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Automated Luggage Carrying System

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Abstract: - Integument personal luggage carrying system can add comfort to the explorer inside an infrastructure possibly airport. The system consists of automated vehicles that can be borrowed and it automatically follows the borrower inside an infrastructure with luggage. These also maintain a distance from the borrower and do not follow in some of the restricted areas like restroom for comfort. After service these will automatically move to the docking station for charging and reuse. In this thesis we have identified the basic construction required for the six wheels based rigid robot body and the basic person tracking movement of the smart card holder for airport traveler's personal luggage carrier.

Keywords: - *Caring luggage , Obstacles detection, , Card tracking.*

I. INTRODUCTION

Automation is the use of machines, control systems and information technologies to optimize productivity in the production of goods and delivery of services. It is the use of control systems and information technologies to reduce the need for human work in the production of goods and services. In the scope of industrialization, automation is a step beyond mechanization. In Airport, Automated luggage loading system is introduced so many years ago which moves the luggage from the check-in to the belts servicing the flights but a passenger need to carry his/her own luggage's from the entrance of the airport till the check-in into the airport with the help of conventional luggage carrying system. Conventional luggage carrying system is both time consuming and labor intensive. At the same time it is an expensive process and slow. The proposed Automated System for luggage carrying system can provide those features needed to overcome the problems mentioned above. A real-time monitoring system using an automated system is introduced to ensure the proper movement following the Smartcard carrying passenger. For the implementation of the desired automated system, a six wheel based robot has been designed. This Smartcard is sending signal to the tower. An ultrasonic sensor is used on the automated system to sense the signal that is received by this sensor from the tower where triangular method takes place. That ultrasonic sensor detects the distance of the location of the associated Smartcard as well as the user. Then the automated system uses the person following algorithm with a view to finding out the exact position of the smart card user and follow the user. The automated system will always keep 2mitre distance from the user with a view to avoiding clashes with the user. The Smartcard will be located at the pocket of the user as well as passenger throughout the whole airport before check-in. If there two or more automated systems are devoted doing the same job for their own smartcard holder, the proper signal is received by the sensors of the each robots for their own smart-card holder and that is done with the help of triangular method. The triangular method sends the right signal to that specific ultrasonic sensor that is already waiting to getting a signal from its own Smartcard. An ultrasonic sensor is thus devoted to work with only one Smartcard. Both the Smart card and the ultrasonic sensor continuously send and receive the signal respectively. This automated system is designed in such a way so that it can sense the location of the restricted area such as wash-room; hospital and police control room inside the airport and keeps itself away from the restricted areas. In such cases there can be waiting rooms beside those kinds of rooms where the user can park their robots while using those confidential areas. This automated system is also designed in such a way so that it can sense any kind of obstacles located in front of it and easily avoid them without having any clashes with the obstacles. If there is any kind of obstacles in front of the automated system depending on the situations it is capable of taking the alternative way to follow its Smartcard holder. The proposed automated luggage carrying system is mainly designed here to walk through the airport smoothly. Airport should have one rest room and one waiting room per each restricted area so that the automated system can gain some power while their smartcard holder is stuck. If 20% of the charge remains, the automated system can get back to the rest place and get some power to work again. When the user is done, the user will keep the smart card into the card holder located on the surface of rigid body. Then the automated proposed system will get back to the rest place.

II. OBJECTIVES

This thesis is done to find out a reliable automated system for the luggage carrying system
This thesis has following objectives:

- To identify the efficiency of convention luggage carrying system and the proposed system.
- To demonstrate the benefits of automated system over conventional system considering some important parameters such as speed, time, human labor and cost expenses.
- To identify the drawbacks of current conventional system.
- To demonstrate the scope of improving the proposed automated luggage carrying system.

III. SCOPE

Automated luggage carrying system in airport has great scope in every country in the world as well as Bangladesh. Luggage handing is always at the heart of an airport. Reducing the manpower required to distribute the baggage as required and efficiency in terms of reliability, maintainability and future flexibility are the main motivation of this automated luggage carrying system. This automated luggage carrying system is designed to arrive the luggage's to the specific smartcard user at a particular distance in the airport would be barely even touched by the human hands once they were loaded into the automated system. If the environment of the airport fully supported the demands of the automated system, it will become much more easy and effective in future to work with this automated system.

IV. WHEEL BASED RIGID BODY CONSTRUCTION

The very first challenge of the research was to implement a rigid body with six wheels. Along with these six wheels six motors are associated where each wheel is basically devoted to rotate one motor. In all robotics applications, mechanical complexity is one of the major sources of failure and considerably increases the cost. To implement this type of wheel based body, we faced mechanical complexity several times. We had to collect materials from "techs hop BD" and sometimes from many other local markets located in Dhaka. We then considered a standard size of the rigid body that is capable of carrying luggage. Then we measured the width and height carefully and constructed this.

V. SYNCHRONOUS ROTATION OF MOTORS

Then the second challenge was to make these wheels as well as motors to rotate synchronously with each other. Then after a few days we were able to rotate the motor but at first it was asynchronous. Then we had to analyze the current problem. We tried to figure out the possible solutions and we did in a short span of time. Thus our design emphasizes mechanical simplicity and promotes robustness. After the synchronous rotation of the motors, we noticed that the rigid body cannot move so fast how we desired as the battery we used was not so powerful. But the use of powerful battery will solve this problem at a glance. So, in future if anybody wants to improve the automated system there will be no inconsistency or lack of information from our documentation.

VI. SMART CARD AND ULTRA SONIC SENSOR

At our proposed automated System, we use Smart card that will be located on the pocket of the user and Ultra Sonic Sensor on the rigid robot body. This Smartcard is continuously sending signal to the tower and the Ultra Sonic Sensor is used on the rigid robot body to sense the signal that is received by this sensor from the tower where triangular method takes place. That Ultra Sonic Sensor detects the distance of the location of the associated Smartcard as well as the user. In this way, location of the user from the proposed automated system is detected but the exact position of the user cannot be determined. To know the proper use of smart card and sensors and how to make them work with user and rigid body respectively, we studied a lot of documentation of these items available on the internet and checked some of them practically and finally selected Ultra Sonic Sensor.

VII. IMPLEMENTATION OF THE PERSON TRACKING ALGORITHM

This was the challenging portion for us to implement an algorithm which results the rigid robot body to track the associated smartcard holder as well as the user. As the proper usage of Smart card and Ultra Sonic Sensor is only able to provide us with the distance of the location of the user but not the exact position of the user. So , to implement the automated system as we desired we were needed to implement a person tracking algorithm which will not only teaches the rigid robot body to trace the person carrying associated smart card correctly but also to face the obstacles which may the proposed automated system may face while following the passengers through the airport. Thus the proposed automated system, if meets any kind of the obstacles while following the smart card holder it will easily calculate the alternative way to avoid the clash and follow its smart card holder without any kinds of hazards.

VIII. LOCOMOTION

The robot will deviate from its path automatically if it faces any hindrance in its path of movement. We have put an ultrasonic sensor at the front of robot and its function is to find what angles the robot should drive. It can be programmed on which side it should move, either front, back, left or right.

8.1 Forward

It consists of 6 wheels and the forward rotation (Fig 1) of all these wheels will cause the advancement of the robot.

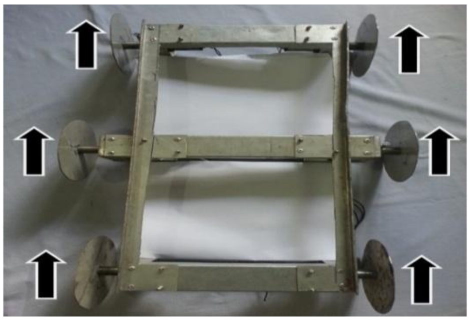

Figure 1: Forward Motion

8.2 Backward

Likewise, the backward rotation (Fig 2) of the wheels will make the robot move back.

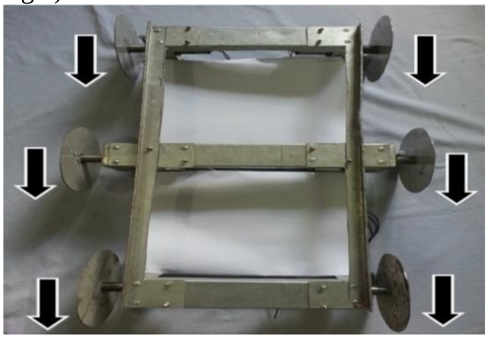

Figure 2: Backward Motion

8.3 Right

Besides, if three wheels at right rotate forward (Fig 3) and the other three wheels at left rotate backward then the robot will move towards right.

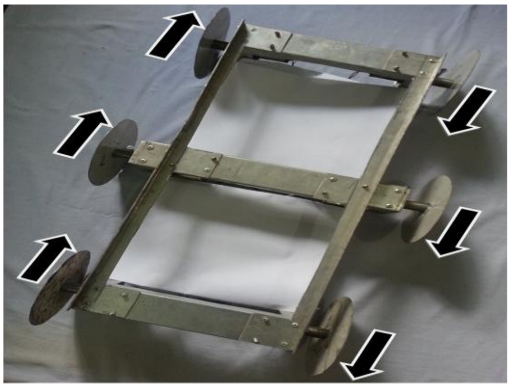

Figure 3: Towards Right Motion

8.4 Left

Again if three wheels at left rotate forward (Fig 4) and the other three at right rotate backward then the robot will move towards left.

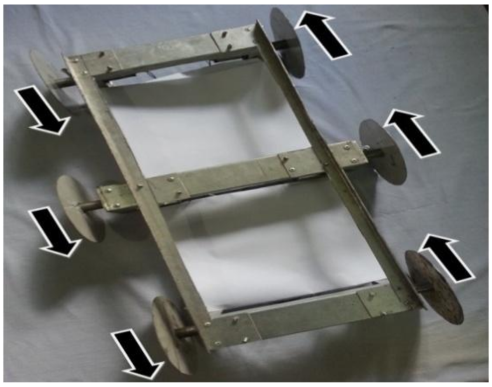

Figure 4: Towards Left Motion

IX. SMART CARD

A smart card is a wireless device that includes an embedded integrated circuit that can be either a secure microcontroller or equivalent intelligence with internal memory or a memory chip alone. The card connects to a reader with direct physical contact or with a remote contactless radio frequency interface. With an embedded microcontroller, smart cards have the unique ability to store large amounts of data, carry out their own on card functions. Smart cards are made of plastic, generally polyvinyl chloride, but sometimes polyethylene terephthalat based polyesters, acrylonitrile (Fig 5) butadiene styrene or polycarbonate.

Figure 5: Smart card.

It resembles a credit card in size and shape, but inside it is completely different. It has an inside a normal card is a simple piece of plastic. The inside of a smart card usually contains an **embedded microprocessor.** The microprocessor is under a gold contact pad on one side of the card. Smart cards can provide identification, authentication, data storage and application processing. Smart cards may provide strong security authentication for single sign-on within large organizations because the microprocessor on the smart card is there for **security. However,** the smart card functions in such a way that it sends a signal to the nearby tower and the tower in turn sends another signal to the robot. Following such method the robot can always know the place about of the user. Also as the robot finishes its work, the user then puts the smart card on its holder and the robot returns to the charging room.

X. CHARGING (REST PLACE)

The robot runs by battery. The battery is charged for reviving power. If the battery shows charge less than 20% then the robot returns to a charging room. Moreover, in case as soon as the robot finishes its function provided by the user then also it returns to the charging room. However in the charging room, the robots stay in a queue. Each of the robots consists of power connector on (Fig 6) each sides of the body.

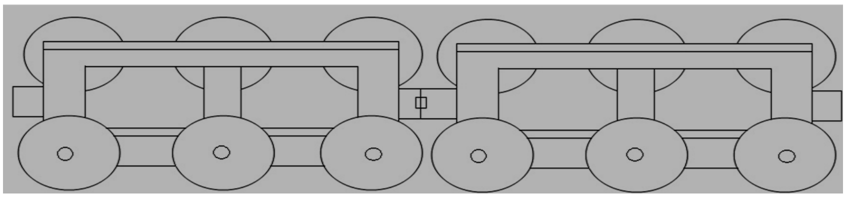

Figure 6: Charging queue.

So automatically the robots after entering the room will line up forming a joint. In this state during charging, if the user needs any robot then the one staying at the front of the queue will be appointed for the respective job. Hence the robot next to the one that has been taken will then come forward and stand on the first position. Thus following this sequence the latter robots will take the initial position of the former robot and do its function as guided by the instructor.

XI. RESTRICTED AREA

In the places like airport, there are spaces for hospital, police control room, washroom etc. So in such cases there can be waiting rooms beside those kinds of rooms where the user can park their robots while going to those confidential areas. The user under such circumstance will use the triangulation method to find the robot. The smart card carried by the user will send a signal to the nearby tower and the tower will send another signal in return to find the actual position of the robot. The robot receiving the signal from the tower after each 2 seconds will advance towards the user and finally the user can get back his robot.

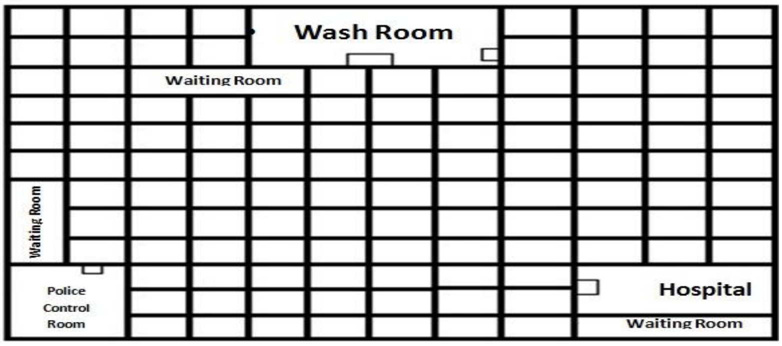

Figure 7: Operation policies while entering the restricted areas

In the cases where the rooms contain 2 doors, if the user enters through one and leaves through the other door then the robot using the same technique can get back to its user.

XII. ALGORITHM

Navigation is a major challenge in the field of artificial intelligence. There are several techniques for navigation of robot over a grid and these papers represent an approach for navigation on a grid by using breadth first algorithm. Here the entire grid of m*n is converted into a tree and with the help of these tree we apply BFS for traversing. We develop an approach for searching an object and also able to avoid an obstacle which was placed in a junction.

There are various tasks which is performed over a grid such as material handling, obstacle avoidance and object detection etc. requires a strong navigation technique which can be fulfill by using these algorithm. The major problem we faces while traversing on a grid is to maintain its current location after encounter a junction and also the path planning is required when an obstacle is detected. These problems are easily tractable with breadth first search. Here we convert the entire grid into a tree type structure. Where we apply BFS for searching the next node. The algorithm is briefly discussed in later section.

A grid is represent as the [m * n] matrix where m is the number of rows and n is the number of columns. The rows and columns are the black line which is drawn over a white surface or white line which is drawn on black surface.

To navigate over a grid we have to follow Cartesian coordinate system for finding the current location on the grid. The robot set its initial location as (0, 0) and maps the entire quadrant according to it. The left node as (-1, 0) the right node as (1, 0) and the node below the origin is taken as (0,-1) and above the origin as (0, 1) respectively. The robot has also to maintain its direction while moving forward, left or right it has to update the direction according to the turn.

The major problem that we faces in navigation is what is decision taken by the bot to find the next coordinate which can be easily achievable when a tree is constructed. Another problem we are face that is at the time of obstacle detection which can also be solve with these approach. The obstacle and object is placed on the junction. The obstacle is a cubical block; we consider the purely black or white block as an object. The decision taken by the bot after obstacle encounter is discussed in later section.

XIII. ENVIRONMENTS USED FOR ROBOT NAVIGATION

13.1Type of Grid

We can use the grid of any dimension of [m * n] as shown in figure-1.The grid may also consist of combination of multiple grid. For such situation we have to place two extra sensors in below the center of both the wheel. These sensors are capable of to keep the robot into the grid with a condition i.e. when all the sensors in (white or black) we have to take (right or left) turn until the line is detected.

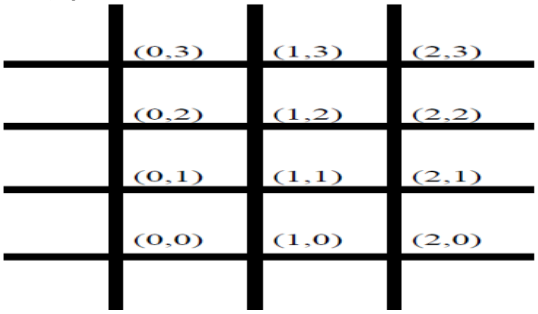

Figure 8: Grid [3*4] (shows about a black line which is drawn in a white surface or vice-versa).The junction is labeled as according to its coordinate system.

13.2 Grid Mapping

The grid is map according to Cartesian coordinate system. Robot sets the initial node as an origin and maps the entire grid according to origin and its direction which shows in (fig 8).

XIV. ALGORITHM USED

14.1 Breadth First Search

In breadth first search require five different parameter such as unexplored vertex, visited vertex, unexplored edge, discovery edge, cross edge. Firstly the node is visited which is closer to the root node or we can say the node which is at the same levels are visited and then the second level and goes to higher level accordingly.

<u>BFS (G, s)</u>

1. For each vertex u ϵ V[G] — {s}
2. Do color[u]←WHITE
3. D[u]← ∞
4. Π[u]←NIL
5. Color[s] ←GRAY
6. d[s] ← 0
7. Π[s] ← NIL
8. Q ← Ø
9. ENQUEUE(Q,s)
10. While Q ≠ Ø
11. Do u ← DEQUEUE(Q)
12. For each v ϵ Adj[u]
13. Do if color [v] = WHITE
14. Then color[v] ← GRAY
15. d[v] ←d[v] +1
16. Π[v] ← u
17. ENQUEUE(Q,u)
18. Color[u] ← BLACK

14.2 Transformation of Grid

While using BFS we have to construct a tree by the use of the grid. By using these transformation reduces the complexity while in navigation. Transformation to tree requires one stack such as traverse stack it keep the record of the visited node. This stack is useful to detect next node. If the coordinates of next node is matched with the traverse stack then such nodes are avoided. While constructing the node on a tree we have to move on higher level on a grid. And the junction of two adjacent node of parent node is treated as a connected node. As in Fig 1 Grid the transformation is done accordingly. The root node i.e. (0,0) consists two connected node such as (0,1) and (1,0) which is at the same level are placed as a child node of the root node and another node of (1,1) is adjacent node of (1,0) and (0,1) are also used as a connected node of (0,0).while connecting as a child node of (0,0) the connected node is checked into a traverse stack if these nodes are presents in the stack then such nodes are avoided and unvisited node are marked as a child node. So the corresponding tree of the grid is shown below is free from obstacle.

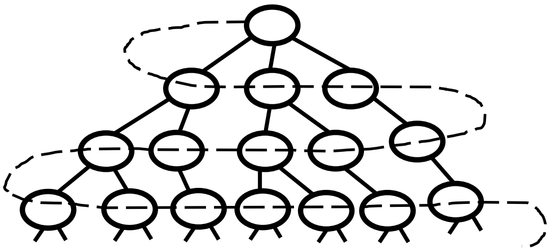

Figure 9: Grid transformation into corresponding tree.

In (fig 9) the bot start from the root node i.e. 00(due to reducing the complexity (0,0)(3,4)(6,3) etc. are written as 00,34,63) it will detect two connected node i.e. 01 ,10 and 11 as explained above. So by these properties the entire tree is formed.

14.3 Grid Transformation in presence of obstacle

The transformation is little bit clumsy when an obstacle is arrived in a junction. Such problem can also be solving by tree traversal algorithm but here we require another stack such as obstacle stack it keeps the record of obstacle. When the obstacle is detected by the bot it has to move into the next level and begin with the initial node of the next level and move up to the node it surpasses the obstacle node and again move to the previous node. For example if in a grid consists an obstacle at (1, 1) and (2, 2). So the bot has to follow the same algorithm as without obstacle but if obstacle is encounter than it has to place the value of coordinate into the obstacle stack and move to next level of starting node i.e. (0, 2) and move until the obstacle node is surpasses i.e. (3, 1) than it has to move to previous level and accordingly as shown in below graph.

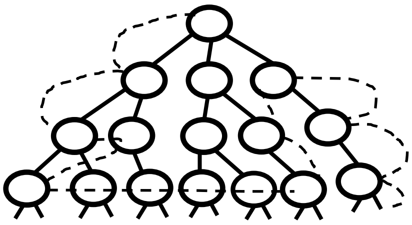

Fig 10: Bot Navigation when grid consists of an obstacle.

In (fig 3.10) grid consist of an obstacle at junction (1,1) and (2,2) whereas the dashed line shows the path i.e. 00->01->02->12->03->13->23->33->32->31->21->10->20->30. The bot navigate until the desired object is detected and give the shortest path from the root node to the object.

14.4 Calculating direction

To maintain the location of boot on any arbitrary points on a grid we have update the direction and value (x, y) which was (0, 0) initially and maintain according to its turn.

Direction	Turn	Set Direction	Set Co-ord.
North	Forward	North	Y++
North	Right	East	X++
North	Left	West	X--
East	Forward	East	X++
East	Right	South	Y--
East	Left	North	Y++
West	Forward	West	X—
West	Right	North	Y++
West	Left	South	Y--
South	Forward	South	Y--
South	Right	West	X--
South	Left	East	X++

Figure 11: Position Calculation.

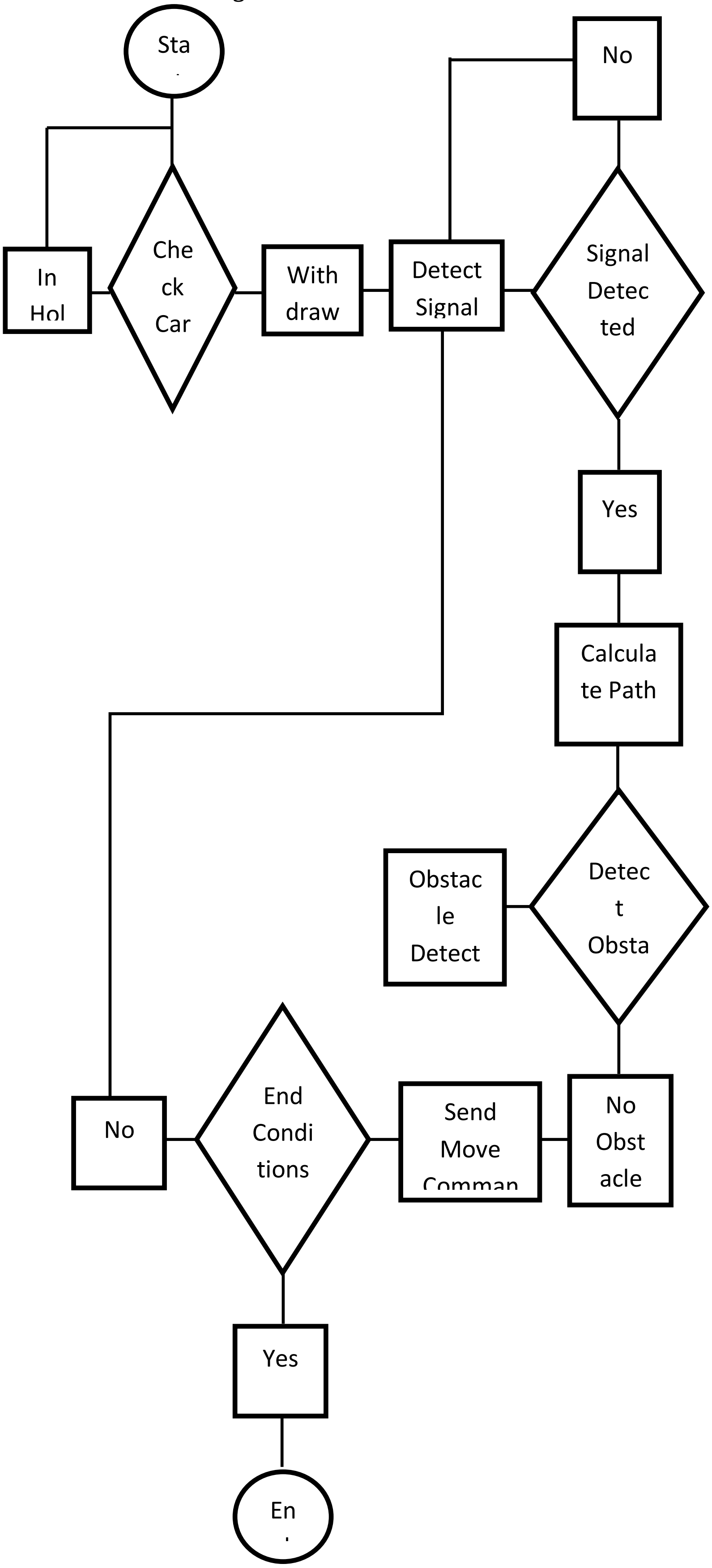

Figure 12: Flow control of overall system.

XV. HOW TO DETECT

Detection is the process of finding both position user and robot. Here we use a wire-free detection method such as triangulation with active beacons. Triangulation with active beacons is a racy, precise, pliant and widely used method of absolute detection. Many types of triangulation algorithms have been offered. These are some examples: Geometric Triangulation, Iterative Search, Newton-Raphson Iterative Search and Geometric Circle Intersection algorithm from the Imperial College Beacon Navigation System triangulation using three circle intersection triangulation using two circle intersection Position Estimator algorithm. The term absolute detection was defined by Drumheller as "the enabling of a mobile robot to determine its position and preference in a way that is independent of assumptions about previous movements".

Among them we are used here Generalized Geometric Triangulation Algorithm by João SENA ESTEVES. The Geometric Triangulation algorithm allows the self localization of a robot on a plane. However, the three beacons it uses must be "properly ordered" and the algorithm works consistently only when the robot is within the triangle formed by these beacons. Triangulation is based on the measurement of the bearings of the robot relatively to beacons placed in known positions. It differs from trilateration, which is based on the measurement of the distances between the robot and the beacons. These beacons are also called landmarks by some authors. According to the term beacon is more appropriate for triangulation methods.When navigating on a plane; three distinguishable beacons - at least - are required for the robot to localize itself (Fig. 3.12). $\lambda 12$ is the oriented angle "seen" by the robot between beacons 1 and 2. It defines an arc between these beacons, which is a set of possible positions of the robot [20]. An additional arc between beacons 1 and 3 is defined by $\lambda 31$. The robot is in the intersection of the two arcs. Usually, the use of more than three beacons results in redundancy. In, triangulation with three beacons is called three-object triangulation. Consider (Fig. 3.12) three distinguishable beacons in a Cartesian plane, arbitrarily labeled 1, 2 and 3, with known positions (x_1, y_1), (x_2, y_2) and (x_3, y_3). L_{12} is the distance between beacons 1 and 2. L_{31} is the distance between beacons 1 and 3. L_1 is the distance between the robot and beacon 1. In order to determine its position (x_R, y_R) and preference θ_R, the robot measures - in counterclockwise fashion - the angles λ_1, λ_2 and λ_3, which are the beacon preferences relative to the robot heading?

Algorithm lines 2 through 5 compute the oriented angles λ_{12} and λ_{31} "seen" by the robot between beacons 1 and 2 and beacons 3 and 1, respectively. Both λ_{12} and λ_{31} are always positive.

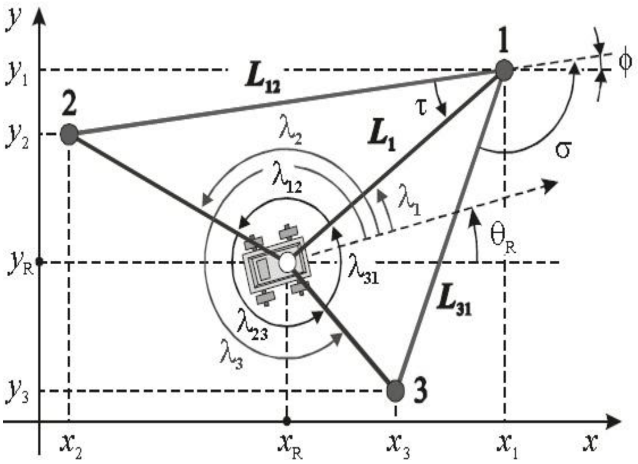

Figure 13: Simulation results for beacons labeled in counterclockwise fashion.

XVI. CONCLUSION

In this thesis we have identified the basic construction required for the six wheels based rigid robot body and the basic person tracking movement of the smart card holder. We have also identified what the proposed automated luggage carrying system would do if there are obstacles in the working route. Moreover there are many limitations left in the research due to time and lack of resources. If there are any restaurant located in the 2nd floor of the airport the proposed automated luggage carrying system cannot cross stairs. Most of the limitations in this research are created by the limitations of resources. But if there are enough resources available, the research can be done in a proper way using high powered motors and high powered battery so that the proposed automated luggage carrying system can go through any kinds of environment into airport such as stairs and unsmooth floor and carry a huge amount of loads so that the efficiency increases in an exponential way. If there are too many obstacles or hazards blocks each and every alternative way to reach the smart card user without having any clashes, the proposed automated system cannot decide quickly which path to select to reach the user safely and thus performance decreases. In future, if those limitations are removed from the proposed automated system, the following system will have better performance to serve the user.

XVII. ACKNOWLEDGEMENT

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