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OPTIMIZATION OF ONION STORAGE SYSTEM THROUGH SMART SENSING AND AUTOMATION

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ABSTRACT

Onion storage is very important for keeping quality and reducing losses after gathering. This article talks about an automatic storage system that uses smart sensing technology to keep onions in the best condition possible. Arduino microcontrollers work with Temperature sensor, Moisture sensor, and MQ135 sensors to keep track of temperature, humidity, and gas levels in real time. The information shown on the screen for watching from afar. Using information from sensors, the system controls air to keep the storage area at the right temperature. By automating the process, the proposed answer increases productivity, lowers waste, and produces better onions. The results of the experiments show that the system works to provide the best storage conditions, which makes farm storage management more efficient

Keywords: Smart Storage, Automation, Onion Storage, Control After Harvest.

I. INTRODUCTION

Onions are an important crop all over the world because they are a basic food in many diets and they help agricultural businesses a lot. India grows more onions than any other country, and they are very important for both internal use and export. In the farming year 2020-21, India grew onions on about 16.24 lakh hectares, which is about 40.1 lakh acres, and made a total of 26.64 lakh metric tonnes [1]. But post-harvest losses are still a big problem. Up to 30% -40% of food is wasted due to wrong storage facility such as high temperature and humidity and lack of proper ventilation [2]. Due to poor storage farmers get too much loss because of which they can't pay the bills, and as the market prices changes it affect both farmers and consumer. Using traditional ways to store things doesn't provide them proper conditions which can cause problems like, weight reduction, rooting and rotting. Moreover the contact between rotten onions with fresh onions increase the chance of rotenning. the [3]. To solve storage problem we will design a smart storage that will manage effectively. the smart onion storage system will use temperature and humidity sensor along with gas sensor to monitor the storage conditions. This system will use a Arduino microcontroller that will give real time information about the storage area in order to reduce waste. Nowadays smart technology used in agriculture related fields has a lot of benefits by making the storage process cost effective and long lasting. If we provide correct storage conditions and a correct environment it will help the farmer economically by reducing the waste. The goal of this project is to build a cheap and creative technology to solve the problems.

Providing proper conditions is important to maintain onion quality and reduce post-harvest losses. Traditional way of storing onions fails to control things like temperature, humidity and gas level which reduces the quality and increases the loss. recently many studies have been done on sensor based solutions to make controlled environment for storage, it uses different sensors and microcontrollers like temperature sensor, gas sensor, humidity sensor etc [4]. Controlling the temperature and humidity is very important for increasing storage life of onions. The Indian Council of Agricultural Research tells that onions should be stored at 30–35°C temperature and 65–70% relative humidity [5]. To achieve this, experts have developed an automated storage system that use microcontrollers such as Arduino and temperature, humidity sensors to track real time data. Like, Sidawadkar et al. (2020) [6] used an ATmega328P microcontroller and a temperature monitor to control the storage conditions. Peltier modules were used in their system to keep the temperature in control, which successfully reduces the spoilage of onions . As the toxic gases like ammonia and ethylene build up, onions rot faster. The MQ135 gas sensor is often used in storage buildings to detect these gases [7].

According to Sidawadkar et al. [8], their storage system constantly checked the levels of gases and started ventilation automatically when saturation levels were found. This made the air better which kept food fresh. Patil and Gupta (2019) [9] looked into microcontroller-based systems for keeping an eye on onion storage in another study. They discovered that processing data from sensors such as temperature, humidity, and gas

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sensor in real time made storage conditions better for onions. Sensor based storage system work amazingly because it reduces the spoilage of onions by 25% when it uses automatic ventilation and dehumidification. Using temperature, humidity, and gas sensors along with microcontrollers results in improving conditions for storing the onions. New studies have also find that how IoT (Internet of Things) technology can improve the conditions for storing onions even more efficiently. Sharma et al. (2021) [10] created an Internet of Things-based monitoring system that allow farmer use a mobile app to check the temperature, humidity, and gas levels in real time from far away. Their system uses wireless monitors that store data in the cloud. This lets them make better decisions and act right away if things go wrong.

In the same way, Rajput and Mehta (2022) [11] tested smart alert systems that send SMS or app messages to farmer when temperature or humidity levels rises too high. These new advance technologies make it possible to automatically operate the storage area without manual interaction. Another speciality about smart system is that it uses small amount of energy . Mishra et al. (2020) [12] checks how well ventilation devices powered by the sun (solar) work in onion storage. Based on their study, solar-powered exhaust fans that were controlled by sensors for temperature and humidity helped in maintaining the quality of onion at low cost. this method work specially for rural areas where frequent power cuts occur or electricity is not readily available. Desai and Kulkarni's work from 2021 [13] looked into what would happen if phase change materials (PCMs) were used to passively control the temperature and humidity in onion storage. PCMs helped keep temperatures and humidity stable, which reduces the food waste without relying too much on electricic ventilation systems. Machine learning has also been used to make it easier to predict when food will get spoil or rot. Verma et al. (2022) [14] say that predictive models that use machine learning algorithms can look at data about the surroundings and find early signs of onion deterioration. Their method gave them useful information that let them take preventative steps before the spoilage got worse.

Singh and Patel (2023) [15] also created a fuzzy logic-based control system that changed the ventilation and dehumidification on its own based on sensor readings. When compared to standard rule-based systems, their results showed that intelligent automation made storage much more efficient. Adding smart technology to the way onions are stored is changing the game. Thanks to progress in IoT, energy-efficient solutions, and machine learning, farmers can now better control how their crops are stored, which means they lose less food after the harvest. In the future, researchers can look into how these technologies can be combined with blockchain to make supply chain tracking more open or with advanced AI-driven analytics to find storage failures before they happen. With these changes, storing onions will continue to be easier, cheaper, and last longer.

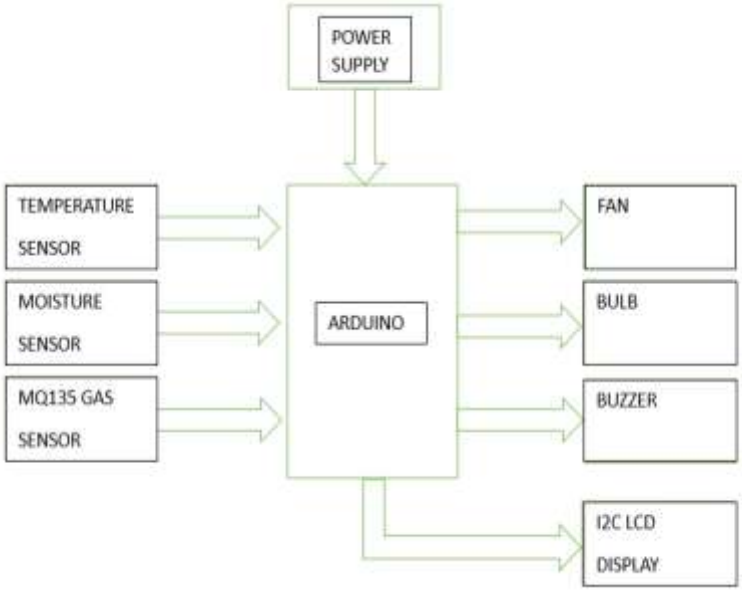

Figure 1: Block diagram of Arduino

Smart storage has many benefits.

Efficient use of money: Cuts down on the costs of monitoring and manual work.

Scalability: It can be used for both small-scale and large-scale storage.

Longer Shelf Life: Keeps onion quality and keeps farmers from losing money

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II. METHODOLOGY

The suggested onion storage method should keep the temperature, humidity, and gas levels under control by constantly checking and adjusting them. An Arduino microcontroller is used to connect temperature sensors, moisture sensors, and MQ135 gas monitors to the system. All of these sensors keep an eye on things in real time, which lets the system fix problems right away. When it gets hotter than 32°C, the device turns on a fan to help move air around and cool the storage room. This keeps it from getting too hot, which can make it lose weight or go bad. The fan will turn off immediately to save energy when the temperature drops to a safe level. Keeping onions cool and dry is also important. The moisture monitor will detect too much moisture, which can lead to rooting and food going bad. When the humidity level rises above 70%, the system turns on lights that make heat and lower the humidity level in the air. It keeps the storage area dry so that the onions don't grow and rot too much. The bulbs turn off immediately when the humidity level drops below the safe level. This automatic feature makes sure that the onions stay in the best state storage and reduces the chance of them going to waste. The system also has gas monitors that can tell when dangerous gases like ammonia are building up, which means the onions are going bad. In the storage room, the MQ135 gas analyzer is always checking the air quality. The method sets off a buzzer to let the farmer know when the ammonia level goes over the safe limit. With this instant warning, the farmer can sort out and get rid of the rotten onions before they spread to other onions.

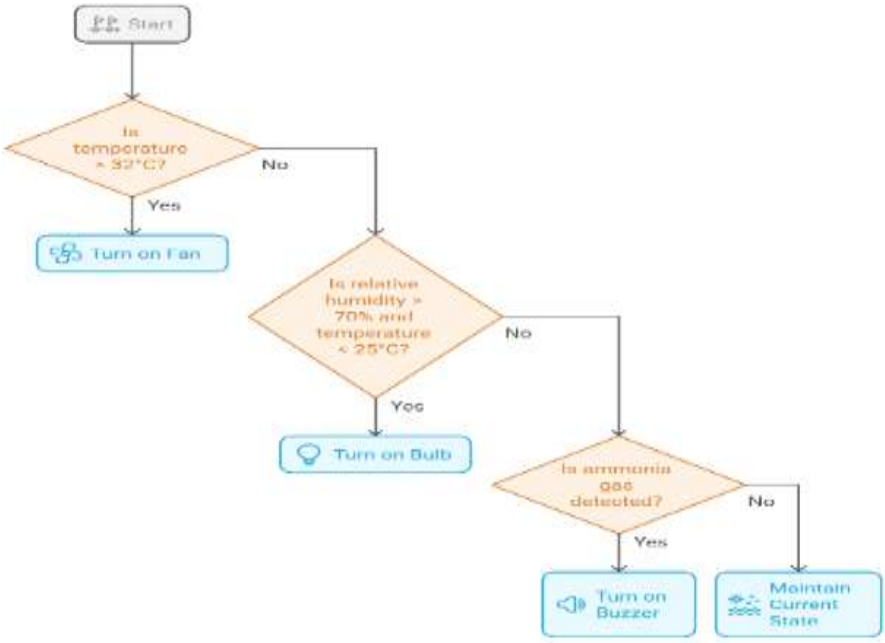

Figure 2: Flowchart showing conditions to turn on/off

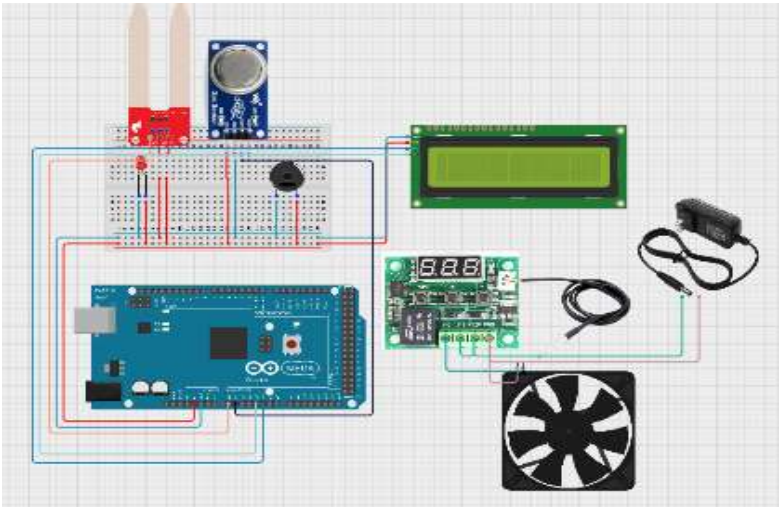

Figure 3: Circuit Diagram

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Figure 4: Control Panel and Original Setup

III. RESULTS

The method keeps the storage conditions for onions at their best on its own. The W1209 Temperature Control Module turns on the fan when the temperature rises above 32°C. This helps the onions breathe properly and keeps the temperature from rising, which could turn them bad.

The machine knows that there is too much water in the air if the humidity level rises above 70%. Because onions grow and rot faster when there is a lot of humidity in the air, the system turns on a bulb to slowly remove the humidity.

You can see in the graphs that as soon as the temperature or humidity rises above saturation point the respective actuators turns on and bring the temperature and humidity down to optimal range.

At the same time, the MQ135 gas sensor keeps looking for ammonia gas, which means some onions are beginning to go bad. The buzzer will sound to let the farmer know if ammonia is found. This warning helps the farmer get rid of the bad onions quickly, before they spread to the other onions.

The LCD screen shows important changes like the temperature, humidity, fan, bulb, and gas levels, making it easy to keep an eye on things. The Serial Monitor in the Arduino IDE also keeps track of all these changes, which makes it easier to see how storage is doing. Farmers can easily use this method to keep onions from going bad, make them last longer, and keep them from losing value.

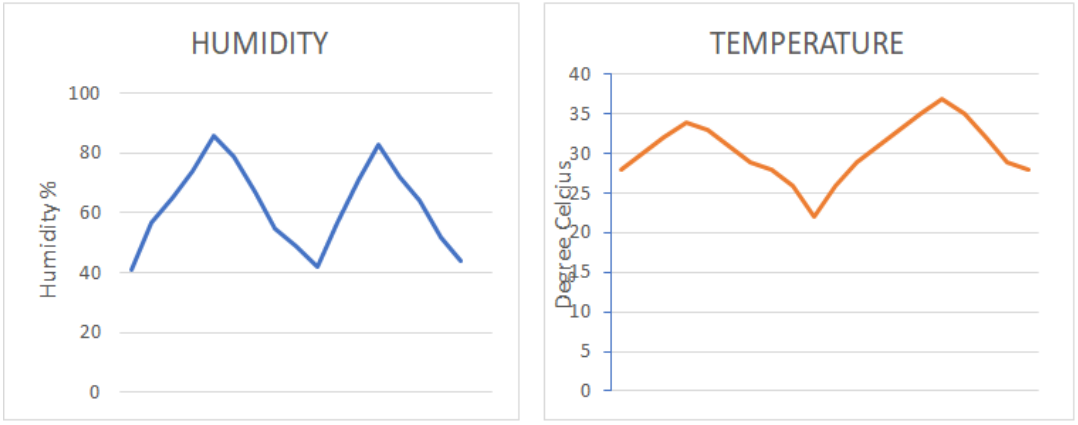

Figure 5: Graphs for (a) Humidity and (b) Temperature

Figure 6: Arduino IDE Results

Figure 7: LED Screen

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IV. CONCLUSION

Farmers have a lot of problems and lose a lot of onions after the harvest because they store them the old-fashioned way. By taking their problems into account, this answer was created to reduce those problems as much as possible while also extending the shelf life to make the most money possible.

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