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Automatic Vehicle Navigation with Intelligent Docking Systems for Extinguishing Fire

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ABSTRACT: Automatic vehicle navigation deals with DIJKSTRA'S algorithm based architecture, designed for the purpose of finding the shortest path between the nodes in vehicle navigation. Dijkstra's algorithm is a graph search algorithm that solves the single-source shortest path problem for a graph with non-negative edge path costs, producing a shortest path tree. This algorithm is often used in routing and as a subroutine in other graph algorithms. For a given source vertex (node) in the graph, the algorithm finds the path with lowest cost (i.e. the shortest path) between that vertex and every other vertex.

In this paper DIJKSTRAS ALGORITHM is implemented for vehicle navigation where the data transmission time is increased with the protocol standard. One of the section runs with driver unit and LPC2148 and another PC as server section runs on a Matlab platform. Communications between two nodes (hardware and application) are accomplished through IEEE 802.15.4. The user can give the source and destination node address to the server section. Using DIJKSTRA'S algorithm the shortest path will be found out and graph plot will be displayed on the server section. Using IEEE standard communication protocol the shortest path will be fed into the robotic module. Using the path as a reference, the robot moves in the specified direction.

I. INTRODUCTION

The proposed navigation system is implemented by DIJKSTRA'S algorithm with Automatic transmission , Wireless communication and less time for path selection. The proposed work is divided into two sections. The first section is the robotic section and the later one is monitoring section. The user feeds the command to the robotic vehicle in robotic section by giving the source and destination address. The vehicle then finds the shortest path to reach the destination by using DIJKSTRA'S algorithm. The function of the vehicle towards the destination is found in monitoring section.

Based on the commands from the user, the vehicle extinguishes the fire using the exhaust fan mechanism. Also the fire is sensed by using the temperature sensor to extinguish the fire. In case of any error found in reaching the destination the vehicle displays the error message through the LCD display mounted on the vehicle. Once the vehicle is implemented it functions by automatic charging mechanism. There is improved safety and security in this system. It is also a simplified system using algorithm. The vehicle consumes low power. The concept used in this paper can also be used in traffic control applications, security applications, shortest path finding applications and military application.

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II. RELATED WORK

R. Hassin, formulated two fully polynomial approximation schemes for the shortest path problem with an additional constraint. The main difficulty in constructing such algorithms arises since no trivial lower and upper bounds on the solution value[1]. A new approach to manage network access in tactical environment for specific vehicles and various forms of optimization strategies are compared and evaluated on realistic scenarios is explained on [2]. Fire brigades

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and special agencies which are often demanded to operate for search and aid of human lives in extremely dangerous scenarios and the safety of the environment and to obtain remotely a clear image of the scenario inside buildings or underground spaces is suggested by Hirose, S to have A team of tracked robots for special urban search and rescue operations [3]. A fire detector circuit which is kept in home that triggers the landline telephone to dial automatically the alternative cellular phone of the resident[4]. In [5], an intelligent voice operated fire extinguishing robotic vehicle, which can be controlled wirelessly through RF communication. Therefore existing systems has disadvantages like more time for path selecting and there is no architecture layer and monitoring section.

III. ROBOTIC SECTION

In the block diagram of robotic section shown in Fig.1, the first block is the power supply unit. It is connected with ARM processor which leads to IEEE 802.15.4 Protocol leading for the purpose of communication in the monitoring section. The processor is interfaced with two driver units for driving two motors namely motor1 and motor2. There is also a display unit connected with the processor to display the error messages if occurred.

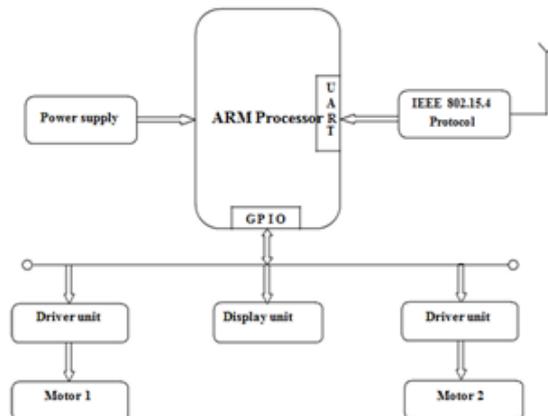


Fig.1 Block Diagram of Robotic Section

One of the section runs with driver unit and LPC2148 and another PC as server section runs on a Mat lab platform. Communications between two nodes (hardware and application) are accomplished through IEEE 802.15.4. The user can give the source and destination node address to the server section. Using DIJKSTRA'S algorithm the shortest path will be found out and graph plot will be displayed on the server section. Using IEEE standard communication protocol the shortest path will be fed into the robotic module. Using the path as a reference, the robot moves in the specified direction. The user feeds the command to the robotic vehicle in robotic section by giving the source and destination address. The vehicle then finds the shortest path to reach the destination by using DIJKSTRA'S algorithm. The function of the vehicle towards the destination is found in monitoring section.

IV. MONITORING SECTION

The second part of the block diagram is monitoring section. Monitoring section is generally the receiver section. It receives the command from the robotic section via IEEE802.15.4 Protocol which is connected with serial data transfer unit which leads to computer panel as indicated in Fig .2

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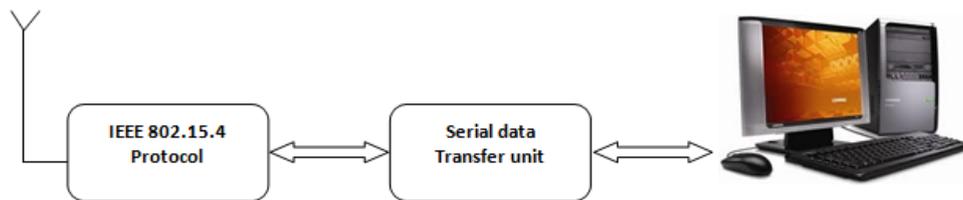


Fig.2 Block Diagram of Monitoring Section

Serial Communication

Computers transfer data in two ways: parallel and serial. In parallel data transfers, often 8 or more lines (wire conductors) are used to transfer data to a device that is only a few feet away. In serial communication, the data is sent one bit at a time, in contrast to parallel communication, in which the data is sent a byte or more at a time.

IEEE 802.15.4 PROTOCOL

Medium access control (MAC) layer, Responsible for providing reliable communications between a node and its immediate neighbors, helping to avoid collisions and improve efficiency. Physical (PHY) layer provides the interface to the physical transmission medium (e.g. radio).

V. TYPES OF SHORTEST PATH ALGORITHMS

The different types of algorithm to find the shortest paths are:

1. DIJKSTRA'S ALGORITHM: It solves the single source shortest path problem.
2. BELLMAN-FORD ALGORITHM: it solves the single source problem if edge weights are negative.
3. A*SEARCH ALGORITHM: It solves for single pair shortest path using heuristics to try to speed up the search.
4. FLOYD-WARSHALL ALGORITHM: It solves for pairs shortest path.
5. JOHNSON'S ALGORITHM: It solves all pair shortest paths and may be faster than FLOYD-WARSHALL on sparse graphs.
6. VITERBI ALGORITHM: It solves the shortest stochastic path problem with an additional probabilistic weight on each node.

VI. DIJKSTRA'S ALGORITHM

Dijkstra's algorithm is called the single-source shortest path. It is also known as the single source shortest path problem. It computes length of the shortest path from the source to each of the remaining vertices in the graph. The single source shortest path problem can be described as follows:

Let $G = \{V, E\}$ be a directed weighted graph with V having the set of vertices. The special vertex s in V , where s is the source and let for any edge e in E , Edge Cost(e) be the length of edge e . All the weights in the graph should be non-negative. Before going in depth about Dijkstra's algorithm let's talk in detail about directed-weighted graph. Directed graph can be defined as an ordered pair $G = (V, E)$ with V is a set, whose elements are called vertices or nodes and E is a set of ordered pairs of vertices, called directed edges, arcs, or arrows.

DIJKSTRA'S algorithm is more general that it is not restricted to acyclic graph. DIJKSTRA'S algorithm requires that weights on edges are positive. As mentioned DIJKSTRA'S algorithm calculates shortest path to every vertex. Therefore, anytime we want to know the optimal path to some other vertex from a determined origin, we can use Dijkstra's algorithm. A potential advantage of this algorithm is that it often does not need to investigate all edges. If edges are relatively expensive to compute then this algorithm might turn out to be faster.

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Dijkstra's algorithm - Pseudo code

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dist[s] ← 0 (distance to source vertex is zero)
for all v ∈ V - {s}
do dist[v] ← ∞ (set all other distances to infinity)
S ← ∅ (S, the set of visited vertices is initially empty)
Q ← V (Q, the queue initially contains all vertices)
while Q ≠ ∅ (while the queue is not empty)
do u ← mindistance(Q, dist) (select the element of Q with the min. distance)
S ← S ∪ {u} (add u to list of visited vertices)
for all v ∈ neighbors[u]
do if dist[v] > dist[u] + w(u, v) (if new shortest path found)
then d[v] ← d[u] + w(u, v) (set new value of shortest path)
(if desired, add traceback code)
return dist

```

V. EXPERIMENTAL RESULTS

The pathway taken by the robotic vehicle using the DIJKSTRA'S algorithm is shown in Fig.3. The graph is plotted between time (x axis) and stage (y axis). The stimulated output by choosing of the nodes in terms of shortest path by using the DIJKSTRA'S algorithm is shown in Fig.4 . The direction of the path is indicated in terms of arrows.

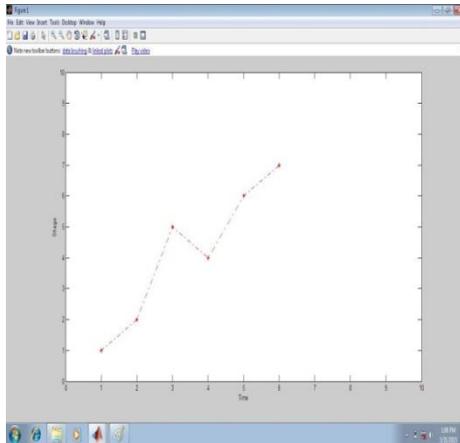


Fig.3 Path using DIJKSTRA'S algorithm

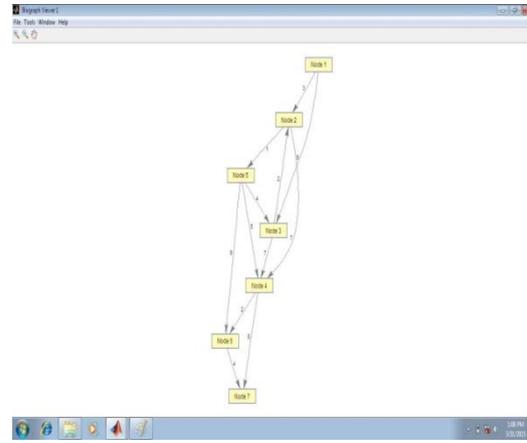
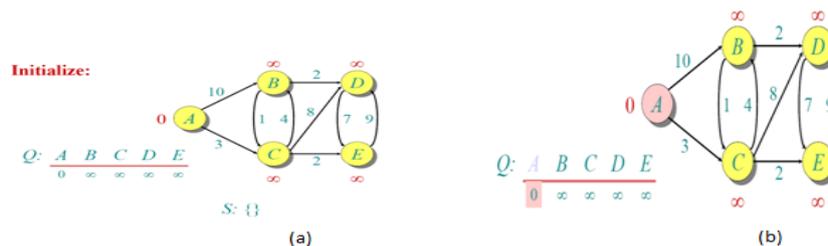


Fig.4 Choosing the nodes for shortest path

Dijkstra's Algorithm Animated Example

Animated example to find the shortest path using Dijkstra's Algorithm by executing the pseudo code is shown in fig.5 with five nodes .



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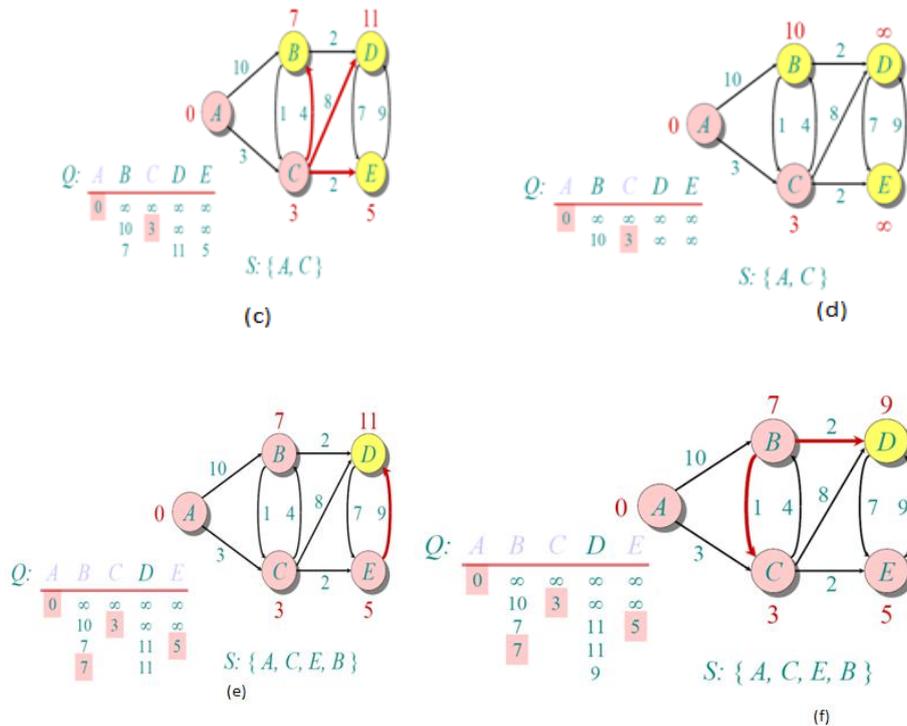


Fig. 5 (a),(b),(c),(d),(e),(f) Animated Example to find the shortest path using Dijkstra's Algorithm

HARDWARE IMPLEMENTATION

The ISP Programmer can be used either for in-system programming or as a stand-alone SPI programmer for Atmel ISP programmable devices. The programming interface is compatible to STK200 ISP programmer hardware so the users of STK200 can also use the software which can program both the 8051 and AVR series devices. The main screen view of the program is shown in Fig.6.

The ISP-30a.zip file contains the main program and the I/O port driver. Place all files in the same folder. Also make sure do not program the RSTDISBL fuse in ATmega8, ATtiny26 and ATtiny23 otherwise further SPI programming is disabled and you will need a parallel programmer to enable the SPI programming.



Fig.6 Main screen of the program ISP-Pgm Ver. 3.0a

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HARDWARE IMAGE

Hardware snapshot is shown in Fig.7 consist of Power supply , ARM PROCESSOR (LPC 2148 BOARD), LCD display, exhaust fan. Based on the commands from the user, the vehicle extinguishes the fire using the exhaust fan mechanism. Also the fire is sensed by using the temperature sensor to extinguish the fire. In case of any error found in reaching the destination the vehicle displays the error message through the LCD display mounted on the vehicle.



Fig.7 Hardware Snapshot

VI. CONCLUSION

Automatic vehicle navigation uses DIJKSTRA'S algorithm for finding the shortest path to every vertex. For a given source vertex (node) in the graph, the algorithm finds the shortest path between that vertex and every other vertex. Hence it is very useful in certain cases like extinguishing fire in hazardous area. It is a simplified system hence the power consumption is very low. It extinguishes the fire by finding the least cost to reach the destination from the source. This concept is not only used in extinguishing mechanism but also in other principles like traffic control applications, security mechanism, etc., The presented work can extinguish the fire beyond a range of 150m, when Zigbee module is used. An efficient route is a difficult problem for many drivers. Car navigation systems offers a special feature on new car. These systems are capable of performing some of the tasks traditionally performed by the driver, such as determining the best route to the destination. Hence the DIJKSTRA'S algorithm implemented with Zigbee in parking areas minimize the parking problems .

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