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Warehouse Security and Cost Optimization by Category of Items

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***Abstract*:** A warehouse is a building used for storing commodities. Producers, shippers, exporters, wholesalers, transportation companies, customs, and other businesses all use warehouses. These are often enormous simple buildings in contemporary parks on the outskirts of metropolitan areas, cities, or towns. In this Thesis, Initial we have experimented on less weight up to 5 Kg because we are using two Load Cell of Weight 5 kg each, first Load Cell will calculate the weight of human while entering the warehouse then second load cell amplifier will calculate the weight picked by the human. In this table, Temperature shown in column 1, Humidity in column 2,Smoke/Gas in column 3, Human weight are defined in column 4, Inventory weight in Column 5, total weight is added by two previous weights in column 6 and Experimental Date & Time in Last column.

Keywords: *IoT, Technology, warehouse etc.*

1. Introduction

Typical shipping bays at warehouses are used to stack and unload cargo from vehicles. Sometimes warehouses are designed for the direct stacking and dumping of products from rail networks, airports, or seaports. For transporting items, which are often placed on ISO standard beds and then piled into bed racks, they commonly employ cranes and forklifts. Any raw substances, pressing materials, spare parts, components, or finished commodities associated with farming, assembly, and creating can be classified as stored goods. A warehouse may be referred to as a "godown" in India.

A warehouse is a kind of commercial structure that houses items in storage. Warehouses are used by producers, dealers, merchants, wholesalers, distributors, customs, etc. The use of a smart WMS is the cherry on top of your smart technology. The cost of storing food grains due to atmospheric conditions should be reduced, hence this warehouse has to be regularly inspected and documented. The old-style granary management prototype will not be able to keep up with the growth of the business and the continuous needs of the variety of food items due to its high capacity and inadequate competency.

A smart warehouse uses a variety of sensors and technology to streamline operations and lessen the demand for labor-intensive human labour.

2. Literature Review

For a pharmaceutical firm, Wei et al. (2015) developed a barcode management application in an effort to manage inventory more effectively, save labor costs, and promote data-driven decision-making. Sahuri and Utomo (2016) developed a web service solution for small-to-medium-sized businesses that helps them to manage their warehousing and commercial activities more successfully.. The main idea behind this approach is to use Short Messaging to connect stock-related data to a mobile device. Decision-making becomes more rapid and accurate as a result.

Han and Zhu (2017) investigated warehousing system problems to find solutions for enhancing logistics and storage. With the aim of increasing organizational efficiency, bringing all departments together, cutting labour costs, and clearing up material confusion, the authors have put into action a supply chain and warehousing optimization strategy. The subject of off base stock utilizing RFID was concentrated by Qin et al. (2017), who additionally made an evaluation model around it. The "bullwhip impact" happens when stock is underreported because of production network contortions. Further holding and shortage charges are the result. Utilization of RFID at later stages prompts more benefits and productivity. The fleece yarn business will utilize the RFID-based data framework design made by Oner et al. (2017) to oversee work underway, count and track stock,

picking, getting, and delivering. Likewise, the proposed technique was practical and could decrease the quantity of laborers expected by 20% while at the same time bringing down the work underway (WIP) rate, prompting lower costs and more noteworthy execution of the fleece yarn industry. Adiono et al. proposed a RFID-based products finder framework in their 2017 review, which comprises of RFID labels that are joined to the bought things and RFID perusers to decide the separation from the place to checkout. Through Bluetooth, a cell phone with WMS capacities is associated with the peruser.

To represent the continually changing creation planned operations processes, Qu et al. (2016) considered a constant creation planned operations synchronization framework inside a cloud producing climate that coordinated cloud fabricating and IoT foundation. Nonetheless, different specialists have proposed practically identical ideas utilizing various advances and wording. The idea was to use a versatile framework to manage execution elements driven arranging infeasibility.

Li and Li (2017) investigated the capability of the IoT cloud, especially the way that Production network Development (SCI) could further develop SCM effectiveness. The creators outlined how coordinating information from assets, cycles, and exercises might advance the general execution of all partners to work on the exhibition of the production network accomplices.

3. introductions to Problem Statement

Thesis aims to design & Implementation of Smart IoT Based system for improving the Efficiency of Warehouse. In this regard many Researchers have already used some types of techniques like IoT Device & Sensors to Increase the efficiency of warehouses so that it can be used efficiently by human beings. Here I am trying to design & Implement such a type of warehouse that can be governed by fully IoT Devices & Sensors with less human efficiency.

One customer at a time utilizes the warehouse's commodities that are put away on the weighing machine with included Sensors so whenever he tries to pick inventory, at that time sensors respond and give the effectiveness as an output. Every time when it picks something all the needed details are added on the screen and after completing the required item the addition of the price are shown at the display window then the customer pays the bills using QR Scan or UPI Pay. When the customer wants to exit, the weighing machine at the exit gate measures their weights for confirmation then the gate will open for exit. After that the gate men again check the bills & Inventory. After successfully completing all the tasks, customers can leave the warehouse.

After Examining all the review & Research papers, there have a lot of issues. Some of them are as follows.

1) Human Weight with Inventory & without Inventory.

2) Picking Inventory from where & How.

Motivation

Now a day, Warehouses are also make more Importance in human life because of their multi-functioning features like all types of Inventory it contains are the necessary of human life in all Category. Day to day life also make impact on human life style. Due to large numbers of queue, they often wait for a long time that’s why they turn to Online Shopping. With the help of this Design and implementation they easily can collect or purchase their inventory without any problem with higher accuracy.

As it implemented on similar types of product with same price but in future it can move to large inventory with different price with using more human efficiency.

It is basically design for such types of warehouses that have contains Similar types of Commodity with proper Controlling by Sensors so that it can easily handled by single person.

4. IoT deployment in a warehouse conceptual framework.

Design Units includes every component utilized to create this research project, including the CPU, sensors, and modules. The architecture diagram of the system we created and implemented is shown in Fig. 4.1. The next section provides a thorough description of each block in the architecture diagram.

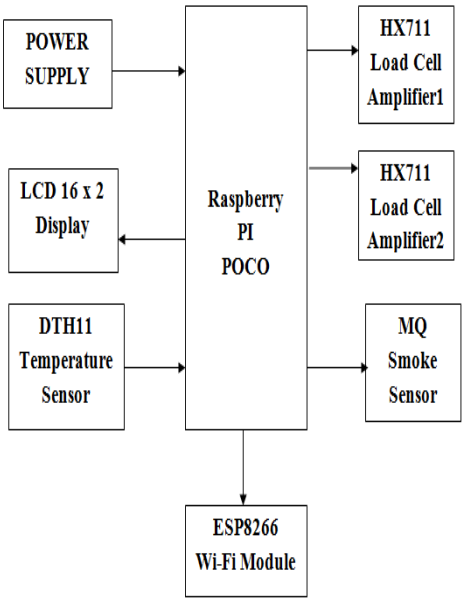

Figure 4.1 Design Unit

4.1 Flow Chart of Working Design:

Design & Implement such a type of warehouse that can be governed by fully IoT Devices & Sensors with less human efficiency. One customer at a time utilizes the warehouse's commodities that are put away on the weighing machine with included Sensors so whenever he tries to pick inventory, at that time sensors respond and give the effectiveness as an output. Every time when it picks something all the needed details are added on the screen and after completing the required item. When the customer wants to exit, the weighing machine at the exit gate measures their weights for confirmation then the gate will open for exit. After that the gate men again check the bills & Inventory. After successfully completing all the tasks, the customer can leave the warehouse.

Based on Block diagram drawn above the final implemented device is shown below:

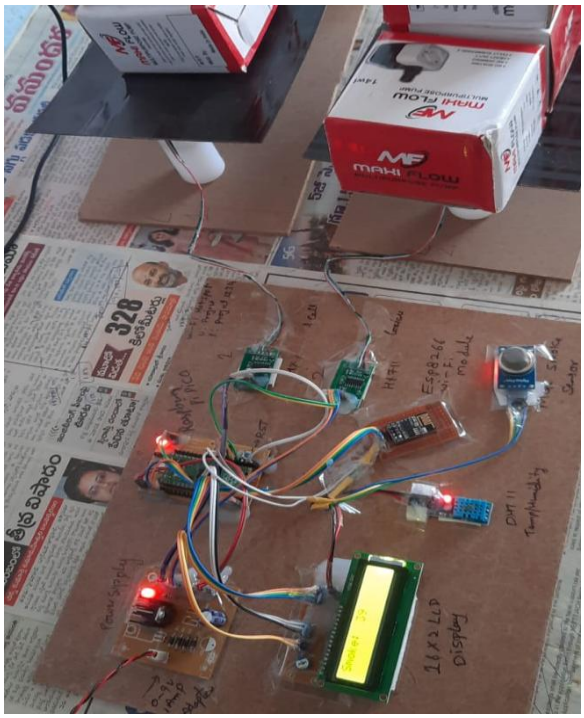

Figure 4.1.1 Design Unit

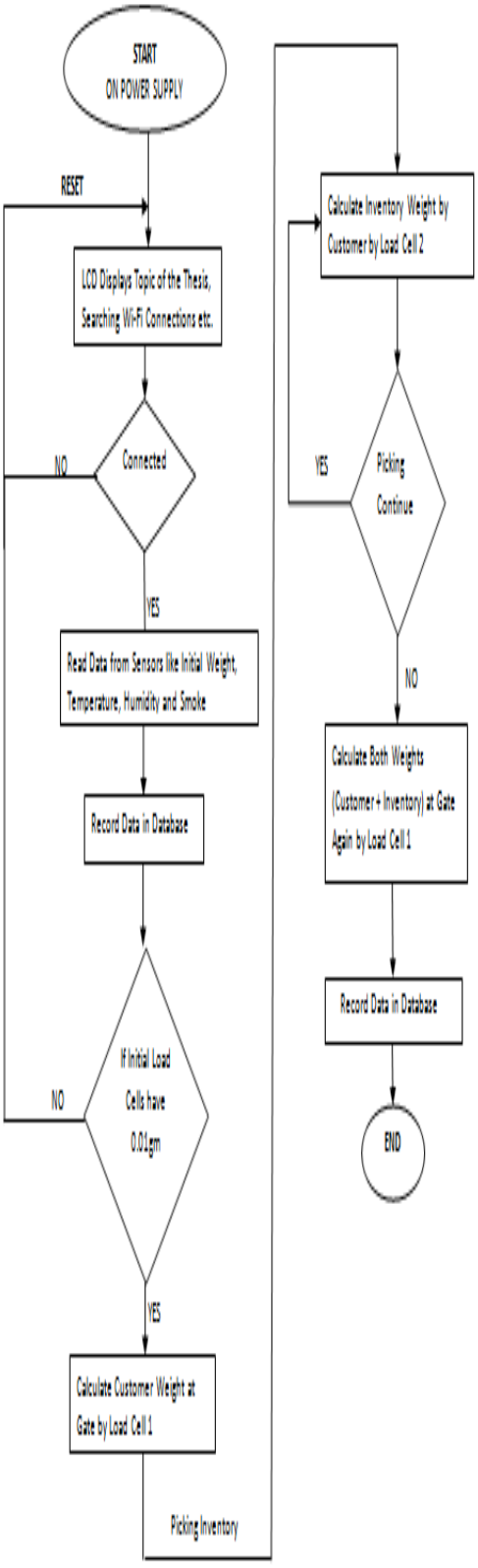

Figure 3.1.2 Design Unit

5. Theoretical Background

This section of the thesis discusses the techniques that were utilized to complete the design and figure it out. It includes sections on simulation, hardware, and programming for the application. Many different types of programmes were used for each design, software, and hardware component of this project, as well as in the application; the programmes utilized are described below.

5.1 SQL

Structured Query Language, or SQL, You may use SQL to access and manage databases. In 1986, the American National Standards Institute (ANSI) and the International Organization for Standardization (ISO) both recognized SQL as a standard.

5.2 Internet of Things

The network of physical items, or "things," that are implanted with sensors, software, and other technologies for the purpose of communicating and exchanging data with other devices and systems through the internet is referred to as the Internet of Things (IoT). These gadgets include anything from common domestic items to high-tech industrial gear. Now, there are more than 7 billion linked IoT devices, and according to analysts, there will be 10 billion by 2020 and 22 billion by 2025. Device partners are part of Oracle's network. The Internet of Things (IoT) is a network of physical connections between things like cars, household appliances, and other objects that have connectivity, electronics, actuators, sensors, and software to allow them to communicate and exchange data. Through its embedded system, the system is interoperable with the aid of the internet and cloud computing.

The Internet of Things (IoT) makes it possible for devices to be controlled and sensed remotely over already-existing network connectivity, reducing the need for human intervention in daily activities. This also opens up opportunities to link the real-time world with computer operating systems, increasing system efficiency.

IoT, or the Internet of Things, refers to the overall network of interconnected devices as well as the technology that enables communication between them as well as with the cloud.

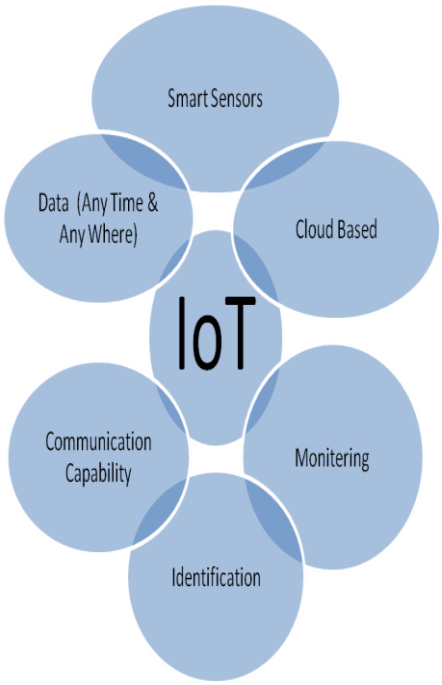

Fig. 5.2.1 Internet of Things

5.3 Hardware Description

5.3.1 Raspberry Pi PICO

Since the creators of the most well-known single-board computer in the world had never shown an interest in microcontrollers, the Raspberry Pi Foundation's decision to offer a microcontroller was a big announcement in and of itself.

But even more shocking than the Raspberry Pi Pico's unveiling was the revelation that it was made using just proprietary Raspberry Pi silicon. They opted to design their own microcontroller rather than relying on the wealth of already available code and support for ESP32 or SAMD21-based solutions.

Therefore, we are all beginning from fresh with the Pico.Numerous technical documents and an excellent manual titled Get Started with MicroPython on Raspberry Pi Pico were made available by Raspberry Pi. Both a paperback copy and a PDF download are available.

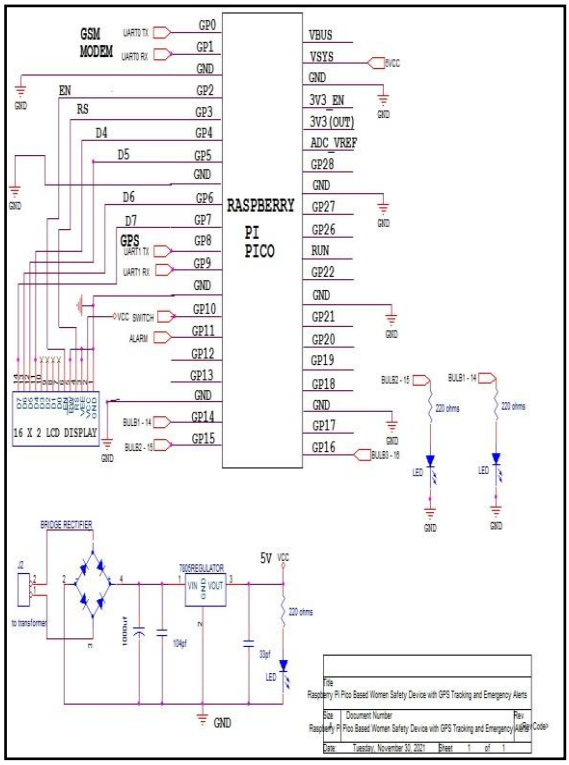

Figure 5.3.1: Architecture of Raspberry PI Pico.

5.3.2 Temperature Sensor:

This electrical gadget measures the temperature of the surface it is installed on and outputs an analogue voltage. A thermistor is the finest illustration. The two types of temperature sensors that are offered on the electronics market are contact and non-contact. To monitor the surface temperature, contact temperature sensors are put directly on it. By assuming that there is no heat exchange between them while they are in an equilibrium condition, this will determine the temperature. Non-Touch Sensor: Sensors that won't make contact with an item are known as non-contact sensors. It will use radiation from the item to measure the temperature.

5.3.2.1 Temperature Sensor DTH11

1) Maximum voltage supply of 5 V
2) Temperature ranges from 0°C to 50 °C giving an error of ± 2 °C
3) Humidity ranges from 20 to 90% RH ± 5% RH error
4) Interface is Digital

5.3.3 Humidity Sensor:

The Raspberry Pi integrates a humidity sensor and a temperature sensor. These are calculated using a single wire serial interface and measured in degrees Celsius. We employ a resistive type component to assess moisture, and a negative temperature coefficient component to measure turbidity. The Raspberry Pi can interpret the calibrated digital signal that the DHT11 outputs, eliminating the requirement for an analogue to digital converter.

Fig 5.3.3.1: Humidity sensor and Digital temperature

5.3.4 Fire Sensor:

Either the smoke or the fires light may detect it. We can get the details as soon as possible and prevent the occurrence from happening systems, smoke detection, batch counting, and automatic lighting control. One of the MQ sensor series' most often used models is the MQ2. A MOS (Metal Oxide Semiconductor) sensor is what it is. Since sensing is based on the change in resistance of the sensing material when exposed to gases, metal oxide sensors are also known as chemiresistors. The MQ2 gas sensor uses 800mW of power and runs on 5V DC. It has a 200–10,000 ppm detection range for LPG, smoke, alcohol, propane, and hydrogen, methane, and carbon monoxide.

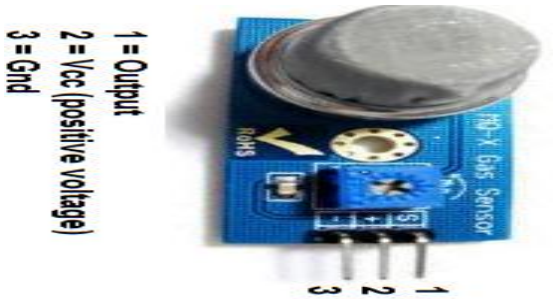

Fig. 5.3.4.1 MQ Smoke Sensor

5.3.5 WIRES

5.3.5.1 Jumper Wire/ Hooked wire

Jumper wire and hooked wire is a cable utilized in an IoT application for interconnecting Arduino with different sensors with the bread board. It is normally used for creating connections between components like Arduino (pin) with the Temperature sensor and Raspberry pi. It helps in completing the circuit giving the readings.

Fig 5.3.5.1 Jumper Wire

In Jumper wire, there are three categories Male to male, Male to female, female to male, Female to female: 15 nos.

Fig 5.3.5.2 Female to female jumper wire

5.3.6 USB Cable

With this connection, you may connect any Microcontroller board to your computer as well as a USB printer, scanner, and other USB devices.

Fig 5.3.6.1 USB Cable

5.3.7 Power Cable

Some Microcontroller boards, including the UNO, MEGA, and DUE, include an AC connection that may be used to power the boards and, if necessary, deliver extra electricity.

Fig 5.3.7.1 Power Cable

5.3.8 Weighing Machine using Raspberry Pi PICO Load Cell & HX711 Module

Sr. No.	COMPONENTS	QUANTITY
1	16x2 LCD Display/Mobile MSG	1
2	Raspberry Pi PICO	1
3	Load Cell 5Kg	2

4	HX711 Module	2
5	Power Supply/Push Buttons	1
6	Connecting Wires	20+
7	DHT11 Sensor Temperature/Humidity	1
8	MQ Smoke Sensor	1

Table 5.3.8.1 Weighing Machine Module

5.3.9 Load Cell

An electrical signal produced by a load cell, the force being measured is directly proportional to a transducer. In essence, it is a tool used by scientists and workers to measure strain and transform force into electric energy. Load cells measure strain to protect nearby people and equipment and to maintain the integrity of the unit under pressure.

A certain kind of mechanical forces—typically tension, torque, compression, or pressure—is converted into an output signal by load cells. A load cable is then used to convey this output signal to the scale's indication, where the operator may use it to measure and read the exact weight.

Fig 5.3.9.1 Load Cell

5.3.10 LCD Display

A type of flat panel display known as an LCD (Liquid Crystal Display) operates primarily on liquid crystals. As they are often used in cell phones, televisions, computers, and instrument panels, LEDs offer a wide range of applications for consumers and enterprises. As compared to the technologies they replaced, such as light-emitting diode (LED) and gas-plasma displays, LCDs represented a significant advancement.

Compared to cathode ray tube (CRT) technology, LCDs permitted screens to be far smaller. As opposed to LED and gas-display displays, LCDs operate on the idea of blocking light rather than generating it, which results in a significant reduction in power consumption. The liquid crystals in an LCD use a backlight to form a picture where an LED emits light.

Fig. 5.3.10.1 LCD Display 16 X 2

5.3.10.1 Working of LCD

Millions of pixels make up a display. The quantity of pixels on a display is frequently used to describe its quality; for instance, a 4K display has pixels that measure 3840 x 2160 or 4096 x 2160.

Red, blue, and green sub pixels—commonly referred to as RGB—combine to form a pixel. A distinct colour can be formed when the colour combinations of the sub pixels of a pixel change. The combination of all the pixels on a display enables the creation of millions of distinct colours. A image is produced by quickly turning on and off the pixels. In essence, LCDs use liquid crystals to spin polarized light while being lighted by a backlight and having their pixels electronically turned on and off. Each pixel has a polarizing glass filter in front and behind it; the front filter is angled at a 90-degree angle.

The liquid crystals, which can be electrically turned on and off, are sandwiched between the two filters. Either an active matrix display grid or a passive matrix display grid is used to make LCDs. A grid of conductors with pixels positioned at each junction makes up the passive matrix LCD. To regulate the light for any pixel on the grid, a current is delivered through two conductors. As each pixel intersection in an active matrix includes a transistor, controlling the brightness of a pixel with less current is possible. For this reason, the current in an active matrix display may be turned on and off more often, increasing the screen refresh time.

5.3.11 ESP8266 Wi-Fi Module

A self-contained SOC with an integrated TCP/IP protocol stack, the ESP8266 WiFi Module allows any microcontroller to access your WiFi network. The ESP8266 is capable of offloading all WiFi networking tasks from another application processor or hosting an application.

Each ESP8266 module has an AT command set firmware that has been pre-programmed, so all you have to do is connect it to your Arduino device to get nearly the same amount of WiFi functionality as a WiFi Shield (and that's right out of the box)! The ESP8266 module is a very affordable board with a sizable and expanding community.

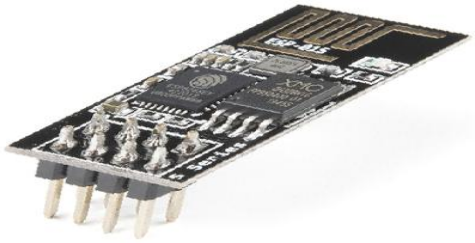

Fig. 5.3.11.1 ESP8266 Wi-Fi Module

With its GPIOs, this module may be coupled with sensors and other application-specific devices with a minimum of upfront programming and runtime loading thanks to its robust on-board processing and storage capabilities. Because of its high level of on-chip integration, it only requires a small amount of external circuitry, and even the front-end module is made to take up little space on the PCB. The ESP8266 includes a self-calibrated RF that enables it to operate in all operational environments and does not require any external RF components. It also supports APSD for VoIP applications and Bluetooth co-existence interfaces.

The ESP8266 has access to a nearly endless supply of knowledge, all of which has been made possible by the great community support. You can discover several tools to help you use the ESP8266 in the Documents area below, including instructions on how to turn this module into an IoT (Internet of Things) solution!

5.4 Oftware Description

5.4.1 Microsoft Visual studio

Microsoft's Visual Studio is an integrated development environment (IDE). Computer programmes, including as websites, web applications, online services, and mobile applications, are developed using it. Microsoft's

software development platforms, including Windows Store, Windows Presentation Foundation, Windows API, and Windows Forms, are used by Visual Studio. Both native and managed code can be generated by it.

Fig. 5.4.1.1 Microsoft Visual studio

5.4.2 Python

Python is a highly interpreted, high-level programming language. It facilitates and offers explicit coding knowledge at both big and small scales. Python's dynamic type system and automated memory management are its key characteristics. It supports procedural, functional, imperative, object-oriented, and several more programming paradigms. It also has a sizable library with many different functions. The programming language Python is interpreted by several operating systems. It uses a community-based development methodology and is a free and open

source version of Python. Similar to almost variant executions. It is a nonprofit organization founded by the software sector.

6.1 Requirements

We needed a few pieces of apparatus and some software to carry out the experiment, and all of the software is open source and the hardware is reasonably priced.

6.1.1 SOFTWARE REQUIREMENTS:

1) Python 3.5 (minimum version) or latest
2) IOT Web Page
3) MySQL Database
4) Email Alert
5) Microsoft Visual Studio

6.1.2 HARDWARE REQUIREMENTS:

1) Micro Controller/ Raspberry Pi Pico
2) ESP8266 Wi-Fi Module
3) Power Supply
4) DHT711 Temperature Sensor
5) 16x2 LCD Display
6) MQ Smoke Sensor
7) Load Cell
8) HX711 Load Cell Amplifier

6.2 System Test Result

According to this research, I have implemented a device which can provide Results for increasing the warehouse efficiency with less human Efficiency & Accuracy with all sensors.

As shown in figure 3.1 initial we have experimented on less weight up to 5 Kg because we are using two Load Cell of Weight 5 kg Each, first Load Cell will Calculate the weight of human while entering the warehouse then second load cell amplifier will calculate the weight picked by the human. In this table, Temperature shown in column 1, Humidity in column 2,Smoke/Gas in column 3, Human weight are defined in column 4, Inventory weight in Column 5, total weight is added by

two previous weights in column 6 and Experimental Date & Time in Last column.

The inventory management for the next-generation smart storeroom management is proposed with IoT-enabled sensor technology through execution and deployment of the present technology. The advantage of this approach or model is that it incorporates very sophisticated technologies and features within the system itself. As a result, the suggested solution would close the gap between consumer happiness and corporate profitability.

The primary stockholders will hopefully benefit from this as they define and establish the standards for next-generation smart storeroom inventory management.

This thesis work will rely on modern, advanced technology and provide a user-friendly, sophisticated, and practical client solution. This system will offer end-to-end management in a more intelligent and creative way. So, we can conclude that it is a real-time tracking system with cloud computing and administrative assistance that is ready for the future. The customizable system with several server topologies both centralized and decentralized.

Design & Implementation of Smart IoT Based System for Improving the Efficiency of Warehouse

Logout

MAIN SCREEN

TEMPERATURE SENSOR	HUMIDITY SENSOR	SMOKE /GAS SENSOR	Human Weight	Inventory Weight	Total Weight after Picking Inventory	Date / Time Display
024	043	040	0.01	0.49	0.50	2023-02-11 18:21:19
025	039	042	0.63	0.49	1.12	2023-02-11 18:20:13
028	036	042	0.57	0.49	1.06	2023-02-11 18:19:08
022	050	042	0.54	0.49	1.03	2023-02-11 18:18:01
022	049	040	0.54	0.49	1.03	2023-02-11 18:16:55
022	049	040	0.21	0.52	0.73	2023-02-11 18:15:47
022	048	042	0.21	0.01	0.22	2023-02-11 18:14:41
024	043	042	0.01	0.01	0.02	2023-02-11 18:11:43
025	044	040	0.01	0.01	0.02	2023-02-11 18:10:37
024	043	042	0.01	0.01	0.02	2023-02-11 18:09:29
024	042	042	0.25	0.11	0.37	2023-02-11 18:08:23
023	055	041	0.01	0.01	0.02	2023-02-11 18:07:17
021	051	042	0.01	0.01	0.02	2023-02-11 18:06:10
021	051	042	0.01	0.01	0.02	2023-02-11 18:05:04
021	052	042	0.06	0.06	0.12	2023-02-11 18:03:58
020	052	042	0.01	0.01	0.02	2023-02-11 18:02:52

Table 6.2.1 System tests carried out at various Results

6.3 Results of LCD

Liquid Crystal Display provides all sensors results in linear form such as Thesis topic name, Wi-Fi devices ON/OFF and Connected, smoke, Temperature and Humidity Weight, website linking, Sending Data and Complete Data send to Website etc.

6.3.1 Website Related Result:

This section shows the connectivity with the Website, Sending Data to Website.

Figure 6.3.1.1 System tests carried foe Web linking

Figure 6.3.1.2 System tests carried out to Website

Figure 6.3.1.3 Results Processing on Website

Figure 6.3.1.4 Results upload completely on Website

6.3.2 Temperature & Humidity Related Result:

This section shows the Results related to Temperature and Humidity.

Figure 6.3.2.1 Results of Temperature and Humidity

6.3.3 Smoke Sensor MQ Result:

This section shows the Results related to Smoke or Fire Alert.

Figure 6.3.3.1 Results of Smoke

6.3.4 Wi-Fi Connection Status:

This section shows the Results related to Wi-Fi Connectivity Status.

Figure 6.3.4.1 Results of Wi-Fi Connectivity

Figure 6.3.4.2 Results of Wi-Fi Connectivity

Figure 6.3.4.3 Results of Wi-Fi Connectivity

6.3.5 Weighing Sensor Result:

This section shows the Results related to Weight.

Figure 6.3.5.1 Initial Weighing Sensor Result

Figure 6.3.5.2 Weighing Sensor Result

6.4 Future Scope

It can be required to release a new version of the product in order to enhance functionality as technology develops or consumer requirements change. The System is complete and operating effectively, but further modules that enhance the System's performance can be added without significantly changing the System as a whole. With this product capability in mind, the system was designed and developed utilizing an incremental process paradigm. A small number of the numerous modules that couldn't be incorporated in the previous increment owing to time constraints have been discovered. Here is a list of them.

6.4.1 Module to Carried out Multiple-Inventory

We can use it when we are working on a single user but when we have to increase the numbers of user one at a time then we have to create another module that can able to pick several inventory one at a time and able to perform best service. Every time when he tried to pick multiple inventories, it’s able to carry look on every activity of a customer. Sometimes user can picked inventory but due to some unavoidable conditions he or she is not interested to purchase then module can act accordingly without the interrupt of others.

6.4.2 Module to Carried out Multiple-Users

Same as given earlier when we want to apply this module on several users then either we can use Artificial Intelligence, Machine Learning or others techniques so that it can perform accordingly. For that we have to add

some other sensors or may be add more sensors to act according to the requirement.

6.5 Conclusion

The subject of off base stock utilizing RFID was concentrated by Qin et al. (2017), who additionally made an evaluation model around it. The "bullwhip impact" happens when stock is underreported because of production network contortions. Further holding and shortage charges are the result. Utilization of RFID at later stages prompts more benefits and productivity. The fleece yarn business will utilize the RFID-based data framework design made by Oner et al. (2017) to oversee work underway, count and track stock, picking, getting, and delivering. Likewise, the proposed technique was practical and could decrease the quantity of laborers expected by 20% while at the same time bringing down the work underway (WIP) rate, prompting lower costs and more noteworthy execution of the fleece yarn industry. Adiono et al. proposed a RFID-based products finder framework in their 2017 review, which comprises of RFID labels that are joined to the bought things and RFID perusers to decide the separation from the place to checkout. Through Bluetooth, a cell phone with WMS capacities is associated with the peruser.

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