

Non-Holonomic Robot Navigation Path Planning Using Fuzzy - Steepest Ascent Hill Climb

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Abstract: Robot navigation is determination position as well as direction movement in a trip . Planning track is Thing most important in the world of mobile robots. in short , determination track will produce dynasty that can traversed (feasible) with availability information that has there is that is map robotic environment . modelling environment map is step first for determine path planning. otherwise for environment that doesn't known , modeling will conducted with the information obtained from the sensors on the robot . on the environment actually , noise and limitations accuracy from the sensor leads to the most basic problem in modeling, that is accuracy , and speed , where influence system navigation live in real-time. For resolve Thing the needed the existence of a Fuzzy Description Environment which consists of over the fuzzy model of information obtained in the environment around robots. of these models will Becomes base reference path planner that is used reference to path planning. From the map environment modeling will processed by Steepest Ascent Hill Climb so produce track going to point end . From the results program simulation is obtained waypoints with distance shortest that is 363.2724 units distance

Keywords: Path Planning ; Fuzzy; Steepest Ascent; Hill Climb

INTRODUCTION

In the last few times the robot is one focus in science . Moreover use of robots as replacement man in Thing exploration and mobilization areas that don't easy passed human . As base from the use of the robot , the mobilization of the robot constitutes very thing urgent where in Thing avoid obstruction and withdrawal decision is Thing important . For avoid obstacle especially for environment that doesn't is known could used a number of method one of them with use Fuzzy for model environment around and Steepest Ascent Hill Climbing for search based on score heuristic something function that gives score for estimation something solution , looking for optimal path for avoid obstacle method this also often used for problem optimization . Generation circumstances next very depending on the feedback from procedure testing " A test in the form of function heuristic this will show

how much good score guesses taken to circumstances other possible " . Point beginning from algorithm this is for optimizing direction robot dynasty to be target . Steps in SAHC (Steepest Ascent Hill Climbing) calculations , namely : (1) calculating occupying box correct place , (2) count possible movement . (3) get value $h(n)$ using manual calculation with use sum occupying box correct place , (4) compare heuristic value of possible moves , (5) apply channel search SAHC (Steepest Ascent Hill Climbing) algorithm with score the $h(n)$ heuristic that has been obtained as determination track or path planning on robot navigation .

LITERATURE REVIEWS

Mobile robots

Mobile robots or moving robots is developing technology rapidly in this world . Mobile robot is a robot that has utility that is move position from one point to another point , move around environment (Gopalakrishnan, S, & R, 2014). For could make a minimal mobile robot is required knowledge about microcontroller and sensors electronics . Sensors are used for recognize environment on the robot so that the robot can avoid obstacles around . For sensor robots usually role as AMR or autonomous mobile robot, besides there are also robots using sensors but without need control intelligent for determine track the way namely AGV or autonomous guided vehicle where this robot use sensors for follow path that has determined in the form of a bright line dark

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(line follower robot), wall (wall follower robot), or light . There are also robots without using sensors, however moved use controller run by humans , this robot now already many for sale marketed form toy use remote control .

Robots Movement

Direction motion nonholonomic limited by effect touch direction wheels attached above surface . Robots don't can move free to direction beside robots. So that the direction the robot should be changed especially formerly before move because direction motion follow direction face wheel . Robots with characteristic motion nonholonomic have limitations in direction motion . Function geometry certain related with orientation must fulfilled for get appropriate motion . Usually a nonholonomic robot use two wheels on the right and left of the robot parallel with one wheel caster as balancer . Every wheel moved with independent motors or also called Differential Drive Motor.

Path Planning

Path planning is one problem fundamental in robotics , and becoming lots of problems learned . Definition from the path planning itself that is find movement free collision Among initial (start) and configuration end (destination) in environment certain . The simplest situation is when track planned in static environment , however in a manner more general path planning can also be formulated for robot system on constraints kinematics , in dynamic environment and not known (random).

Global Path Planning

If you have is known modeling environment around the robot then path planning can conducted with review modeling environment in a manner live without review possibility hindrance in a manner dynamic . Because Global Path Planning can conducted with static state

Path Planning

Local Path Planning can conducted without know environment around robots. Sensors will feel obstacles and tasks from path planner is give point to controller already sensors are found .

Dynamic Path Planning

Dynamic Path Planning is combined from Local Path Planning and Global Path Planning. Method this is the most suitable with study this . Where are the circumstances obstacles felt by the sensor will made modeling environment for processing globally .

Steepest ascent hill climbing

Steepest ascent hill climbing is method lots of algorithms used for problem optimization . one its application is for look for shortest route with cam maximizing or minimize score from function existing optimizations . kindly steepest literally means the highest , while ascent means increase . With thus the steepest ascent means highest increase . So principle base from method this is look for the highest increase from circumstances around for reach the most optimal value.

METHODS

Differential Drive Motors

A differential drive robot has two wheels that can move in a manner independent . Difference or similarity speed second wheel determine what are these robots will move rotation or straight (Dudek & Jenkin, 2010). Where L is distance Among two wheel right and left . v_r and v_l is speed translation wheel right and left in a row . And R is measured distance from ICC (Instantaneous Center of Curvature) which is rotating robot point with point the middle of the robot (period middle Among two wheel) (Dudek & Jenkin, 2010).

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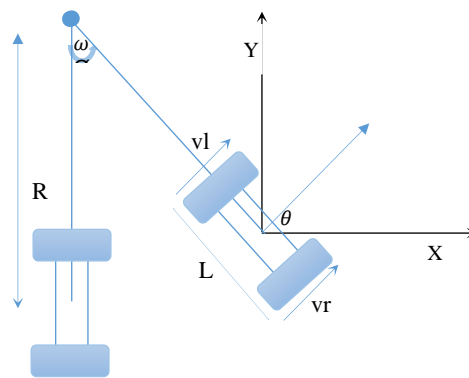


Figure 1. Parameters of Differential Drive Robot

Where L is distance Among two wheel right and left . vr and vl is speed translation wheel right and left in a row . And R is measured distance from the ICC (Instanteous Center of Curvature) which is rotating robot point with point the middle of the robot (period middle Among two wheel) (Dudek & Jenkin, 2010)

$$ICC = [-R \sin (\theta) , y + R \cos (\theta)] \quad (1)$$

With ω is change robot rotation about ICC each time . So when $vl \neq vr$, ω will comparable with vl and vr .

$$\omega \left(R + \frac{L}{2} \right) = vr \quad (2)$$

$$\omega \left(R - \frac{L}{2} \right) = vl \quad (2)$$

If equations (2) and (3) are combined so got equations (4) and (5)

$$R = \frac{L \cdot vr + vl}{2 \cdot vr - vl} \quad (4)$$

$$\omega = \frac{vr - vl}{L} \quad (5)$$

From the equations on could pulled a number of things , including : (Dudek & Jenkin, 2010) 1. If $vl = vr$, then will obtained motion straight linear to front . R worth not finite and not there is motion resulting rotation ω has a value of 0 2. If $vl = -vr$, then R is worth 0, and will obtained rotation on point axis the middle of the robot (L /2) or spin on the spot . 3. If $vl = 0$, then wheel left will Becomes axis turn so that will obtained $R = L /2$ and motion rotation to left so is when $vl = 0$ then will raises motion rotation to right .

Fuzzy Environment Model

Fuzzy logic is logic where the solution no worth booleans however worth continuous and vague depending on the degree acquired membership . For example logic distance that is n't only far and near , however worth close enough close , normal, enough far , far . Determination membership and degrees truth depend on us as giver fuzzy logic . In Thing it's fuzzy used for model robotic environment in the form of obstacle used as the path parameter to be sought by the colony program ants . For modeling the fuzzy obtained from the obtained obstacle parameters the distance each time $o_t^1, o_t^2, o_t^3, \dots, o_t^q$ to current robot position time t, (Pt (xi , yi)). Got distance $D(P_t, P_t^{ol}) = \sqrt{(x_t - x_t^{ol})^2 + (y_t - y_t^{ol})^2}$ where P_t^{ol} is the state of the i-th obstacle (i = 1,2,.. ,q)

Membership function is obtained from connection Among distance , obstacle radius specified minimum distance of action and distance maximum our action define . For study this , the action is determined that is as score loading probability on the ant colony in order movement ant no too random because no limited .

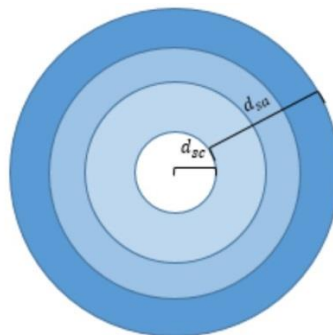


Figure 2. Membership function of Robots Environment

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Polar Histogram

The polar histogram is method that can used for describe chart with shape chart polar (circle). Because of its polar shape, method this normal used as modeling or system avoidance collision (collision avoidance). Where is the size from every degree is obstacle distance to robots point . With change distance to be density hindrance We could control robots for avoid hindrance . If the obstacle density is small so We direct the robot to little direction the obstacle .

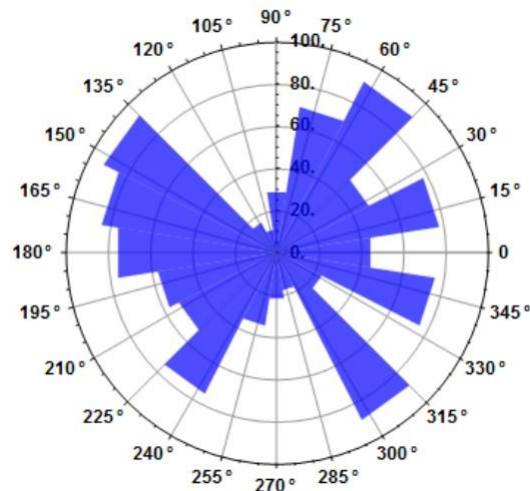


Figure 3. Polar Histogram

The use of a polar histogram is used in loading state selection in the ant colony process. Where is the point to be directed in the direction corner of robots have loading depending on the degree of density. For case this the more high density then the more small score loading at point the . So that possibility big point the no selected in the state selection .

Steepest ascent hill climbing

This steepest ascent hill climbing method is development from simple hill climbing method . The difference is a simple hill climbing to determine the next stare with compare current state with one more successor and first successor good will chosen be the next stare. While the steepest ascent will be compare current stare with all existing successors nearby so that in the steepest ascent hill climbing, the next stare is the best successor or the closest aim .

A literature review is a critical, analytical summary and synthesis of the current knowledge of a topic. It should compare and relate different theories/research, findings, and so on, rather than just summarizing them individually. It should also have a particular focus or theme to organize the review. In this section, the researcher can describe some of the related previous studies. Researchers can review the gaps in the research, then it can be used as a basis for research to be carried out

In this section, each researcher is expected to be able to make the most recent contribution related to the solution to the existing problems. Researchers can also use images, diagrams, and flowcharts to explain the solutions to these problems.

Design Device Hard Robot Car

Device block diagram hard from two car robots could seen in figure 3. Microcontroller is brain from existing system because all outputs will be regulated by the microcontroller based on existing inputs . Microcontroller used is AT89S52 microcontroller . Microcontroller this designed in single-chip mode, without memory external . So that possible memory used only the internal memory is 256 bytes. With thus , network designed microcontroller very minimal and of course give effect Suite Becomes more small . Microcontroller this on duty for do steepest ascent hill climbing algorithm then move the robot car for walk follow the line up purpose corresponding with results from the steepest ascent hill climbing process.

Two limit switch sensor mounted on the arm clamp for mark position where arm robotic clamp should stop . Position first is position moment arm clamp open and down which means the robot is ready for clamp . Position second is arm clamp closed and on top . There are 4 infrared sensors used in this system namely two sensors for line tracking , one side sensor for detect intersection , and one object sensor for detect exists thing . Photodiode used as receiver on the infrared sensor . Suite comparator used for adapt input sensor output voltage is still

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analog into the digital voltage range . this conducted with compare analog output voltage from the sensor with a voltage reference . With thus the sensor output status can be read by the microcontroller .

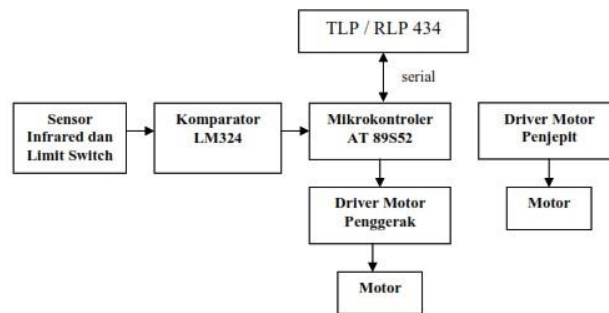


Figure 4. Device Block Diagram Hard Robot Car

motor drive driver circuit is designed with using network models HBridge which consists of 4 transistors. The input of this motor drive driver circuit be equipped with optocoupler as safety so noise is not could bother system .

One pair of TLP and RLP 434 modules is used as means for communication without cable between second robot. Module this working on a frequency of 434 mhz with ASK method . The TLP 434 module is used for sending data serially while RLP 434 module is used for serial data reception . Second module communication without cable this connected to the serial port from microcontroller .

Table 1. Position Mapping Result Storage in Microcontroller Internal RAM

Y \ X	0	1	2	3	4	5	6
0	30h	31h	32h	33h	34h	35h	36h
1	38h	39h	3Ah	3Bh	3Ch	3Dh	3Eh
2	40h	41h	42h	43h	44h	45h	46h
3	48h	49h	4Ah	4Bh	4Dh	4Eh	4Fh
4	50h	51h	52h	53h	54h	55h	56h
5	58h	59h	5Ah	5Bh	5Ch	5Dh	5Eh
6	60h	61h	62h	63h	64h	65h	66h

Mapping is the most important thing to do first in program flow . Succeed or nope search thing or determination track shortest no free from mapping this . With mapping this so all existing areas will depicted . Results that got from mapping the will made reference for count square distance straight every point in the area with respect to point purpose . Yield value calculation distance obtained the will stored inside microcontroller RAM address . the value then will analyzed with use steepest ascent hill climbing method . With method this so will obtained the shortest route going to point purpose . However , route this still form RAM address instead score the real output port . because that need changed be an output port . Then the robot could browse path that has got .

Such path is track shortest going to desired goal . After reaching point desired destination so will conducted appointment thing . Here the robot will give data information to other robots that thing has found . Sending the data in the form of data F0h sent 255 times . Another robot will receive the data and compare the data 7 times . Comparison that 7 times for ensure that data received is information data thing found . Sending robots after finished will send data return to position beginning with the path data that has been saved .

The design of the map area is shown in Figure 4. In this map area, the car robot will look for route shortest and then move follow route that has got . From pictures field such , seen there are 49 points that can Becomes position beginning or position purpose . Design field as this conducted because limitations total available memory . Table 1 shows location space RAM memory storage results field map area mapping .

RESULTS

Scheme of testing carried out is do testing with various position start and position purpose . Testing this has conducted over and over again for look performance from system that has made . Following is one results testing performed the car robot will move from position start at coordinates (6,3) menu ju coordinates (4,1) as

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shown in Figure 6. Meanwhile Obtained route with use the steepest ascent hill climbing method is as shown in the picture

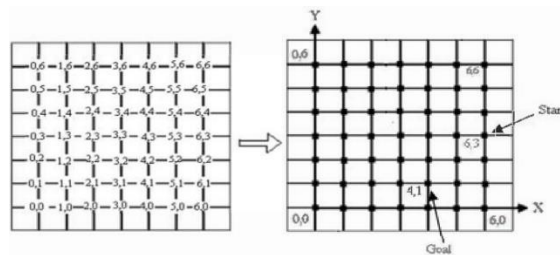


Figure 5. Map of the Car Robot Start Position in (6,3) with Purpose (4,1)

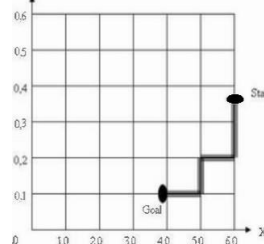


Figure 5. Steepest Ascent Hill Climbing Results Route

Test results show that car robot could look for route alone with use the steepest ascent hill climbing method and the robot can walk with good reach goal position or purpose follow route that has got .

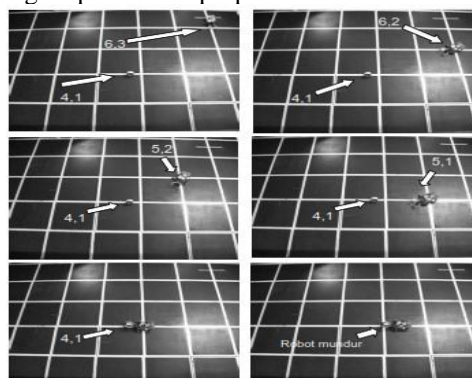
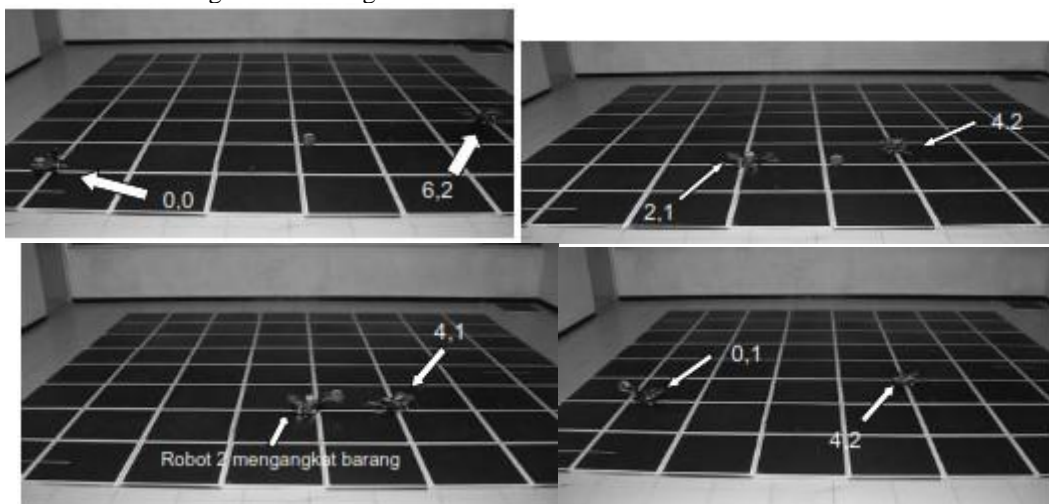
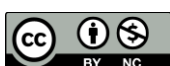


Figure 6. Movement of the Car Robot from Position (6,3) Towards (4,1)

Testing following is testing system in a manner whole . The first robots start move from position beginning with coordinates (6,2) and the second robot move from position beginning with coordinates (0,0). The target is placed at coordinates (3,1). Test results show that both robots can look for route respectively and can move towards the appropriate target with route that has got . Saar the second robot has succeed lift thing , the first robot no forward journey and return to position early . Following is a number of picture showing movement both robot cars are taken from video recording results testing that has been done .



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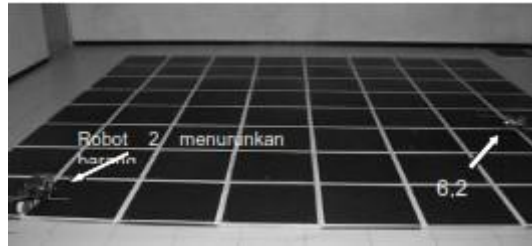


Figure 9. Movement Both Car Robot Test Results Whole

CONCLUSION

From the results testing that has been done, then could taken conclusion that the steepest ascent hill climbing method has been succeed implemented on the AT89S52 microcontroller for look for route shortest Both robots can move corresponding with route that has got with use method of steepest ascent hill climbing and also both robots can work together and communicate with ok. But due to the designed area for testing shaped symmetrical, then should there is more from incoherent solution form route shortest. In case this, the steepest ascent hill climbing method only could find incoherent solution just. The steepest ascent hill climbing method is not could used for reassuring the shortest route when evaluated point have same distance. For development next, preferably the area for testing, don't made symmetrical so that can seen clear success deep hill climbing method search route shortest

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