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Improved Virtual Digital Trainer Kit

Navneet Kashyap[1], Pravin Choudhari[2], Hrishikesh Warghade[3], Atul Chougule[4]

[1-4]*Student, Department of Computer Engineering JSPM's ICOER, Maharashtra, India*

Abstract - *Digital training kit is used for the design of combinational and sequential logic circuits. There are a number of sources which provide virtual digital training kit but there are issues with the sources. Mobile has more computing power than computer which makes mobile a better platform for such applications. To increase the efficiency of the application we will be using improved A* algorithm and to make the GUI simple for the end user to understand we will be dividing the screen into square grids and to decide the next grid we will use heuristic value.*

Key Words: **(1): Digital training kit (2): Virtual digital training kit (3): Improved A* algorithm (4): Square grid (5): Heuristic value**

1. INTRODUCTION

In the field of research digital training kits are very important for circuit making. It helps the researcher to build combinational and sequential circuits. The digital training kit is very important for the academics of the young engineers. Many colleges cannot provide the digital training kit 24/7 to the innovative minds of the young engineers to work on their ideas and also to practice at home. As the digital training kits are expensive students cannot afford to buy one and issuing it from college is not the best alternative as the kits can be damaged. This is where the idea of virtual digital training kits came. There are n number of software's which were created but there are some major issues, these software's are platform dependent, they have some specification requirements and need some previous knowledge to operate. To overcome the drawbacks of these software's, some researchers created digital training kits on websites. These websites which are providing virtual digital training kits are not platform dependent and do not require any previous knowledge for the implementation but there are issues with websites as well as the computation power of websites is less because of which many complex algorithms cannot be implemented which requires high computation power. This will eventually reduce the use of that particular website as many surveys have shown that users switch the website if it takes more time to respond.

The current situation of the computation field is that mobile phones have more computing power than the computers and there are more mobile users than the computers as the mobile applications are easy to handle as compared to the computer software. Here we will be providing a mobile application which will provide a virtual digital training application and this application will overcome the drawbacks of the previous technologies available in the market. The technologies used is Heuristic value, Improved A* algorithm and square grid..

2. IMPROVED A* ALGORITHM

A. ***The pseudo code of A* algorithm is as follows:***

```
function find_path( Source, Destination){
  OPEN_List = [Source];
  CLOSED_List = [];
  Current_Node = null;
  Neighbours = [];  Path = [];
  Source.Parent = null;
  while ( OPEN_List is not Empty ) {
        Current_Node = OPEN_List.remove_least_node();
        if( Current_Node == Destination )
       break;
        CLOSED_List.add(Current_Node);
       Neighbours = Map.search_neighbours( Current_Node );
        foreach (n in Neighbours) {
              examine(n);
              n.Parent = Current_Node;
              OPEN_List.add(n);
              }
       }
while( Current_Node is not null ) {
        Path.add( Current_Node );
        Current_Node = Current_Node.Parent;
        }
}
```

The A* algorithm maintains two lists (OPEN List and CLOSED List) to keep track of examined/traversed nodes. The OPEN list contains the nodes, which have been discovered but yet to examine. Whereas, the CLOSED list contains the nodes, which have been discovered as well as examined. In the

OPEN list, the nodes are kept in a sorted manner with respect to the Cost value of the Node. While finding the path, the A* algorithm add the Source Node to OPEN list, and then repeatedly remove the node with least cost value from the OPEN list and add their walkable neighbor nodes to OPEN list, until the destination node is removed from the OPEN list. Due to sorted order of nodes in OPEN list, the removal of node with least cost value become very much faster and optimal. The removed node from OPEN list is then examined. If the removed node is the destination node then A* algorithm will be terminated. Otherwise, the walkable neighbor nodes of the current node are discovered and then added to OPEN list after calculating cost value of each neighbor node by cost function of A* algorithm. And after adding each walkable neighbor node to OPEN list, the current node is added to CLOSED list

In order to reduce the number of rotations taken by the A* algorithm, the cost function needs to be modified. As the heuristic cost function does not consider any obstacle in between the current node and destination node, it may or may not consider any rotation. But in the case of actual cost function, it takes care of the cost of moving from source to current nodes. And by adding a cost to actual cost value for each turn taken by that path, the more accurate result i.e. path with less turn can be achieved. The actual cost function g(n) of the A* algorithm g(n) = g(parent) + movement_cost can be modified as follows:

g(n) = g(parent) + movement_cost + R

Where, R is the cost of changing the direction i.e. the cost of rotating left or rotating right. The value of R can be defined as follows:

If turn is detected then R = CR

Otherwise R = 0

Where, CR is the cost of rotation. The Cost of Rotation depends on the size of Grid. The larger the grid size, the higher value of rotation cost required. Due to this, after taking each turn the cost value of the node will be increased. And hence, as algorithm chooses the nodes with least cost value from OPEN list, it will also select the nodes with less number of turns, which may result into the path with less number of turns.

To find the path from the Source to the Destination, if the improved version of A* algorithm is applied. The following results were obtained (Figs. 1, 2 and 3).

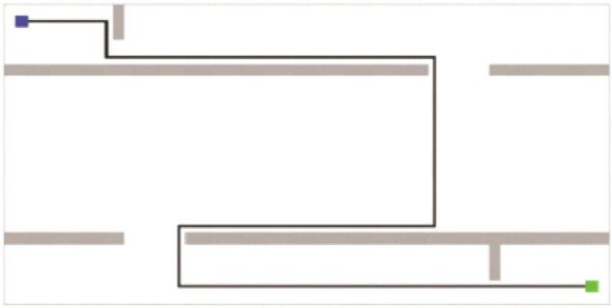


Fig 3. Grid 3

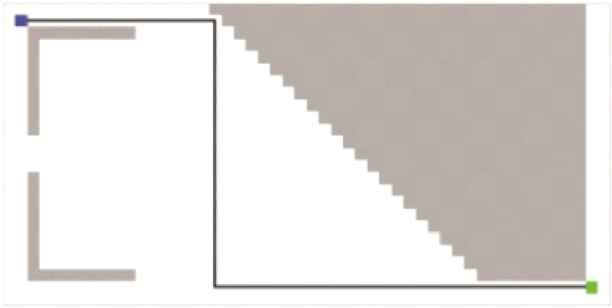


Fig 1. Grid 1

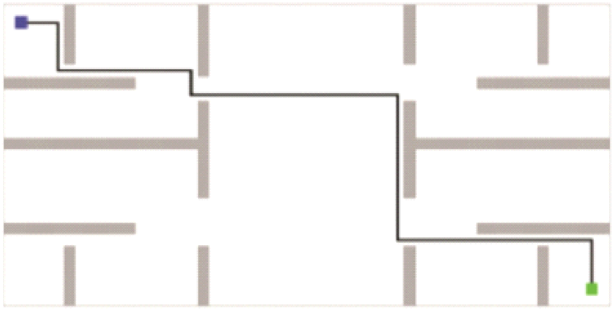


Fig 2. Grid 2

Table 1: Result of improved A* Algorithm.

Grid	Time required (in milliseconds)	Path length	Number of rotations
Grid 1	0.3082	70	2
Grid 2	0.4852	70	7
Grid 3	0.5446	112	6

The traditional A* algorithm takes less time (in milliseconds) to find the path, but the number of turns in path are more, whereas the improved A* algorithm takes few more milliseconds but give less number of turns. As the rotation cost increases gradually, the value of cost function of A* algorithm also increases, as a result, the accuracy of algorithm increases, i.e. number of turns taken reduces. While doing so, a few extra numbers of node could also be discovered. For those extra discovered nodes, the A* algorithm requires little bit more time, due to this the time required by algorithm also increases gradually.

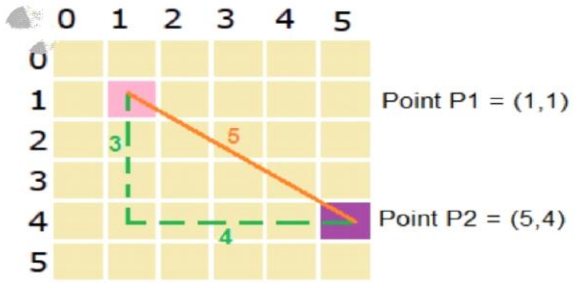
3. HEURISTIC FUNCTION

Heuristics search refers to a search strategy that attempts to optimize a given problem by iteratively improving the solution based on a given heuristics functions or a cost measure.

Algorithms behavior based on heuristic and cost functions can be very useful in the game.

Speed as well as accuracy can be exploited to make your game faster. Construct an exact

Heuristic to pre compute the length of the shortest path between every pair of prints.



Euclidean distance = $\sqrt{(5-1)^2+(4-1)^2} = 5$

Manhattan distance = $|5-1| + |4-1| = 7$

The function of heuristics are most important:

Function

Heuristics function is a function that estimates the cost of getting from one place to another place. (From the current state to the goal state) Also called as a heuristic. Used in a given decision process to try to make the best choice of list of possibilities (to choose the move more likely to lead to the goal state)

A. This is not feasible for most game maps.so there are ways to approximate this heuristic.

1) Fit a coarse grid on top of the fine grid. Pre compute the shortest path between any pair of coarse grid location.

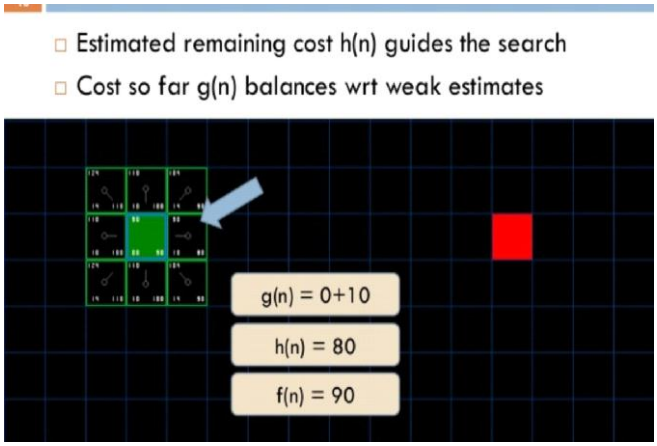
2) Pre compute the shortest path between any pair of given waypoints. This concept is a generalization of the coarse grid approach.

3) If there is no obstacles and no slow terrain, then the shortest path from the starting point to the goal should be straight line. On a grid there are well known heuristic function to use.

B. Important of heuristic search:

Heuristics reduce the mental effort required to make choices and decisions.

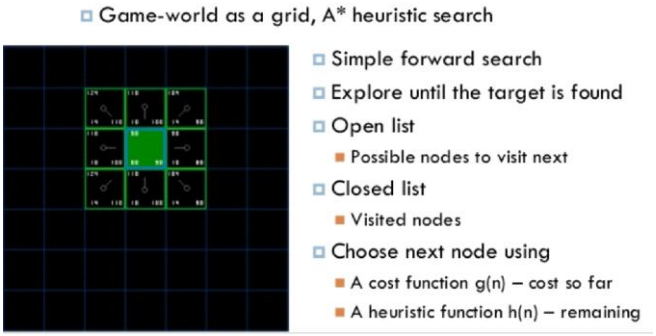
Fast and Frugal: Still other theories argue that heuristics are actually more accurate than they are biased. In other words, we use heuristics because they are fast and usually correct.



C Heuristic function to use in :

On a square grid that allows 4 directions of movement, Manhattan distance.

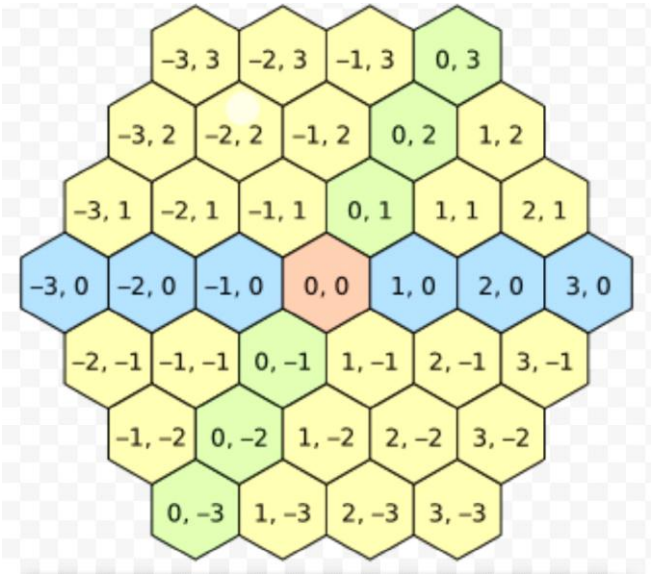
The Manhattan distance is an admissible heuristic in this case because every tile will have to be moved at least the number of spots in between itself and its correct position. The subscripts shoe the Manhattan distance for each tile.



1) On a square grid allows 8 directions of movement, diagonal distance.

2) On a square grid that allows any direction of movement, might or might not want Euclidean distance

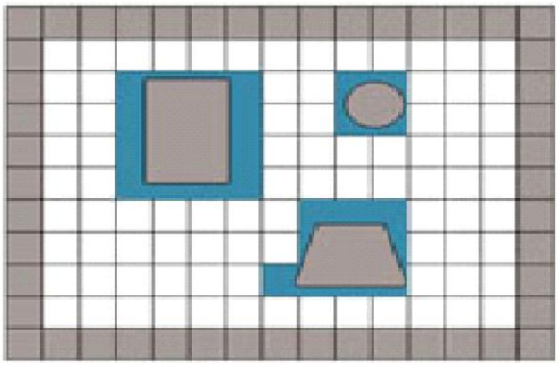
3) On a hexagon grid that allows 6 direction of movement, uses a Manhattan distance adapted to hexagonal grids.



4. GRID

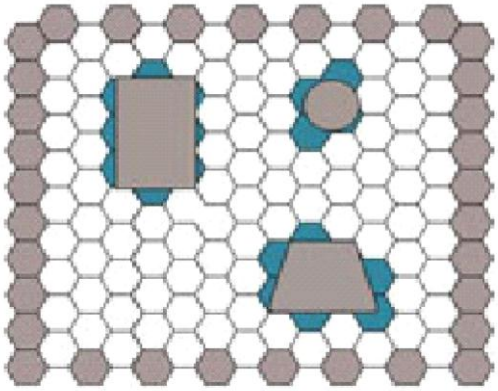
Terrain topology is the foundation of the mobile application and generating the graph is the most important part of it. Here we are studying different graph generating techniques such as 2D square grid (octile), 2D hexagonal grid and 2D triangular grid. A grid contains vertices and edges which connects the vertices. *Study done by Zeyad Abd Algfoor, Mohd Shahrizal Sunar and Hoshang Kolivand gives us the idea about the advantages and disadvantages of 2D square grid, 2D hexagonal grid and 2D triangular grid.*

B. 2D square grid



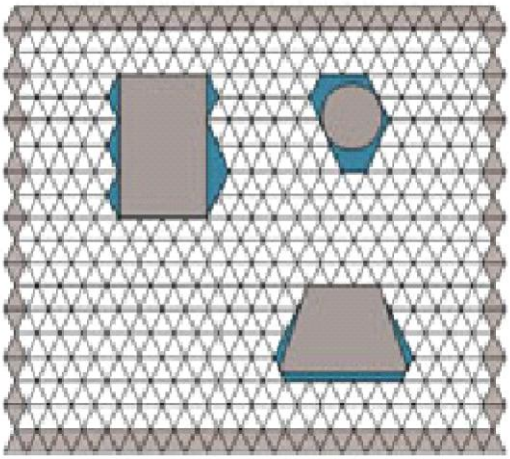
1) Square grid is very popular in computer games and number of algorithms have been proposed for path finding problem. Harabor and Grastien have given the jump point search (JPS) single-agent algorithm. This algorithm was given to solve the well-known problem named "uniform-cost octile grid in static environment." Uras et al published a method to accelerate the path search by generating subgoal graphs. Bnaya et al proposed the Exhaustive and Monte- Carlo Iterative Taxing Algorithms (EITA/MC-ITA) for the multi agent path finding problem. The drawback of these techniques is that it assigns priorities randomly to one or the other agent. Anderson presented an excellent additive heuristic for a single-agent search on a four-connected square grid with dynamic obstacle.Koenig and Sun demonstrated the advantages and disadvantages of real-time and incremental heuristic searches in square grids.

C. 2D hexagonal grid



Bj¨ornsson et al have shown that 2D hexagonal grid have many of the properties of the square grid[]. Hexagonal grids have smaller search time and memory complexities than grid graphs constructed from squares. The only problem with 2D hexagonal grid is that it takes more time to execute for the large map. Path finding algorithms have mainly been implemented on square grids, and the multi agent problem on a hexagonal grid has not yet been investigated in dynamic or real-time environments.

D. 2D triangular grid



Triangular grids are not widely used as compared to square grid and hexagonal grid but still triangular grid have some desirable properties. There TA* and TRA* algorithm found out to be perfectly working on the large maps.

The study of all three graph making strategies gets up to a conclusion that for mobile application 2D square grid would be the most suitable.

5. LITERATURE SURVEY

1 Multisim

NI Multisim (formerly MultiSIM) is an electronic schematic capture and simulation program which is part of a suite of circuit design programs, along with NI Ultiboard. Multisim is one of the few circuit design programs to employ the original Berkeley SPICE based software simulation.

1.1 Features:

1. It is a widely used tool for digital circuit designing.
2. It is a good tool for professional designers.

1.2 Drawbacks:

1. Only works on Windows platform.
2. It requires a minimum 2GB hard-disk space and 512 MB RAM.
3. It was developed for professional designers, which is not satisfactory for students.
4. It has the code base and gate base architecture.
5. It requires at least basic knowledge of VHDL syntax to use it.

2 Digital works 3

Digital Works is a graphical design tool that enables you to construct digital logic circuits and to analyze their behavior through simulation. Circuits can be composed of simple gates (AND, OR, NAND, NOR, XOR, XNOR, NOT) and simple flip-flops (D, RS and JK). You can also use tri-state and memory devices to construct systems with buses. It also provides mechanisms for detecting race conditions and bus contention.

2.1 Features:

1. Simple gates and flip flop connections can be implemented smoothly.

2.2 Drawbacks:

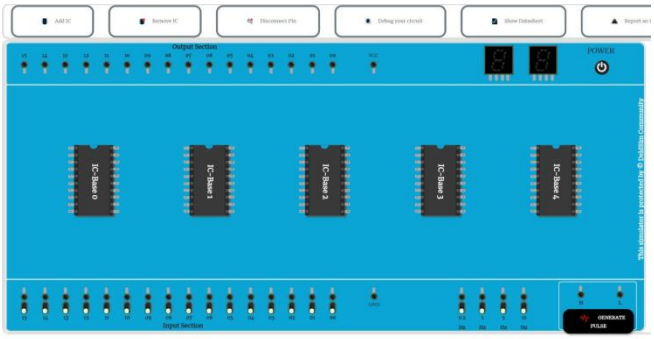
1. Only works on Windows platform.
2. We cannot have multiple output connections from a gate
3. Complex circuits cannot be implemented efficiently.
4. It has a confusing GUI.

6. PROPOSED SYSTEM

This system will simulate the working of a Digital training kit. The input connections from the user will be taken as input for the system. The input connection data will be stored in our system for further processing. Paths for those connections will be found with the help of a path finding algorithm. Then the circuit will be implemented according to user input and then finally the system will give the Timing diagrams and Logical Design view of your circuit as output. All these issues lead to developing a new tool which will be platform independent and will integrate all the functionalities of above mentioned tools. Besides that, Tool should not have any types of dependencies. By studying all these parameters, we will try to develop a system to help students in studying digital electronic circuits. Our intent was to develop the tools within the digital logic thread of IT and Computer Engineering stream, and then apply it within other streams of engineering like Electrical Engineering, Mechanical Engineering and Electronic and Telecommunication (E&TC) Engineering. We believed that we could develop innovative techniques to facilitate improved learning.

Deldsim(App) is a simulation tool that will be focused on providing powerful design features that will be integrated seamlessly into the implementation of the circuit design flow. This environment will help students to easily, successfully and quickly complete their assignments. In case of any complexity, Deldsim will provide benefits by offering powerful features at all levels of implementation from the fundamentals of placement of IC's and wire connections, to the advanced features like timing diagrams. This system will focus on the design of logic circuits, Timing diagrams that we use to improve student's performance and efficiency. Deldsim will be the simulation tool that assists you in carrying out the major steps in the circuit implementation flow. Deldsim will be designed for IC functionalities, simulation, generating automatic truth table and timing diagrams. It will also work efficiently for single source multiple destinations, i.e. from single output multiple connections can be possible, which will be its big advantage. It will support each of the SSI and MSI digital electronics experiments. Circuit simulation will help students to uncover varieties of flaws in the earlier stage of design and implementation process. Deldsim will be a powerful simulation tool that will enable the students to reduce design and implementation iterations and save valuable time which was required in trial and error method on actual digital electronic kit. To drive efficiency for electronics design,

Deldsim will include a wide variety of sophisticated simulation features such as timing diagrams, single source multiple destination connections, user friendly GUI and the integration with varieties of ICs.



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