POSITION ENCODERS: AN EFFICIENT SYSTEM FOR WAREHOUSING

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Abstract— This paper covers some intricate details of an automated model designed to improve the efficiency of warehouses. It describes the hardware of the warehouse robot and further discusses the implementation of robot's navigation using position encoders. It also outlines the development of an android application that enables the users to interact with this automated model.

Index Terms— Micro-controller, Position Encoders, Webpage, Xbee.

I. INTRODUCTION

Warehouses are large commercial buildings utilised for the storage of goods. It is used by manufacturers, wholesalers, importers etc. to store their goods in bulk. There are several advantages of using warehouse facilities like storage of goods and transporting them or for the storage of materials which require a certain period of maturation between production and retail. Electronic commerce companies like Amazon use warehouses to store various dealer's products and deliver it to the customers as per the demands[2].

Warehouse functionalities are pretty complex considering the large area it has to cover and the huge number of goods it has to handle. There is no margin for even the tiniest errors in this system considering that it is almost impossible to track it down leading to unhappy dealers losing their goods. It is important that every operation i.e. carrying the goods, placing them in its desired location for storage or retrieval, keeping track of all the goods, etc. is done with utmost precision.

However it is observed that, human intervention becomes essential to keep any warehouse operational. Fortunately with the technological advancements gained so far, it is possible to reduce the human intervention by using sophisticated programmed robots to perform certain tasks. The use of robots eliminates the tendency of errors and also speeds up the entire process. This forms the present day warehouses which are functional with the efforts of humans and robots both working hand in hand. The inventory is managed by the humans with the help of the barcode scanners and the movement of cartons from one place to another is done by the robots[1].

II. OVERVIEW OF THE SYSTEM

A completely automated system would further ameliorate the efficiency of the warehouse. A robot has been designed to navigate across the large area of warehouses. It uses position encoders to move from one location to another. The presence of any good is recorded during its entry by using RFID readers at the entry. The same reader detects the exit of that particular good from the warehouse. XBee modules are utilised for wireless communication between the central unit and the entry module and also for the communication between the central unit and the robot. Central unit has python program running on it which performs the most crucial operation i.e. inventory management. Loading Unloading mechanism involving a gripping mechanism, designed using servo motor arrangements, is mounted on top of the robot. To allow dealers to interact or communicate with the warehouse, an android application has been developed. All these tasks, when interfaced together in the right sequence gives the desired automated model.

III. ROBOT HARDWARE

A two wheeled chassis fabricated out of mild steel forms the base of the robot. A castor wheel is fitted at the front making it a three wheeled robot. The chassis has slots at the bottom to easily accommodate the DC motors with specifications of 12 kg-cm torque and 60 rpm. Motor Driver is used to power the motors and generate desirable motion as per the Arduino instructions. Atmega 2560 is the main controller of the robot's movements. In order to exchange certain information like destination location, indication of task completion etc. it is essential to enable the wireless communication between the robot and the central unit. The robot has an ultrasonic sensor fixed at the front to detect any obstacle and also to move the robot to the most optimum distance from the carton before it performs the loading operation. The ultimate purpose of the robot is to traverse from one location to another, stop at an optimum location and load or unload the carton in front according to the instructions given to it by the controller.

A. Position Encoders.

In the Betty bots used by Amazon, barcode scanners are used to track the robot movements. Since barcode scanning is a bit tedious, to make the system more efficient, line follower was implemented. However, many problems were faced during its execution such as if the line is disrupted by any means, then the robot gets stuck, it has no idea where to propagate, as the line guiding its movement is no longer available. So to deal with this, redundant paths were made available to make sure that the warehouse is always operational. But the robot failed to choose a single path and navigate along it in case it encountered a cross path. Also since faster movements are desirable, the robot tends to wobble a lot as it moves along the line. Thus in the crave of employing the most efficient system for traversing in the warehouse position encoders are used[3].

To find exact position of the wheel at destination from the source, the Position Encoder sensors are used. It consists of IR LED and Photodiode mounted facing each other enclosed in plastic body. When light emitted by the IR LED is blocked because of alternating slots of the encoder disc the logic level of the photo diode changes. This change in the logic level is sensed by the microcontroller. The number of times the logic level changes is calculated and accordingly the distance is determined. The sensor is placed on the motor mount such that the encoder disc attached to the wheel perfectly intercepts the IR LED.

The basic robot movements are controlled by the combination of an Arduino and the motor driver. However, to halt the robot after moving for a particular input distance or an angle precisely, the encoders are used. A peculiar algorithm was followed to complete this task. The robot is moved for a particular distance or an angle and the number of spikes through which the IR LED intercepts till that length is recorded. Using the above values, resolution of the encoder sensor is calculated. This resolution helps in further robot navigation as shown in the flowchart.

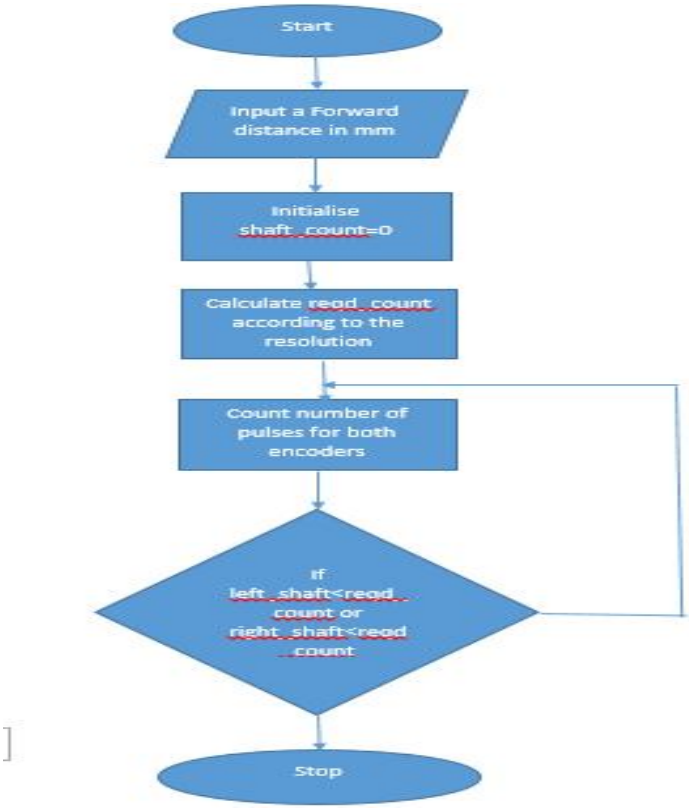

Figure.1. Flowchart for Position encoders

However, the position encoders gives an optimum output only if a Schmitt trigger IC CD40106 is used. The robot hardware most importantly the motors, the motor driver and the battery should be in synchronisation with each other. The motors should be matched else the robot does not follow a straight line. To make it follow a straight line the resolution or pwm of the motors needs to be adjusted.

B. Loading Unloading Mechanism

The primary purpose of the warehouse is to store goods and retrieve them whenever required. Since the system has a robot to execute this storage or retrieval, a mechanism needs to be provided for the transportation of these goods. The robot has to load the carton at the entry unit and place it at an appropriate location. It also has to load the carton from a particular

position, get it to the exit unit and unload it.
A mechanism is developed such that the carton is gripped properly and holding it steady until the carton reaches the destination. Such a mechanism is made by the assembly of two servo motors. The first servo is used to grip the carton and hold it tight in its claw and the other servo motor is used to pick the gripped carton or to put it back in the shelf designed to store the cartons. However, since the servos can bear a very little weight the claw is made using the acrylic sheet [4].

III. WEBPAGE

To provide comfortable and an easy access to warehouses, a webpage is created. It aids the dealers to keep track of their goods stored in the warehouse. The webpage enables them to place further orders according to space availability and also to retrieve stored goods.
The webpage is created with help of HTML, CSS and python language. Hyper Text Markup Language, commonly referred to as HTML, is the standard markup language used to create web pages. Along with CSS and JavaScript, HTML is a cornerstone technology used to create web pages, as well as to create user interfaces for mobile and web applications. Web browsers can read HTML files and render them into visible web pages. Cascading Style Sheets (CSS) is a language used for describing the presentation of a document written in a markup language[5].

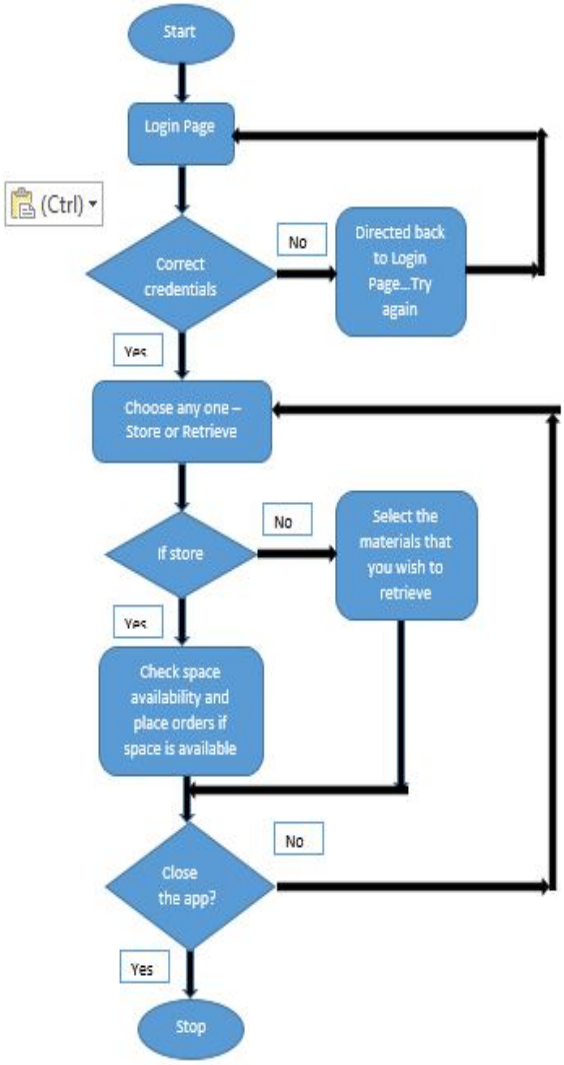

Figure.2. Flowchart for algorithm of the user application

Because the final formatting of your paper is limited in scale, you need to position figures and tables at the top and bottom of each column.
When we start running the application, we first come across the login page. This page consists of two empty text boxes where the user has to enter correct credentials. If the input credentials go wrong the user is redirected to the same login page. However, if the user correctly logs in he will come across a page which has two options store and retrieve. He can click on

either of the two. If the user clicks on store, he will come across all the tag numbers he has to store the goods and also the space available to store goods in the warehouse. If the space is available he can accordingly choose any tag and place the order. If the user choses to retrieve he will come across the page which has information of all the goods he has stored in the warehouse. This time the user can accordingly chose any stored good and will be directed to the billing page. The billing information will be calculated by the central unit in the warehouse depending upon the amount of time the user has stored his goods in the warehouse. Later on the application can be closed.

IV. RESULTS AND IMPLEMENTATION

A. Robot Hardware

The complete robot hardware was implemented successfully. The robot can move to a specified location with limited errors using the position encoders.

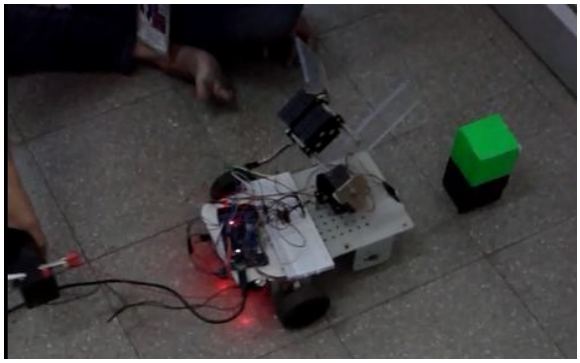

Figure.3. Robot with Loading Unloading mechanism

B. Webpage

The login page of the webpage consisting of the empty boxes for username and password was created.

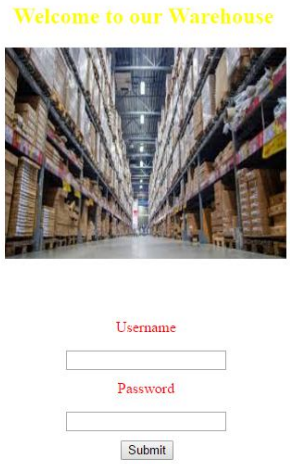

Figure.4. Login Page

If the login details are correct it shows u the message ‘LOG IN SUCESSFUL’ and shows an empty box where the operation have to be chosen.

Figure.5. Webpage asking for operation to be performed

If the action chosen is ‘Store’, it checks for the spaces available in the warehouse comparing the database created on any store operation and accordingly allocates the space as per the requirements of the user. It also sends a prompt to the robot via the wireless network so that it understands it has to undergo store operation.

Whereas if the action chosen is ‘Retrieve’, the webpage asks for which good it has to retrieve, if the particular good is present in the database it gives the robot a prompt to perform retrieve options.

	A	B	C	D	E
1	55000D41657C	Kshitija	Soap		
2	55000DA749B6	Ashitha	Soft toys		
3	55000D283A4A	Kshitija	Perfume		
4	55000E1E2E6B	Ashitha	Football		
5					
6					
7					

Figure.6. Database maintained at the warehouse

CONCLUSION

The rotary encoders provide the robot with the essential information to trace any given path. However certain deviations are observed, i.e. the robot may deviate slightly from its desired path. It is important to limit such deviations to the most minimal levels such that the robot will reach the decided destination. The robot can now navigate across the whole area of the warehouse as per the requests from customers.

The customers access the services of the warehouse by means of a user friendly webpage. This webpage provides authentication and displays only the necessary details required by the customers to enable them to place their requests. It is also possible to create an android application using drive API so that the item related information are available to the user. There are still other ways to create a user friendly interface such that the users can interact with the warehouse.

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