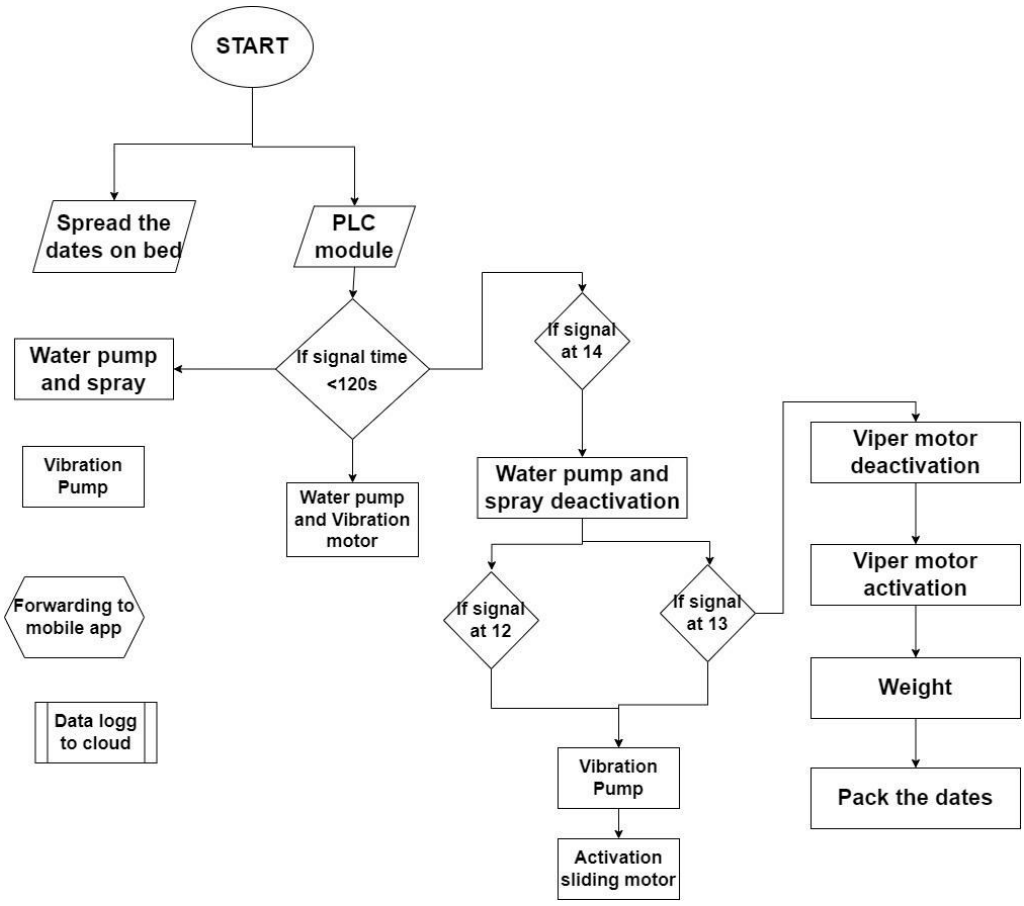

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Fig. 1 Flowchart of the proposed system

Cleaning Module: This component is responsible for cleaning the dates before they are processed and packaged. This is an important step to ensure that the dates are free of dirt, debris, and other contaminants.

Sensing Module: This module is equipped with various sensors that monitor the temperature, humidity, and other environmental conditions during the processing and packaging of the dates. These sensors ensure that the conditions are optimal for preserving the quality of the dates.

Control Module: The control module is responsible for managing the various motors and actuators that are used in the system. It receives data from the sensors and uses this information to adjust the operation of the motors and actuators as needed.

IOT Module: The IOT module is responsible for connecting the system to the internet, allowing for remote monitoring and control through a mobile application. It also enables the logging and storage of data in the cloud database [17], [18].

Packing Module: The packing module is responsible for packaging the dates in airtight packets, which helps to preserve their quality and extend their shelf life.

Reporting Module: The reporting module is responsible for generating reports on the performance of the system, including data on the efficiency, accuracy, and overall quality of the processed and packaged dates.

Figure 1 shows the whole procedure movement of the scheme. When the scheme is turned on, the programmable logic controller (PLC) starts detection and interactive with the various instruments. The entire procedure is recorded in a provisional storage and transported to the smartphone. The registered data that is established in the app boundary is then deposited in the cloud storage for additional analysis and research. It combines the latest technologies, such as IOT and deep learning, with advanced automation techniques to optimize the processing and packaging of dates. By reducing the reliance on human labor and improving the efficiency and accuracy of the process, this system has the potential to revolutionize the industry and enhance the quality of the dates produced.

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2.1 Cleaning module

The cleaning module of our prototype is designed to remove any dirt, debris, or contaminants from the dates before they are processed and packaged. It consists of a sieve bed with holes that are 1 cm in diameter, allowing the dust particles and other contaminants to be washed away while protecting the dates from damage. The sieve bed is equestrian on a base with a high-tension spiral and is connected to a vibration motor, which vibrates the bed to help loosen and remove any remaining dirt or debris. The vibration motor used in the research, is a single-phase that is used to sieve the dates automatically, end to end with a sprinkling of water. Table 1 provides more information on the model and specifications of the vibration motor. Overall, the cleaning module is an essential part of our prototype, ensuring that the dates are free of contaminants and ready for processing and packaging. By using a sieve bed and vibration motor, we are able to efficiently and effectively clean the dates without damaging them. This helps to improve the quality of the final product and reduce waste.

Table 1 Specification of the vibration motor

Specification	Description
Type	Single phase
Horsepower	1/4 HP
Frequency	50 Hz
Voltage	240 V
Rotational speed	2800 RPM
Current	6.5 Amps
Torque	1.5 Kgf.cm
Poles	2

Figure 2 shows the cleaning module for our dates processing and packaging system. To ensure the highest quality and durability, we have used grade 314 stainless steel, which is a

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high-grade material that combines a high level of chromium and nickel. By using this material, we aim to provide a long-lasting and reliable cleaning module that is able to effectively remove contaminants from the dates without damaging them.

2.2 Sensing module

The sensing module of our proposed dates processing and packaging system is equipped with a variety of sensors that enable the system to operate intelligently and complete tasks on its own. These sensors include a temperature, light, water flow, moisture, dust, rain, water content sensors. The light sensor is made to measure the concentration of sunlight, which is used to determine when the bed should be covered with a close throughout the darkness time. The various sensors mentioned above are used to measure the environmental conditions, including the temperature and humidity, which are used to determine the optimal water level or ventilation time for the dates. If the dates are dehydrated too much, they may not be suitable for consumer markets, so it is important to carefully monitor the hydration process to ensure that the dates are dried at the proper temperature.

Fig. 2 Bed used in this research

The dust sensor is used to detect the movement of dust particles in the air, while the rain sensor is used to notice rainfall on the bed. If the dirt levels are high owing to a tempest or strong winds, or if it is raining, the actuator is triggered to refuge the bed. The water sensor is castoff to measure the water quantity, and to control the water pump flow sensor is used in this research. The flow sensor is castoff to screen the weight of the water flow and prevent

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the dates from being pushed to one side due to high pressure. Overall, the sensing module of our system is an important component that enables the system to operate intelligently and ensure the optimal processing and packaging of the dates. By using a variety of sensors, we are able to monitor the environmental conditions and control the various motors and actuators to ensure that the dates are processed and packaged accurately and efficiently.

2.3 Control module

The controller module of our prototype is powered by a programmable logic controller (PLC). The PLC is responsible for receiving input signals from the various sensors and activating the motors and actuators according to the programmed instructions. In our prototype, we have used a PLC from RIEVTECH, which is equipped with an MQTT Ethernet interface and is enabled for IOT. The complete specifications of the PLC regulator module are provided in Table 2. Hence, the PLC is an important component of the controller module, serving as the central control unit for the prototype. It receives input from the sensors and uses this information to activate the motors and actuators as needed, ensuring that the system operates efficiently and accurately. The use of a PLC with IOT capabilities also allows for easy control of the scheme concluded a mobile application or other internet-based devices.

Table 2 Specification of the PLC

Specification	Description
Processor	32-bit
Memory	512 KB
I/O points	128
Communications	Ethernet, USB
Operating system	Windows CE
Programming	Ladder logic, C, C++

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2.4 IoT module

The IOT module of our prototype is linked to the programmable logic controller (PLC) to recover the state of the various sensors. It is equipped with a built-in WIFI module that allows it to establish a linking to the cloud and store all the recovered information from sensor. This data can then be accessed through a mobile application, which is connected to a Firebase database in the cloud. The IOT module is an important component of our prototype, as it enables the system to connect to the internet and access cloud-based resources. This allows for easy control of the system through a smartphone application, and enables the date agriculturalist to stay informed about the dissimilar conditions of the scheme. By using IOT technologies, we aim to provide a convenient and efficient way to manage the dates processing and packaging process.

2.5 Packing module

Our prototype is responsible for packaging the dates in airtight packets to preserve their quality and extend their shelf life. It contains of a deliberation unit and a stuffing unit. The deliberation unit is equipped with a load cell that is used to compute the heaviness of the dates. It also includes a keypad that allows the user to set the desired weight, which can range from 100 grams to 3 kilograms. Founded on the set heaviness, the stuffing unit is able to package the dates into appropriate packets. Overall, the packing module is an essential part of our prototype, as it helps to ensure that the dates are properly preserved and ready for long-term storage. By using a load cell and keypad, we are able to accurately calculate the weight of the dates and package them accordingly, improving the efficiency and accuracy of the packing process. This helps to improve the quality of the final product and reduce waste.

3. Result and Discussion

The trial run of our prototype was a success, as it produced efficient and expected results. We took care to replace any malfunctioning sensors to ensure optimal performance, and conducted thorough testing under a variety of environmental conditions. The results of this investigation are provided in Table 3, which shows that the prototype performed well across a range of conditions.

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Table 3 State of the sensor and system

Sensor	Level	Condition of water pump	Condition of the Actuator	Storage in cloud
Dust	OFF	ON	ON	No
Rain	ON	OFF	OFF	Yes
Humidity	ON	ON	ON	Yes
Dust	OFF	ON	ON	No
Light	ON	ON	ON	Yes

One of the key features of our prototype is its ability to connect to the internet and access cloud-based resources through an IOT module. This enables the system to be easily monitored and controlled through a mobile application, which is connected to a Firebase database where data from the system is stored. The date palm farmer was able to retrieve this data and view it through the mobile app, which provided them with a convenient and intuitive way to monitor the performance of the prototype.

Overall, the results of our trial run were very positive, and the prototype showed great potential for improving the efficiency and accuracy of the dates processing and packaging process. By using the latest technologies, such as IOT and deep learning, we were able to create a system that is able to operate intelligently and adapt to different conditions. By automating many of the tasks involved in dates processing and packaging, we aim to reduce the reliance on human labor and improve the overall quality of the final product.

There are several key advantages to using our prototype for dates processing and packaging. First and foremost, it is designed to be highly efficient and accurate, ensuring that the dates are processed and packaged correctly to preserve their quality and extend their shelf life. This can help to improve the profitability of date palm farming by reducing waste and increasing the yield of high-quality products. Another key advantage is the use of IOT technologies, which enable the system to be easily monitored and controlled remotely through a mobile app. This provides convenience and flexibility for the date palm farmer, who can check the status of the system and make adjustments as needed without having to physically visit the location. This can help to save time and reduce the need for manual labor. Finally, our

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prototype is designed to be durable and reliable, with high-quality components and materials that are resistant to corrosion and wear. This helps to ensure that the system will continue to operate smoothly and effectively over time, reducing the need for maintenance and repairs.

In conclusion, the results of our trial run demonstrate the great potential of our prototype for improving the efficiency and accuracy of dates processing and packaging. By automating many of the tasks involved in this process and using IOT technologies to enable remote monitoring and control, we aim to create a system that is able to reduce the reliance on human labor and improve the quality of the final product. We believe that our prototype has the potential to revolutionize the date palm farming industry and help farmers to increase their profitability and productivity.

CONCLUSION

In conclusion, the research presented in this article has demonstrated the feasibility and potential of using IOT and deep learning approaches to create a novel dates palm processing and packaging management system. Through the development and trial run of a prototype system, we have shown that it is possible to automate many of the tasks involved in dates processing and packaging, and to use IOT technologies to enable remote monitoring and control of the system.

The results of our trial run were very positive, and the prototype showed great potential for improving the efficiency and accuracy of the dates processing and packaging process. By automating many of the tasks involved in this process and using IOT technologies to enable remote monitoring and control, we aim to create a system that is able to reduce the reliance on human labor and improve the quality of the final product. We believe that our prototype has the potential to revolutionize the date palm farming industry and help farmers to increase their profitability and productivity. Overall, the research presented in this article has demonstrated the value of using IOT and deep learning approaches to improve the efficiency and accuracy of dates processing and packaging. We believe that these technologies have the potential to significantly impact the date palm farming industry and help to drive innovation and progress in this field.

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