A FEASIBLE VOICE BASED INHOUSE NAVIGATION SYSTEM FOR THE VISUALLY IMPAIRED

Soham Roy

Kalinga Institute of Industrial Technology, Bhubaneswar, India

ABSTRACT

A proposal has been made to implement an inhouse navigation system for the visually impaired persons, whichiscosteffective,easyto implementandveryeasyanduserfriendlytouseandcanbeusedbyblindor partially blind people to go about the inside premises of an office or any building or floor having turns and obstacles and differentlocations.

KEYWORDS

RFID tag/reader, antenna, navigation, BFS, obstacles, messages, transmissions

1. INTRODUCTION

We are all familiar with google maps in the roads which has become a part of our day to day life. While they immensely help in the navigation the unknown streets that enables us reach our destination,animplementationofsuchanapplicationwithallthefeaturesinvolvedisonlypossible toaglobalgiantlikegoogle.Butifwethinkofsuchnavigationsysteminsidethe buildingsfore.g. like inside of an office premises, just the thought of it feels to be swept aside as to why a normal person would require a navigation system inside the building, which has probably all the directions/signboards and can be familiarized in a few visits. But the same cannot be said for a visually impaired person, hewould still be required instructions on the directions he needs to walk and the turns he needs to make and the obstacles that is in front of him to make him reach his destination. As building an app like google maps for each such office premises is out of question, a proposal has been made that is cheap and easy to implement and effective and aimed at the solution to thisproblem.

2. METHODOLOGY

We have come up with a solution to combine the capabilities of RFID reader /tags which are basically small sticker like equipment's which can be attached to a wall or any surface and the tag can respond and can transmit message to an antenna/reader which comes in close proximity , the range of proximity can be set according to requirements .

Incorporatingthistooursolution,thetagwillbeintegratedwiththesmartphone,whichisadevice that everyone uses, and a separate hardware device won't be required. That will be used as an antenna and coming in proximity to the tag will transmit signal to the smartphone and which in turn will instruct directions to the visually impaired person typically in the form of like keep walking straight, turn right, left and soon.

We have categorized obstacles into two parts:

Permanent obstacles like office bays, walls and objects that cannot be moved which comes in the way of the user from the source to the destination and the avigation system has to bypass and guide the user through a viable path by providing instructions.

Temporary obstacles like chair, and other stuff that can be moved from the path , these kind of obstacles will be notified to the user by means of object detection algorithm and the smartphone can be used for this one too.

3. PROPOSEDSOLUTION

For the scope of this paper we will focus only on the permanent obstacles (Point 1), as for Point 2 there are several state of the art solutions available.

Forthesakeofsimplicitylet'sassumethattheuserwillbenavigatingonefloorofanofficebuilding and the floor is a rectangular floor. And the user will be present at any location on the floor and will use the navigation system to go to any destination in the same floor for e.g. lobby, cafeteria, restroometc.

So,intherectangularfloorwehaveplacedRFIDreadersatstrategiclocationswhichcantransmit signal to the user antenna and then after the RFID unique identifier matches, the instruction will be passed on to the user at the right moment. The floor has been considered from a bird's eye view for better visualizationpurposes.
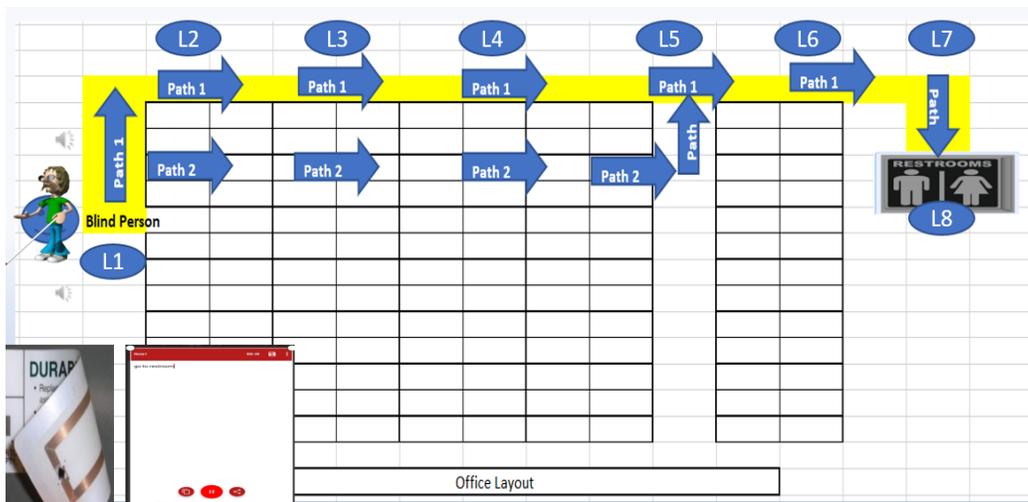

Figure 1 is a snapshot of how this looks like, the L_N are the position of the RFID tags which is guiding the user to the destination.

Let's assume the floor is a 2D matrix and the RFID readers have been placed strategically at an intersection of a row and a column. every permanent obstacle will be known by the 2D map of the

floor in the system from beforehand so when calculating the path, it can steer the user to a relevant path probably by directing him, to turn left/right.

If the algorithm selects the PATH 2 to the restroom here, so the command in this case will be

Go straight ⬛ gostraight ⬛ go straight ⬛ gostraightandyou haveto takelefton next⬛turn leftandyouhavetoturnrightonnextturn ⬛ turnright ⬛ gostraightandyouhavetoturnrighton nextturn ⬛ turnright ⬛ destinationreached

Each of this instruction above will be passed on to the user one by one as he reaches to close proximity to each of the RFID readers. Here also the user is also being notified from before if he has to make a turn like right or left. And a failsafe mechanism has also exists if the user deviates from the path then the algorithm/RFID system will guide the user on the right track.

4. ALGORITHM / WORKING:

For our purpose we have assumed the floor is a 2D rectangular matrix of shape (50*90) and the RFID readers have been placed at every 10th intersection of a row and a column. every permanent obstacle will be known by the virtual map of the floor from beforehand and will be marked ranging from one tag to another. i.e if their exists an obstacle then the path encompassing the nearest 2 RFID tags will be blocked. the location of the major destination will also be provided in the floor maplike desk no, lobby , cafeteria etc.
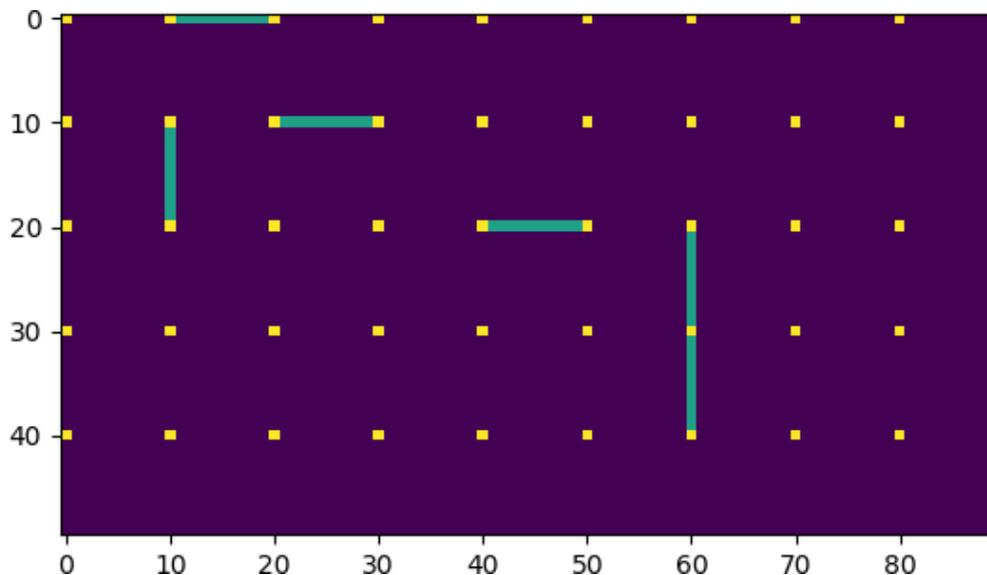

Figure 2. -the birds eye view of the floor, the yellow dots represent position of the RFID tags, the lines in green represents the permanent obstacles.

For the core navigation algorithm we have used Breadth First Search Algorithm and each node is a location of a RFID reader and the obstacles are marked in the map from beforehand i.eprior to running the algorithm the navigation system will have a complete knowledge of the permanent obstacles in the map as well as the destinations.

During the start of the application the location of the user will be determined based on nearest RFID tag and the destination will be prompted from the user, after we have the set of current loc and destination loc, the navigation function using BFS as the core algorithm will be invoked and the list of the unique identifier of the RFID tags that will be on the path is determined and the steps or instructions to guide the user will also be determined and stored. Now as the user antenna attached to the smartphone matches and receives the signal from the nearest RFID readers, it matches with the RFID unique identifier to that of the imminent RFID UID in the list of the path determined(from the navigation algorithm), if it matches then the user is on the right track and the message of the next step(i.e go straight/left/right) is transmitted to the user or else this entire process is started from beginning to reroute the user in the right track.

Pseudocode:

Funcstart_application(destn=Blank):

Present_loc_coordinates = Determine_present_locaton()://from nearest matched RFID tag
If(destn == blank):
Destn= ask_user_input()

Destn_coordinates = determine_destn_coordinates(Destn)// from mapped data

Points =   determine_nav_path_coordinates(present_loc_coordinate   ,
destn_loc_coordinate)
//this fn will return list of coordinates of the RFID tags in the path
Path_RFIDUid = Get_RFIDUids_for_path_determined(Points)//will return list of RFIDUids
//Which will come in the path of the
user

Messages_List = Determine_messages(Path_RFIDUid)//this function will return a list of messages
//to be passed on to the user
While(destn_reached=False):

Listen= detect_transmission()

If Listen.id != RFID_in_list.head()//user deviated along the way Func_start_application(destn = Destn)//restart the application
with
//Destination
as the parameter Elif Listen.id ==
Path_RFIDUid.head() : Path_RFIDUid.pop()

Transmit_msg(Messages_list.head())
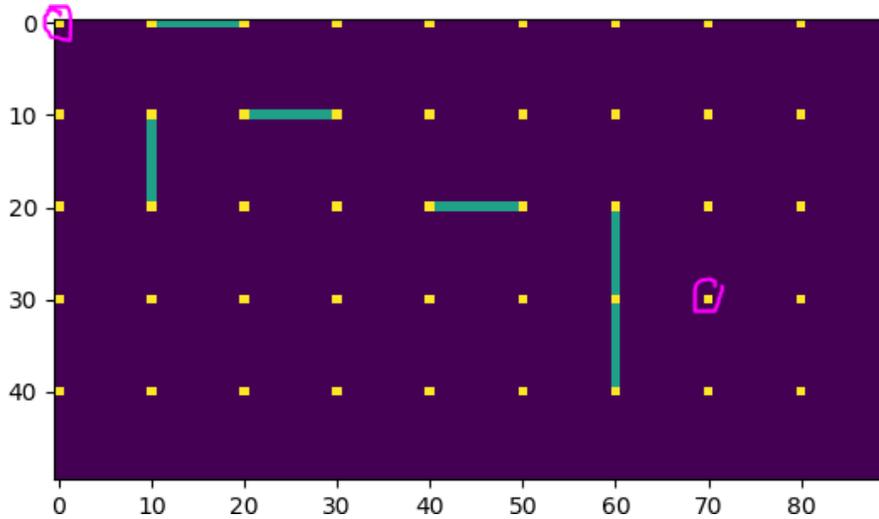Messages_List.pop()   End of Func_start_application()

RESULTS:-

Figure 3- Birds eye view of the floor, circled in pink are source and destination

This figure shows the source and destination of the user, the top left (0,0) is the source and the point (30,70) is the destination which is mapped as location "USER DESK" in the map After running the Func_start_application() for this set of source/destination: We get RFID UIDList={ 0, 9, 18, 19, 20, 21, 22, 13, 14, 15, 16, 25, 34 }

At Step1:- RFID UID=0 (which is also source location of the user marked in Figure 3)

For simplicity s sake we assumed that the user face is turned towards the direction of movement
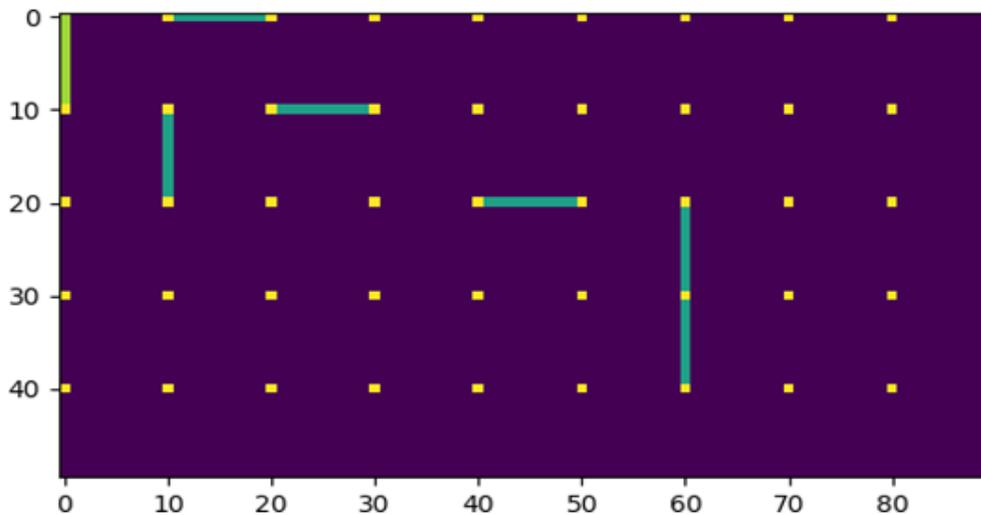
Figure 4. step 1-RFIDUid-0

Message transmitted="start moving straight "

At Step2:- RFID_UID_detected = 9 (matches RFID_UIDList = True)
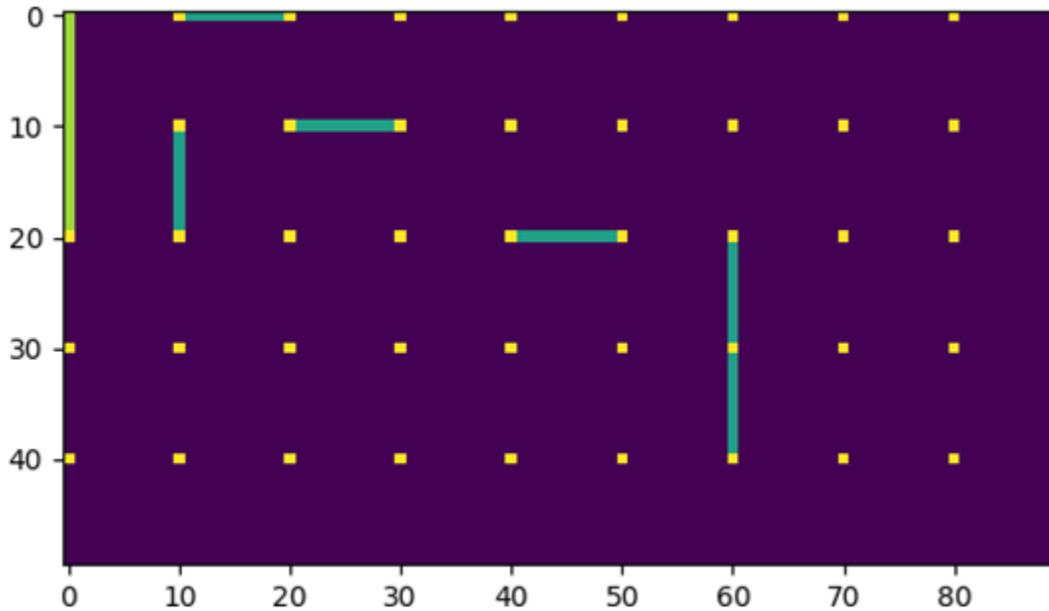
Figure 5. step 2-RFIDUid-9

Message transmitted="go straight and you have to take a left on the next turn"

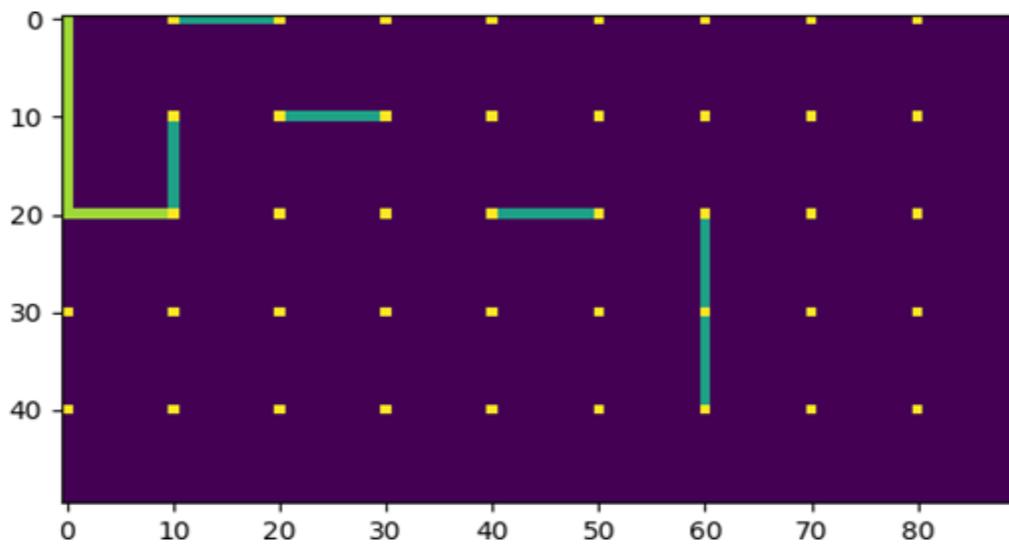At Step3:- RFID_UID_detected = 18 (matches RFID_UIDList = True)

Figure 6. step 3-RFIDUid-18

Message transmitted="Turn Left "

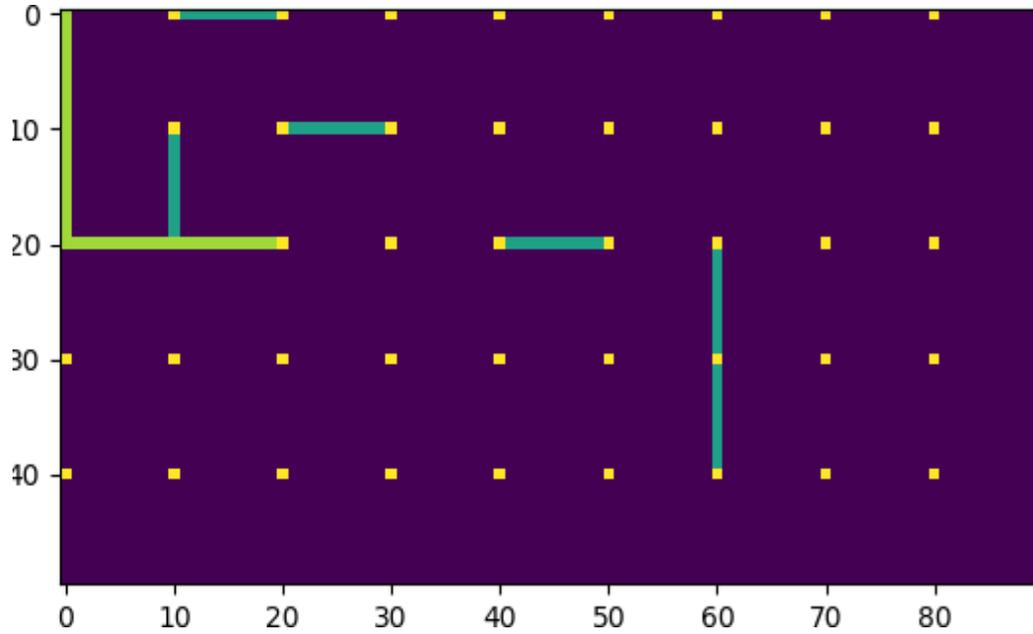At Step4:- RFID_UID_detected = 19 (matches RFID_UIDList = True)

Figure 7. step 4-RFIDUid-19

Message transmitted="go straight "

At Step5:- RFID_UID_detected = 20 (matches RFID_UIDList = True)
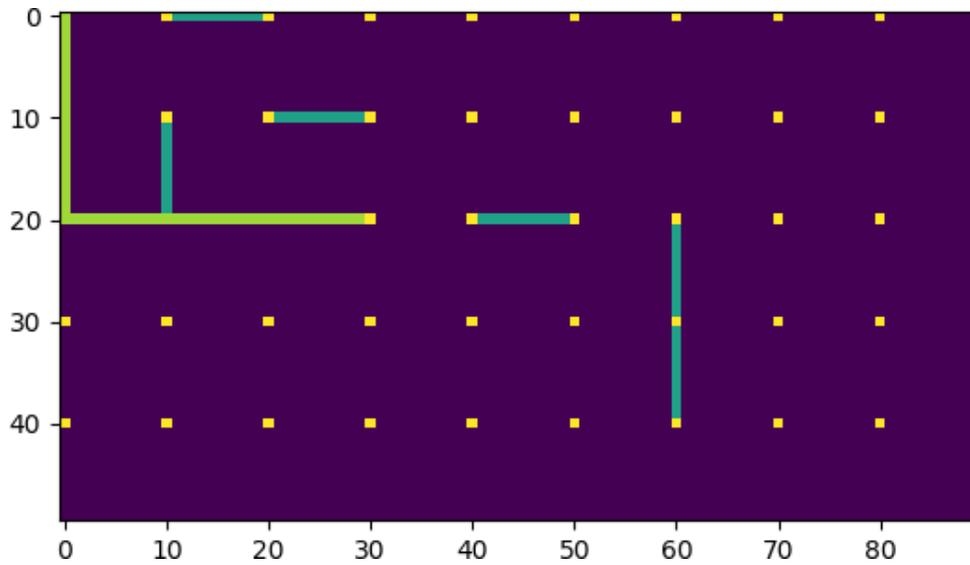

Figure 8. step 5-RFIDUid-20

Message transmitted="go straight "

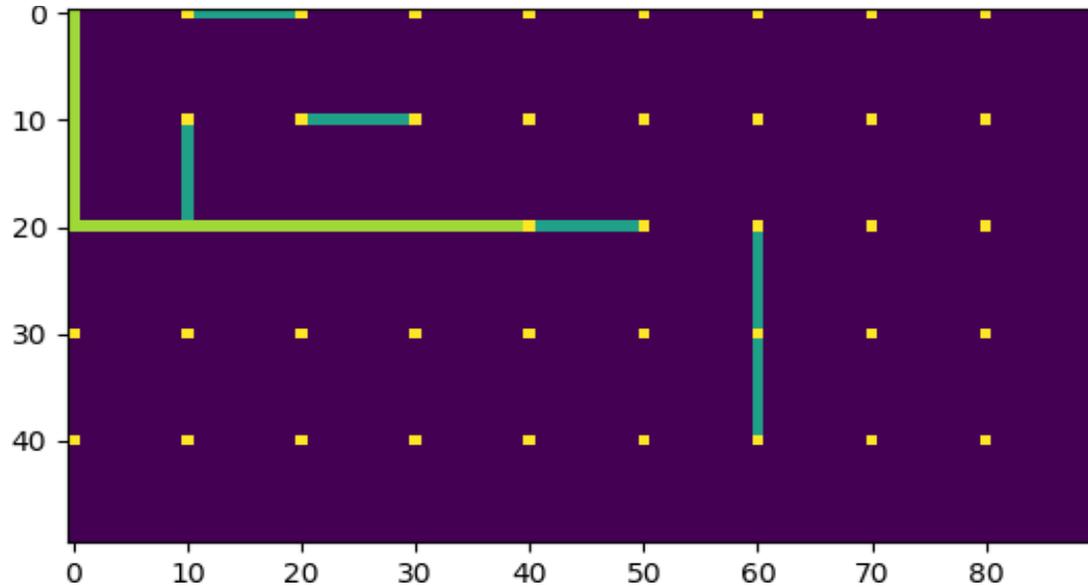At Step 6:- RFID_UID_detected = 21 (matches RFID_UIDList = True)

Figure 9. step 6-RFIDUid-21

Message transmitted=" go straight and you have to take a left on the next turn"

At Step 7:- RFID_UID_detected = 22 (matches RFID_UIDList = True)
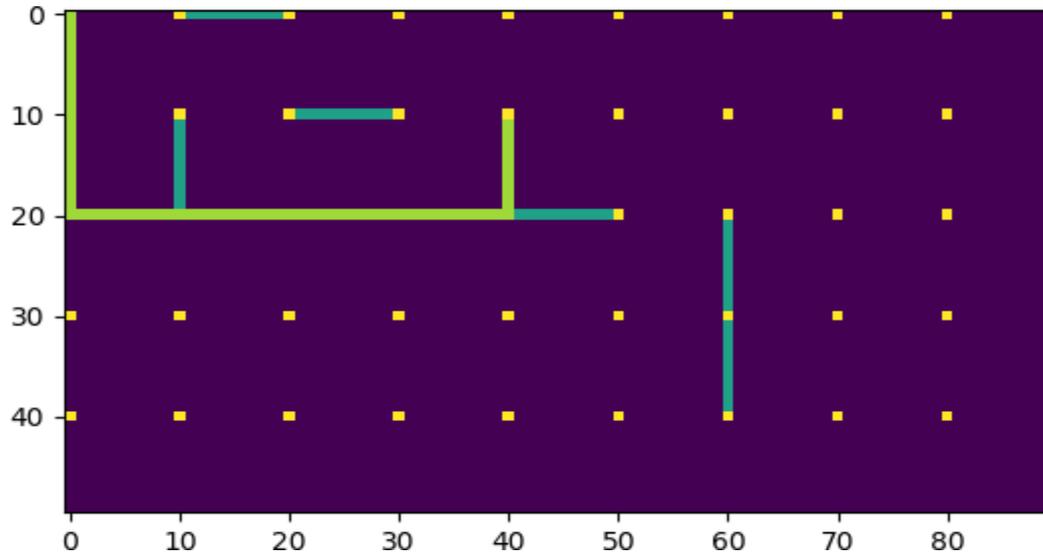

Figure 10. step 7-RFIDUid-22

Message transmitted="turn left and you have to take a right on the next turn

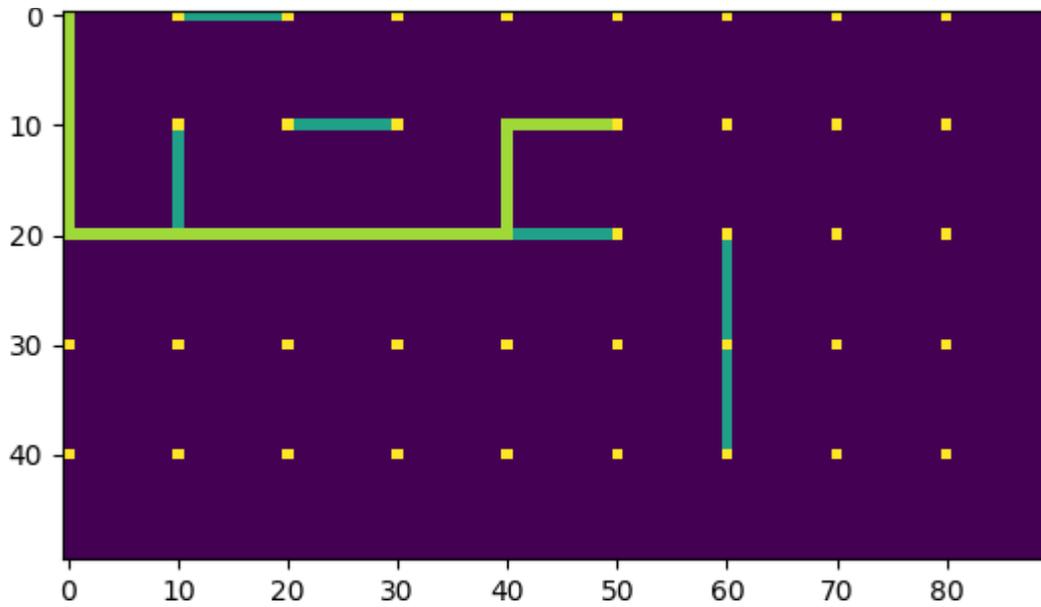At Step 8 :- RFID_UID_detected = 22 (matches RFID_UIDList = True)

Figure 11. step 8-RFIDUid-22

Message transmitted="turn right"

At Step 9:- RFID_UID_detected = 13 (matches RFID_UIDList = True)
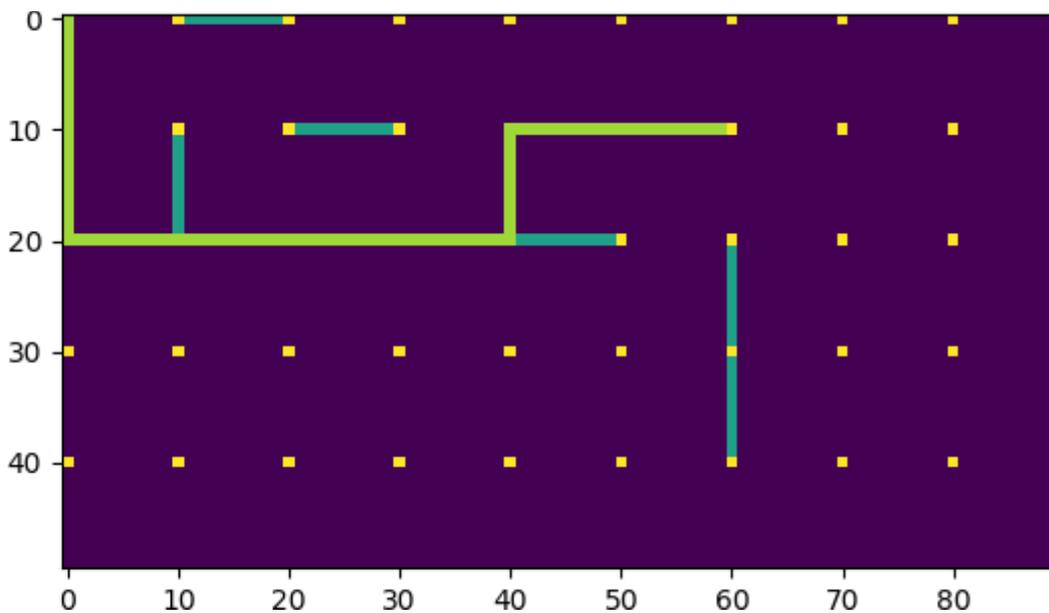

Figure 12. step 9-RFIDUid-13

Message transmitted="go straight "

At Step 10:- RFID_UID_detected = 14 (matches RFID_UIDList = True)
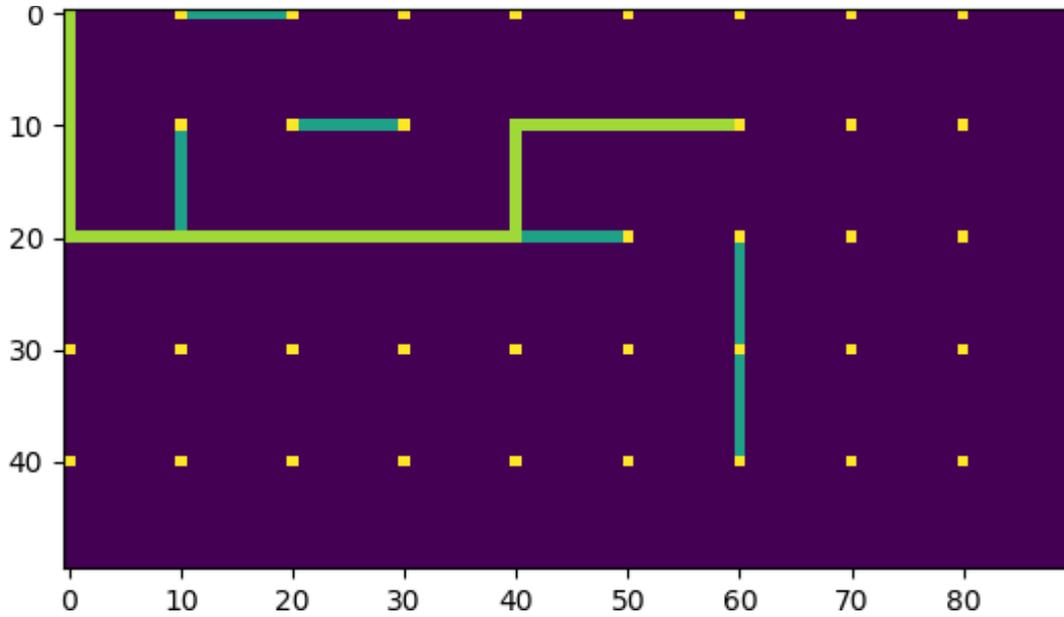

Figure 13. step 10-RFIDUid-14

Message transmitted="go straight "

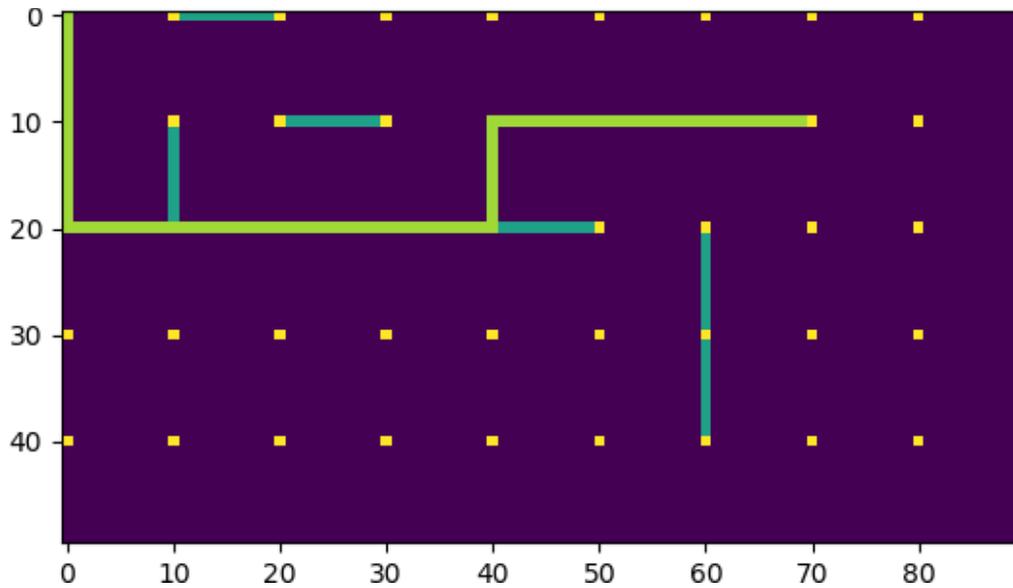At Step11:- RFID_UID_detected = 15 (matches RFID_UIDList = True)

Figure 14. step 11-RFIDUid-15

Message transmitted="go straight and you have to take right on the next turn"

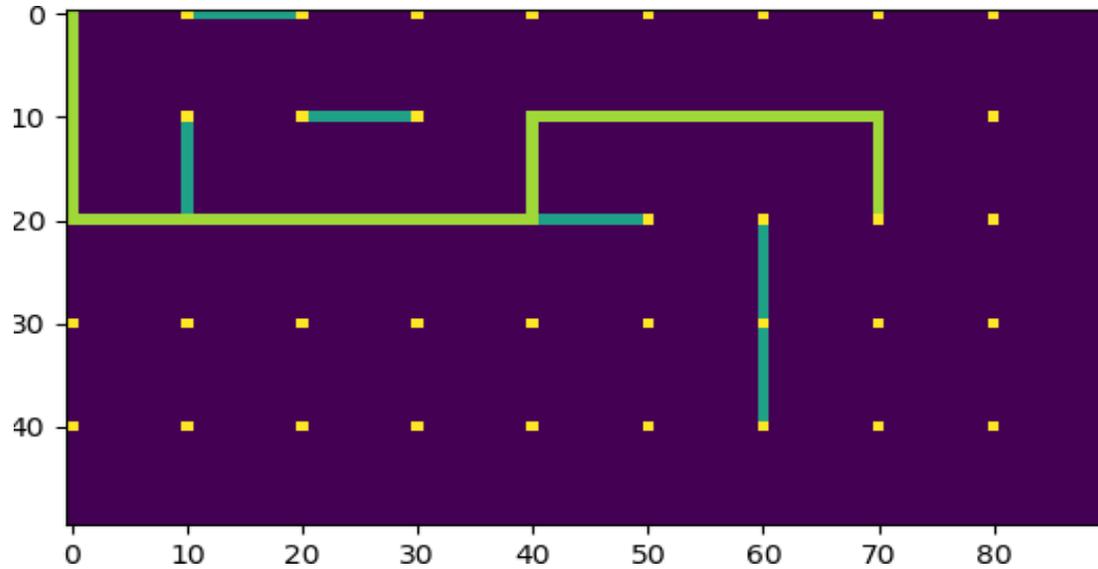At Step12:- RFID_UID_detected = 16 (matches RFID_UIDList = True)

Figure 15. step 12-RFIDUid-16

Message transmitted="turn right"

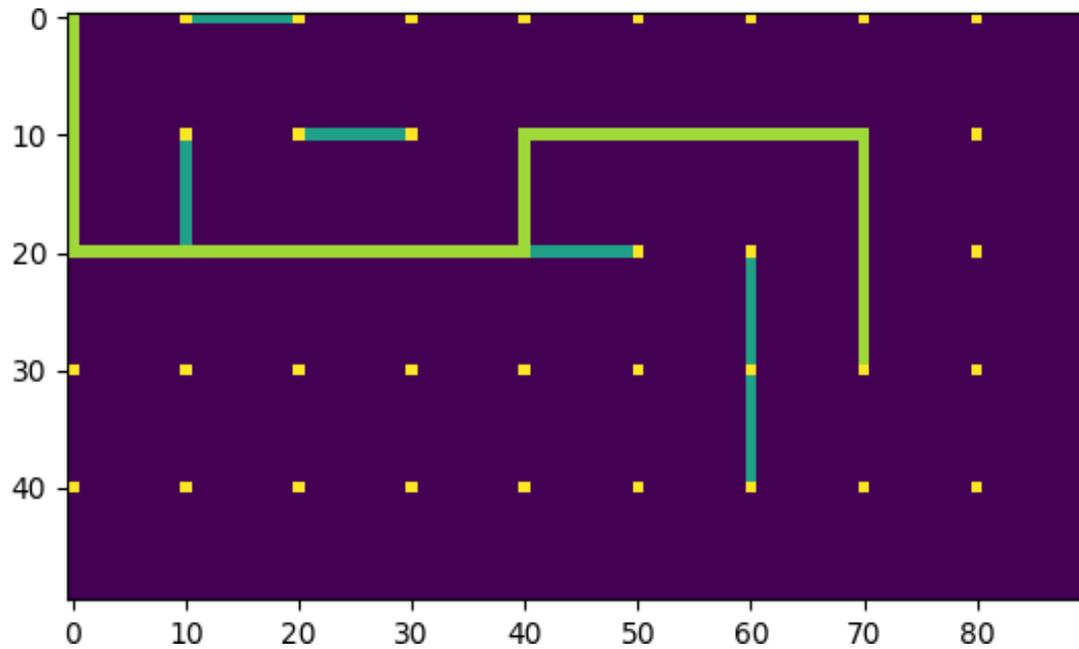At Step13:- RFID_UID_detected = 25 (matches RFID_UIDList = True)

Figure 16. step 13-RFIDUid-25

Message transmitted="go straight "

At Step14:- RFID_UID_detected = 34 (matches RFID_UIDList = True and this is destination location or destination RFID tag)
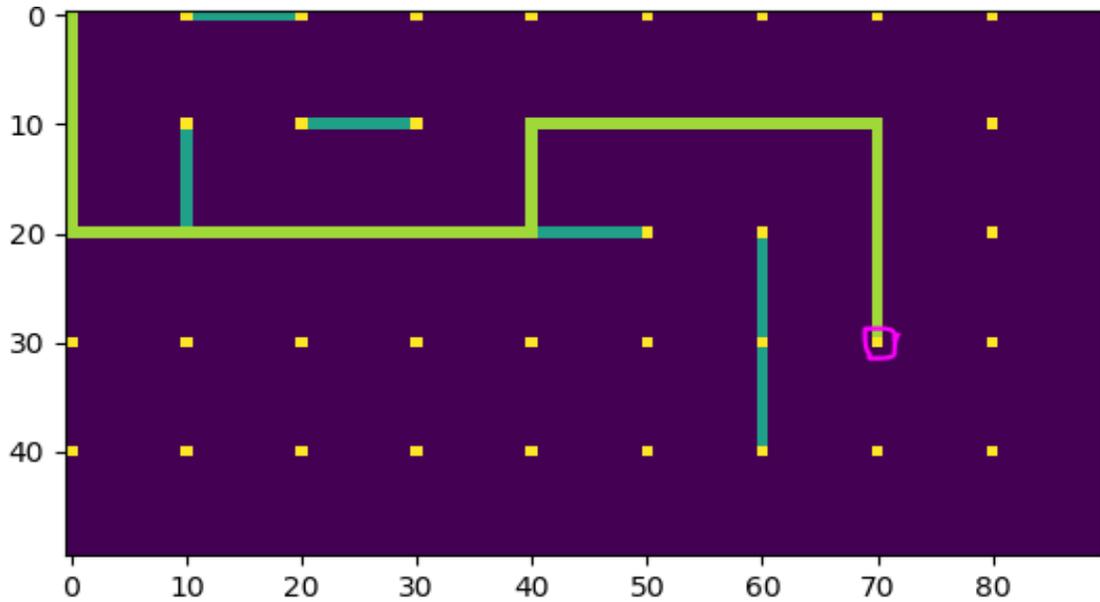

Figure 17. step 14-RFIDUid-34
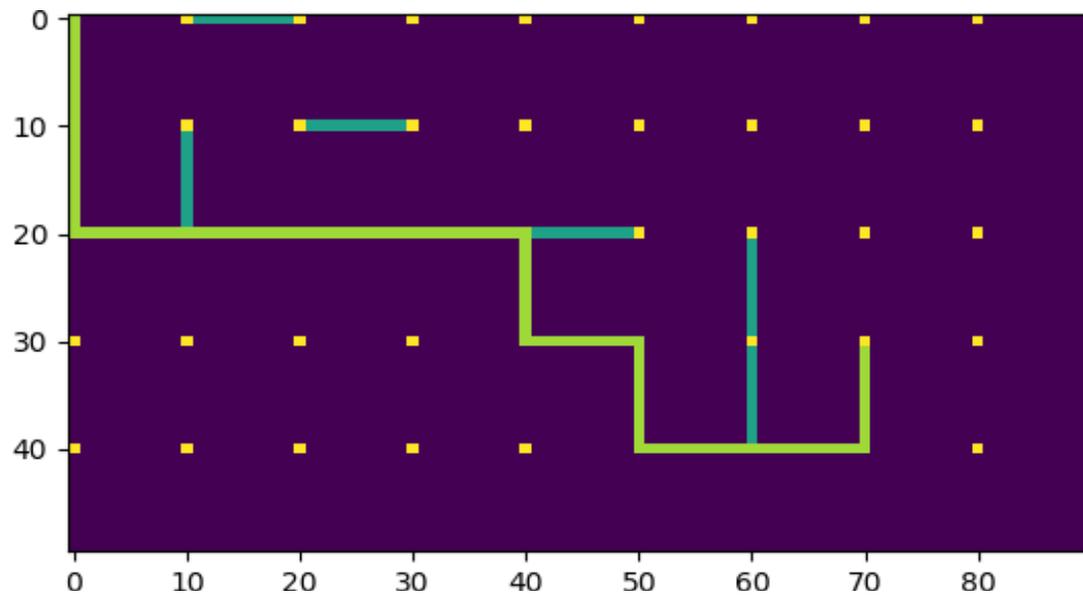
Message transmitted= " Destination reached"

Figure 18s. Direction plot of alternate path

An alternate path to reach the same destination:

Step1 :RFIDUid 0- Message= "start moving straight"
Step2: RFIDUid 9 – Message ="go straight and you have to take a left on the next turn" Step3 :RFIDUid 18- Message= "turn left"
Step4 :RFIDUid 19- Message= "go straight" Step5 : RFIDUid 20- Message= "go straight"
Step6 : RFIDUid 21- Message= "go straight and you have to take a right on the next turn" Step7 : RFIDUid 22- Message= "turn right and you have to take a left on the next turn" Step8 : RFIDUid 31- Message= "turn left and you have to take a right on the next turn Step9 : RFIDUid 32- Message= "turn right and you have to take a left on the next turn" Step10 : RFIDUid 41- Message= "turnleft"
Step11:RFIDUid42-Message="gostraightandyouhavetotakealeftonthenextturn" Step12 : RFIDUid 43- Message= "turnleft"
Step13 :RFIDUid 34- Message= "destination reached"

ThusthemovingpositionsoftheuserwereidentifiedbytheRFID/reader/antennasignaltransmissionswhenevertheycameincloseproximityanthentherightmessagewastransmittedtotheuser onthenextmovementstepstobetakenandofcoursethiswillbecoupledwithobjectdetectionto notify the user of temporary objects which lie in its path so as a whole this will turn out to be a compete feasible ,easy to implement voice enabled navigation system.

5. CONCLUSION

A novel arrangement was proposed on guiding an impaired user to a destination which is very accurate, efficient, feasible, cheap and easy for custom implementation in any physical space or inhouse premises. However, in the solution discussed above it is of utmost importance that the accurate virtual map be set up in memory resembling to the real location/floor map as closely as possible as the virtual map in the memory is the ultimate playground upon which this algorithm pivots. One also has to bear in mind of the strategic locations of the placement of the RFID tags on the floor especially at the corners and turns. There is no hard and fast rule of the correct distance between RFID tags as the algorithm is independent of the distance between the tags. It depends on the budget and the complexity of a map, the more a map is of complex nature with corners and turns and wide spaces, the more the number of RFID tags will be needed to fit the model. However, in our implementation and testing we had set up the entire system with a straight-line distance of 5 to 7 meters between two tags and that gave very good and accurate results of efficiency to cost output. The failsafe mechanism is also checked at every iteration of the algorithm and is triggered at the point of deviation when the user misses any instruction and strays from the determined path, which is also very fast to recalculate the path and a new batch of instructions. Even though in this case, the entire algorithm starts from the beginning it worked very fast on our tested 90*50 matrix without the user even realizing it.The complexity of the algorithm is O(N2) where N is the number of RFID tags used in the map, and it produces an optimal result owing to the fact that only a finite number of RFIDs will be used even to cover a large area. So, in a whole this a quick and complete solution to a problem which falls under a very complicated space like navigation. As a part of future work, we would like to test with complex and arbitrary shaped locations which would lead to more complicated maps and bring about more describable and elaborate messages along with other navigation features like traffic analysis etc. to encompass and address a wider problemin navigation space.

REFERENCES

[1] S.A. Weis, S. Sarma, R. Rivest, and D. Engels. Security and privacy aspects of low-cost radio frequency identification systems. In *First International Conference on Security in Pervasive Computing*, number 2802 in Lecture Notes in Computer Science, pages 201–212. Springer-Verlag, Berlin Germany, 2003.

[2] Vajda and L. Butty´an. Lightweight authentication protocols for low-cost RFID tags. In *2nd Workshop on Security in Ubiquitous Computing*, pages ?–?, 2003. In conjunction with Ubicomp2003.

[3] DamithRanasinghe, Daniel Engels, and Peter Cole. Security and privacy: Modest proposals for low- cost RFID systems. Auto-ID Labs Research Workshop, Zurich, Switzerland, September2004.

[4] Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Cli_ordStein.Introduction to Algorithms. MIT Press, 2001. SecondEdition

[5] Rong Zhou Palo Alto Research Center 3333 Coyote Hill Road Palo Alto, CA 94304.Eric A.Hansen Dept. of Computer Science and Engineering Mississippi State University Mississippi State,MS39762

[6] S. Kaiser, M. Khider, and P. Robertson, "A maps-based angular PDF for navigation systems in indoor and outdoor environments," in *Proceedings of the IEEE International Conference on Indoor Positioning and Indoor Navigation (IPIN '11)*, pp. 1–7, IEEE, Guimarães, Portugal, September2011.

AUTHOR

Soham Roy - Completed his Bachelors in computer science and engineering from Kalinga Institute of Industrial Technology in 2018.His primary research interest lies in Data Science AI/ML, Neural Networks and Algorithms.