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INTELLIGENT WAREHOUSE SYSTEM FOR COMMERCIAL APPLICATIONS

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ABSTRACT

The day-to-day growth of online shopping and increasing demand for fast delivery force a huge optimization in the process of shipping a product from manufacturer to customer. In the repeated process the warehouse plays an important part as a hub to store the package where all the packages are stored asper the demand and shipping them quickly is important. To pick a package in a warehouse to deliver it there are many different ways to accomplish it. We choosea horizontal rack-like structure to work efficiently and a highly automatable controlled environment to store and pick a package.

By this way, the package can easily be transported. Our product is Automatic Storage and Retrieval System (AS/RS) which helps to reduce the transporting time. By using the current technology the working process is automated and connected to the internet for real-time updates. The reason for selecting this robotic project is that we would like to create both hardware and software combined solutions and to implement an innovative idea in the field of robotics.

Keywords: Pick and Drop, Warehouse Robot.

INTRODUCTION

1.1 Overview of the model:

Our Project is mostly suitable for warehouses because they act as a central hub for delivering the package to customers and they are the most beneficiary user of our solution. Online e-commerce is a huge process and Warehouse is an essential part of them and we are trying to improve our idea.

As they have a huge space to establish a work environment. They already have their own customers and partners like delivery, supplier agents, etc… who canbenefit from our product.

We are going to produce robots and develop an environment in a warehouse-like Industrial Space. This unit also includes the designing of the new product and services. Based on the parameters like the size of the warehouse, the number of robots, and their key requirement, we are going to create software to maintain, monitor, and optimize

their work to make our solution work the best for them. Each customer has a unique type of robot based on the parameters like warehouse size etc. Based on it, We will be designing and upgrading it.

1.2 Objective:

This project's main objective is to get the product's data as input from the userand do a pick or drop function based on their request. It also provides an efficient way to manage the storage unit of the warehouse. It is cost-efficient. This model provides a fast and reliable way to transfer the packages inside the warehouse. Since it is an AGVs [Automated Guided Vehicle], things are handled in automation. So it is fast and reduces labor costs.

1.3 Scope of the project:

Our project is efficient and provides a complete automated process for the warehouse. It reduces the time-consuming work and completes the job in an efficient way. Another advantage is that it can specifically pick and drop, unlike other robots. It can pick a product from a specific place based on the user's need and drop it in the desired location. It is connected to a local server that holds the warehouse data to which the robot can access the information. The server is connected to the internet for real-time updates. The upcoming chapter tells about the Literature review of this project.

SYSTEM ANALYSIS

3.1 Existing System:

There are two types of existing systems: using robots and doing manual labor. The manual process is a time-consuming and labor-intensive working method but more flexible. To overcome this issue, the robotic system is introduced in the current system to enhance efficiency. In the current system, the robot which is used mostly to pick and drop is a vertical robot but this has some drawback such as

- Compact size - In order to operate, this system use more space
- Functionality - this robot still lack some function such as picking anindividual object, which causes time and cost efficiency problem
- Cost - Since this equipments are huge and complex it will increase the cost

3.2 Proposed System:

Compact Size: Since Design was made in an effective manner, Size of the AGV will become compact. Movement: Our Model can move in both the x-axis & y-axis and left & right to cover more area. Pick: This robot can pick a specific single object from a basket rather than picking the whole basket. Drop: Thi robot can drop the package wherever we want by providing the location. Communication: This robot can communicate with the database to know the location and gets information about obstacles [other robots] to calculate the shortest path.

The following are the features of our proposed model:

Improved working method: to improve efficiency, some of the robotic processes will be sent to the local server to do it. So it increases the efficiency and requires low-power hardware for the robot. The data sent to serve will be processed and different approaches are done based on it. It also is able to grab only one object in the basket instead of grabbing the whole basket which also increases its efficiency.

Cost-effective: By using the automated robot, Most of the work is done by automation so it reduces repetitive work which cuts down labor costs compared to other solutions. By implementing a new design and integrating all parts into one board and interface with it, Our model costs less and requires fewer resources to work. This model reduces hardware usage and does most of the calculation on the server side with the help of software which reduces hardware cost.

Single Control System: A local server is established which is capable of controlling all the robots in the warehouse and an AI is deployed in the server in order to reduce the hardware requirement of the robot and to make an improved working method.

- The Local server will create the instructions for the robot like location, routes, and deploys location. The reason to use the Local database is that it is easy to access, has fast response, is cost-efficient, and also connects to the internet So it can test from anywhere.
- **Database:** It contains information like the product's name, data, and location. Both the server and Robot can access the database directly for the working process.
- **Prioritize based on the shortest route:** Instead of prioritizing FIFO [i.e the route, based on the order of task given], it will prioritize the route based on places nearby the robot.

Artificial intelligence: the trained AI is used to detect the object in the basket by using the captured image which happens in the local server. The Robot will capture the image and send it to the server the image will be processed and send the coordination back to the robot to do the further process. We use AI to detect the object's location in the rack and train the robot to grab the Object in the rack.

3.2 WORKING PROCESS:

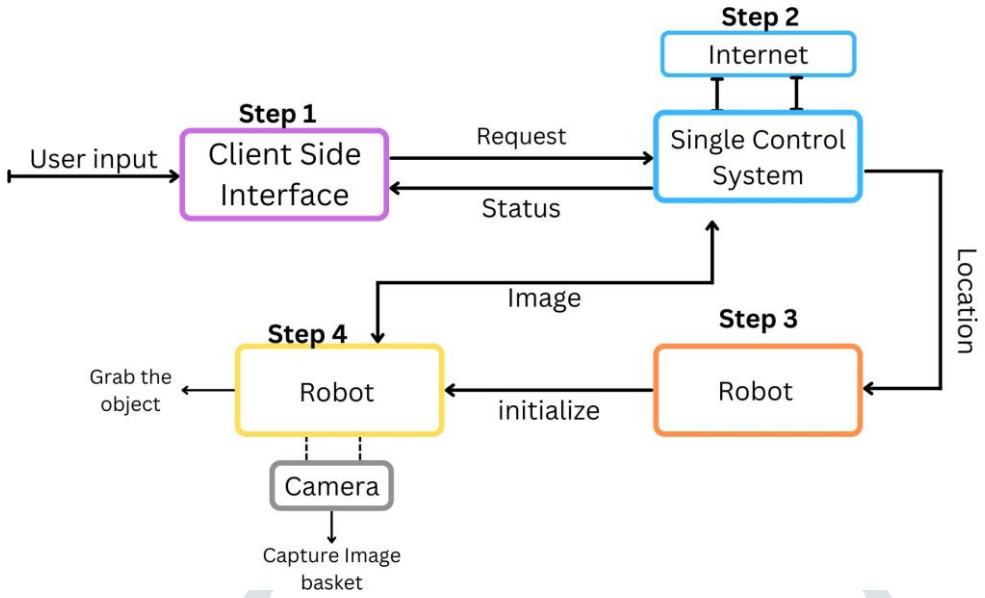


Fig 3.3.1: Block Diagram

User input:

- User side of the device can either be operated manually or Automated
- User sends the request to the database server where it checks for theproduct's availability and the status of the current process.
- The user side is essential and by improving the user experience, it makes iteasy to use the system.
- By using the user device the system can be improved and optimized fortheir use case.
- Online ordering list is directly shared to the User device.

Local Server & Database:

- The Server is a multi-purpose area that handles the major work. It works as local Computing, Image Processing, database, and Connects with the real-time Internet.
- Based on user request, it finds the availability of the product and then sends the location of the product to the nearest robot to pick up the product.
- It also holds the status of the process.
- It stores all the product locations as a database and their availability as well.
- Through Internet connectivity, we can monitor the process easily from anywhere.

Robot 1 X & Y Moving:

- After getting the location of the product from the server, the robot finds a way to the product and picks the product from the basket.
- Due to limited space availability, the robot cannot turn easily. To overcome this issue, Our robot will have a special design that makes the robot move in the x-axis direction as well as the y-axis direction.
- It can be done by moving the base of the robot up & down to switch the direction.

- It also carries a tri-arm to pick up & drop off the product.
- It does not communicate directly with the user but it does communicate withthe server and works automatically as instructed by the server.

Pick & Drop:

- This is the second part of the robot which is attached to the frame. It also holds a camera with it.
- This is used to pick a specific object from the basket using the camera.
- The camera will capture the image of the basket and send it to the server. The Pre-trained AI is deployed in the server which is used to determine the box position and depth.
- The server will send the calculations back to the robot and by using the information the tri-arm will grab the object.

REQUIREMENT SPECIFICATION

4.1 HARDWARE REQUIREMENT:

4.1.1 ESP8299 wifi Module:

The ESP8266 WiFi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all WiFi networking functions from another application processor.

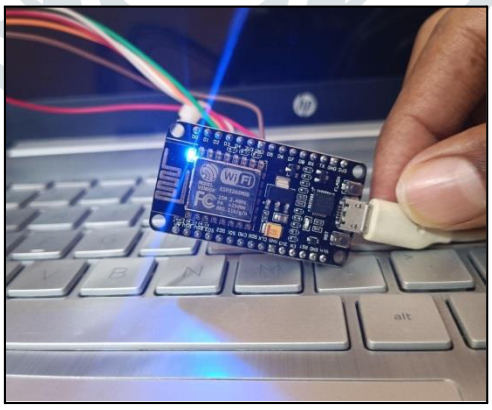


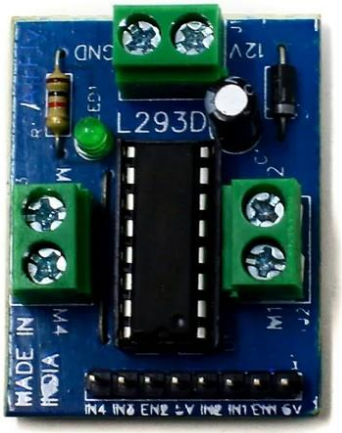
Fig: 4.1.1 ESP8266

4.1.2 L295D Motor Driver:

The L295D is designed to provide bidirectional drive currents of up to 600 mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, DC and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

The L293D is a 16-pin Motor Driver IC that can simultaneously control two DC motors in any direction. The L293D is designed to provide bidirectional drive currents of up to 600 mA (per channel) at voltages from 4.5 V to 36 V (at pin 8). You can use it to control small dc motors - toy motors. Sometimes it can be extremely hot.

Fig: 4.1.2 L293D



4.1.3 Servo Motors [MG90]:

Servo motors operate from 4.8V to 6.5V, the higher the voltage higher the torque we can achieve, but most commonly they are operated at +5V. Almost all hobby servo motors can rotate only from 0° to 180° due to their gear arrangement so make sure your project can live with the half circle. If not, you can prefer a 0° to360° motor or modify the motor to make a full circle. The gears in the motors are easily subjected to wear and tear, so if your application requires stronger and long-running motors you can go with metal gears or just stick with normal plastic gear.

Application:

- Used as actuators in many robots like Biped Robot, Hexapod, robotic arm,etc..
- Commonly used for steering systems in RC toys
- Robots where position control is required without feedback
- Less weight hence used in multi DOF robots like humanoid robot

Fig: 4.1.3 Servo Motor

4.1.3 DC Motor:

This is a DC motor with a heavy and steady motor connection. The function of this wheelset is a motor connected to the gearbox which will increase the torque of the wheel attached to it.

Fig: 4.1.4 DC Motor

SOFTWARE REQUIREMENT:

4.1.4 Firebase:

Google Firebase is a Google-backed application development software that enables developers to develop iOS, Android, and Web apps. Firebase provides tools for tracking analytics, reporting and fixing app crashes, and creating marketing and product experiments.

It is used to store and fetch data from the cloud and it is accessed via the internet. Firebase is used to fetch the Product Name, Location, Quantity, and Availability status of the products that can be accessed by the robot. In the same way, Robot will also communicate and update its current working status.

RESULTS AND CONCLUSION

5.1 Experimental results and discussion:

In the current model, we create a user database in the firebase platform andconnect the user database with the robot and make communication between the robot and the database using the internet.

5.1.2 PROCESS:

The input is created by the user manually in firebase or esp8266 and esp8266 will get data from firebase. The input data will have the location of the product. The firebase will provide input to the robot by changing the working status to in progress and the robot will respond to the request and send back the robot status. Then the robot gets the location coordinates from the firebase and controls the wheel to move to the specified location. This can be achieved by altering the X, and Y directions.

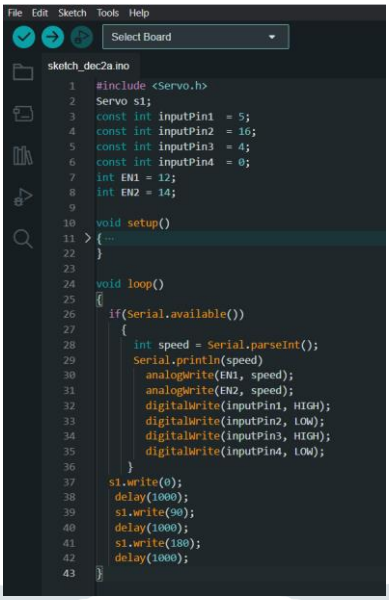


Fig: 5.1.1: Motor Driver Code

For robot movement, we created a 3D model to visualize the robot. The robot functions are done by esp8266, motor gearbox, and servo motor to create a response to firebase input.

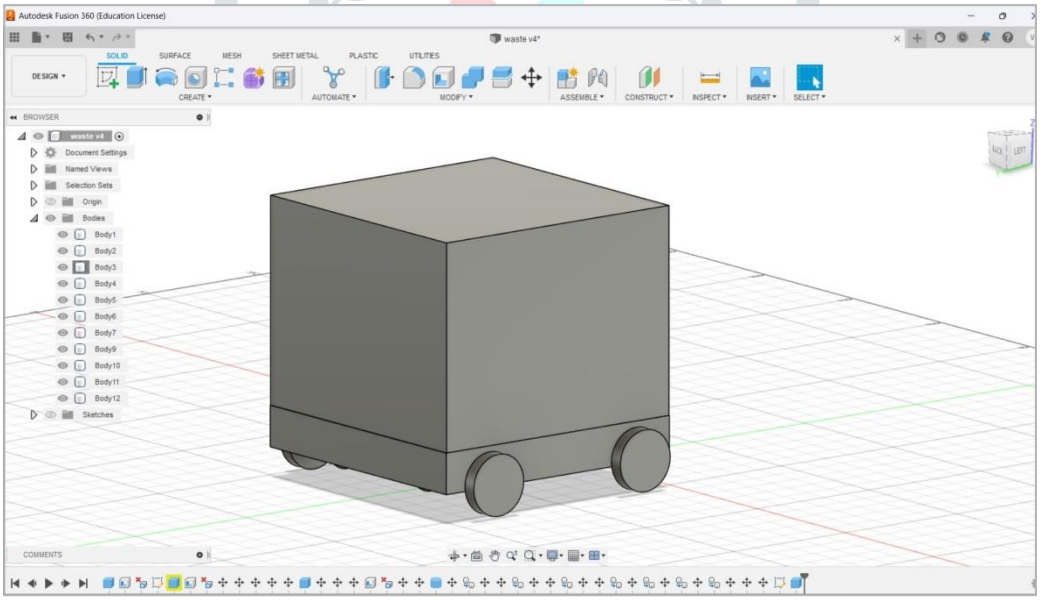
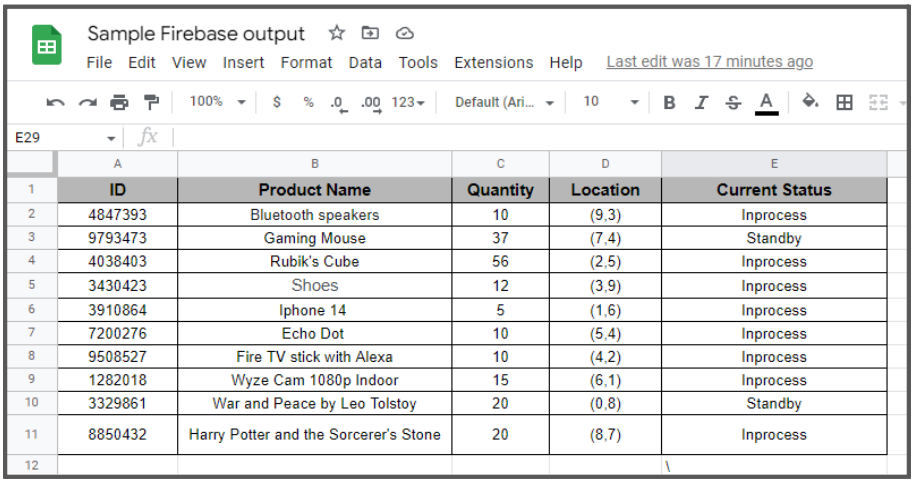


Fig 5.1.2: Fusion 360 Simulation

The below sheet will be used to understand the database which stores the data of the available product. The database holds data like product name, quantity, etc which can be fetched by both the user and the robot to operate. The user can access all data but the robot can access only the location.



Sample Firebase output

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E29

	A	B	C	D	E
1	ID	Product Name	Quantity	Location	Current Status
2	4847393	Bluetooth speakers	10	(9,3)	Inprocess
3	9793473	Gaming Mouse	37	(7,4)	Standby
4	4038403	Rubik's Cube	56	(2,5)	Inprocess
5	3430423	Shoes	12	(3,9)	Inprocess
6	3910864	Iphone 14	5	(1,6)	Inprocess
7	7200276	Echo Dot	10	(5,4)	Inprocess
8	9508527	Fire TV stick with Alexa	10	(4,2)	Inprocess
9	1282018	Wyze Cam 1080p Indoor	15	(6,1)	Inprocess
10	3329861	War and Peace by Leo Tolstoy	20	(0,8)	Standby
11	8850432	Harry Potter and the Sorcerer's Stone	20	(8,7)	Inprocess
12					

Fig: 5.1.3: Sample Output

5.1.3 Output:

In our model, we create a database using firebase which holds information about product name, id, quantity, location, and working status. The robot responds to firebase requests and then fetches location data from the database and creates a response by moving to the location.

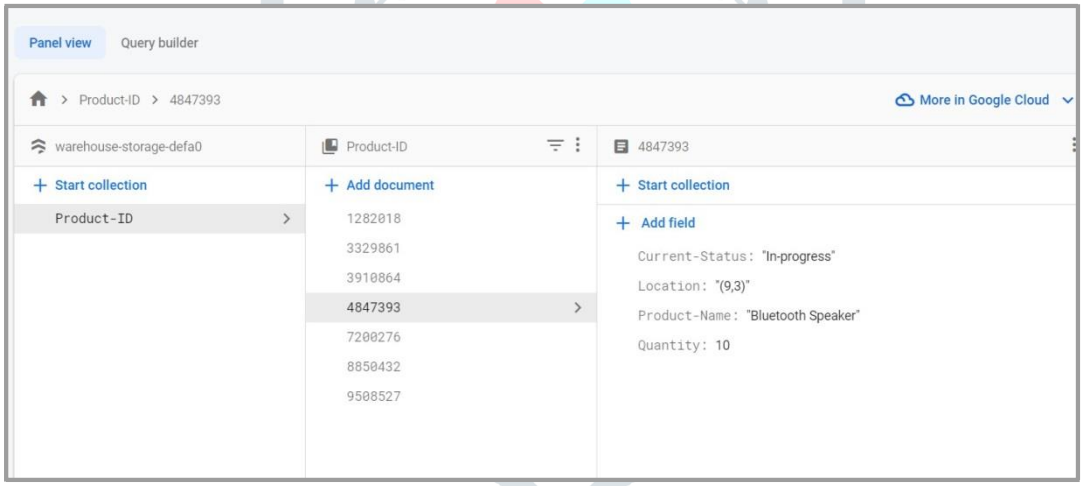

Fig: 5.1.4: Firebase Module

5.2 Conclusion:

By using a pick-and-drop robot we can pick individual objects from the basket and drop them to specific locations easily. This method will also reduce the storage space and increase the efficiency of the picking process. It helps to automate the working process and multiple operations can be done with single or multiple robots at the same time. This robot is also upgradeable and improved over time by enhancing and optimizing each module to improve overall performance.

FUTURE SCOPE

This robot can be upgraded and modified to work in different areas such as supermarkets and fulfillment centers and different fields to utilize automation and works with databases and it can verify remotely. In the next stage, multiple robots are connected and it will split the work among them and will finish tasks more rapidly at the same time.