A* Path Finding Algorithms Based Designing the Best Possible Eco-Friendly Structure Spatial Landscape and Natural Setting

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Abstract

The design of conventional architectural landscapes often has issues with inadequate direct visual effects and inadequate levels of resident satisfaction, but the design of green architectural landscapes typically does not have these issues. Creating room for landscaping is likewise an impractical endeavor. Because of this, the authors of this study suggest a number of different Path-finding algorithms for green building landscape space and environmental optimization design. A variety of path-finding algorithms may be used to maximize the multi-objective scale of the architectural landscape. The expense of the construction as well as public utilities such as the space environment are included among the optimization's goals and objectives. The findings indicate that the many pathfinding solutions that were presented are able to optimize the architectural landscape setting, and the occupants' level of happiness has increased as a consequence.

1. Introduction

The construction industry is moving in the direction of green building as a growth direction. When planning the functions of a building as well as the whole life cycle of a green building, energy savings, land savings, water savings, material savings, and environmental preservation must all be taken into consideration. The design needs to take into account the economic unity as well as the environmental advantages. When it comes to the process of designing a green building, the building itself serves as the primary point of entry to actualize the sustainable growth of the structure. And garden planning and design is the process of strategically placing plants and creating their layout to enhance an area's natural, living, and recreational qualities; it draws on garden art and engineering practices. This may be achieved by strategically planting and creating plants to enhance the local ecosystem. The planning and design of garden landscapes include sustainable green construction practices in very significant ways. At this point in time, environmentally friendly architectural design is still in the beginning stages of its development [1]. This essay examines the challenges of incorporating environmentally responsible construction practices into garden planning and design and offers suggestions for addressing those challenges. The conventional approach, which involves organizing temporary construction and construction machines on the site based on previous experience, is not enough for meeting the requirements of contemporary construction since the criteria for site layout are increasing in severity. The result of this is that the site layout is often unable to accommodate the requirements of the building process or create a convenient environment for any future alterations. Architects have the impression that the requirements are difficult to understand and cumbersome to apply in practice when it comes to the design of energy-efficient buildings. And garden planning and design is the process of planting and creating plants to enhance an area's environment via the application of principles of garden art and engineering to the task of constructing a natural, living, and recreational space. One way to achieve this goal is by growing and creating plant life specifically for the purpose of enhancing the local environment. [2]. Using Wuhan's residential buildings as an example, we can optimize the design by adjusting the building's orientation, window-to-wall ratio, exterior wall structure, roof structure, heating temperature set point, air conditioning temperature set point, combination factor of shading factor, and window glass type in order to minimize energy consumption and costs. This should be done simultaneously [3]. In conclusion, the results of the optimization are compared with the regulations that are now in place for the design of green energy-saving buildings, and new reference values for several factors in green building design are provided.

A* is a popular algorithm for pathfinding because it is able to find the shortest path between two points efficiently and accurately. It is often used in games and other applications where it is necessary to find the best path between two points. Here are some reasons why A* might be considered a good choice for designing the layout of green spaces in a building or other environment:

A* can quickly find the shortest path between two points, which can be useful for determining the most efficient route for people to take through a green space and it can handle complex environments with obstacles and other constraints, making it well-suited to designing green spaces that have a variety of features and restrictions.

A* can be used to optimize the layout of green spaces for accessibility, ensuring that people with disabilities or mobility issues are able to easily navigate the space. It also used to optimize the layout of green spaces for environmental sustainability, for example by minimizing the number of paved surfaces or maximizing the amount of green space.

A* can be used to optimize the layout of green spaces for aesthetics, by considering the visual appeal of different paths and routes through the space. This algorithm can be used to optimize the layout of green spaces for recreational activities, by designing paths and routes that are suitable for walking, running, biking, or other activities.

A* can be used to optimize the layout of green spaces for educational purposes, by designing paths that take visitors on a tour of the space and highlight important features or landmarks. Also it used to optimize the layout of green spaces for social interaction, by designing paths that encourage people to interact with each other and the space.

2. Related Work

According to the study that has been done so far, the design of a classical garden is mostly focused on the local environment and incorporates major regional and personal features. Despite the fact that the traditional garden landscape has a relatively straightforward aesthetic, it nonetheless maintains some traits in terms of cultural legacy and incorporation [4]. Not only do many of China's well-preserved classical gardens document the progression of civilization over the course of thousands of years, but they also represent the national cultural features of various eras. This one-of-a-kind garden landscape offers a useful suggestion for advancing the progression of social development and the planning of contemporary garden landscapes. Traditional landscape architecture has been criticized for having several flaws, most of which have been brought to light as a result of the passage of time.

The conventional garden landscape has become inadequate to suit the diverse demands of people as a result of the continual developments that people have made in their knowledge of society and their thoughts about it [5, 6]. For instance, contemporary architecture necessitates that the garden landscape environment that it is paired with no longer be restricted to only inheriting history and culture, but rather it must fit people's expectations of what an ecological and natural setting should be like. As a result, the notion of traditionally designed garden landscapes has to be concurrently modernized.

In a static setting, route planning requires the robot to have some level of perception and to use local path planning algorithms in cases when the environmental information is incompletely understood. Warehouse and supply chain management are only two of the many practical uses for this kind of planning. The assessment of the shortest route in a static environment may be done with the help of A*, which uses the knowledge gathered about the barriers in that environment [7]. The assessment of the shortest route in the given static environment is a problem that has two levels. The task may be broken down into two parts: the selection of possible node pairs and the assessment of the shortest route based on the feasible node pairs that have been acquired [8]. The fact that none of the aforementioned requirements are present in a dynamic context renders the algorithm ineffective and impracticable in such settings. In this particular scenario, the technique for dynamic route planning is not appropriate for application in a setting that is considered to be static. The A* algorithm was selected since it is representative of the core algorithms used inside modern real-time route planning systems operating in a static environment. Recent discoveries are building on this algorithm in order to obtain higher levels of performance and efficiency.

According to the study that has been done so far, the design of a classical garden is mostly focused on the local environment and incorporates major regional and personal features. Despite the fact that the traditional garden landscape has a relatively straightforward aesthetic, it nonetheless maintains some traits in terms of cultural legacy and incorporation [9]. Not only do many of China's well-preserved classical gardens document the progression of civilization over the course of thousands of years, but they also represent the national cultural features of various eras. This one-of-a-kind garden landscape offers a useful suggestion for advancing the progression of social development and the planning of contemporary garden landscapes [10]. Traditional landscape architecture has been criticized for having several flaws, most of which have been brought to light as a result of the passage of time. As a direct result of the consistent growth in people's awareness of and capacity for thinking about it, the study presented above outlines the wayfinding algorithm that should be used for the most effective landscape space environment design in green buildings.

3. Difficulties With Green Building, Garden, And Landscape Planning

3.1. Disregard Cost and Environmental Safety

Ignoring price and ecological setting safety may be a haul within the designing and style of gardens and landscapes in inexperienced buildings as a result of it will result in the utilization of inappropriate or unsustainable materials and practices [11]. As an example, mistreated materials that don't seem to be domestically sourced or that have a high carbon footprint will increase the environmental impact of the garden or landscape. In addition, if the price of maintaining the garden or landscape isn't thought about, it will become a financial burden for the building owner or residents.

3.2. Insufficient local flavor and aesthetics

Lack of regional fashion and identity: Incorporating regional vogue and cultural characteristics is vital within the designing and style of gardens and landscapes in inexperienced buildings as a result of it helps to make a way of place and may contribute to the property of the project. as an example, mistreatment plants that square measure native to the region will cut back the necessity for irrigation and different resources, as they're already tailored to the native climate. In addition, incorporating cultural components, like ancient garden styles or plant species, will enhance the aesthetic of the garden or landscape and create a sense of association with the local people.

3.3. Uncertainty Regarding the Idea of Green Building

It is vital to possess a transparent understanding of the idea of inexperienced building once designing and coming up with gardens and landscapes in inexperienced buildings. Inexperienced building refers to the planning, construction, and associate degree operation of buildings in an environmentally accountable and resource-efficient manner.

4. The Steps Of The Path-finder Algorithm

It is finished; no matter what, it will always discover a solution if one is available. The procedure may be greatly sped up with the use of a heuristic. It is possible for the movement costs from node to node to vary. This makes it possible for specific nodes or pathways to be more difficult to navigate, such as when an explorer in a video game travels more slowly through rugged terrain or when an airliner takes more time to go from one location to another. If requested, it is able to search in a variety of different directions.

The node's g score is its starting point and represents the cost of traveling from the root to the current node.

g(n) = g(n.parent) + cost(n.parent,n)---------- (1)

cost(n1,n2) = the movement cost from n1 to n2 ---------------(2)

H-score: a heuristic evaluation

The heuristic provides a computationally cheap approximation of each node's distance from the target.

With the H score being computed at least once for every node examined on the path to success, it is crucial that doing so requires little in the way of processing resources. Here are some of the most frequent strategies for implementing the H score, while this metric may be implemented in a number of different ways based on the characteristics of the graph being searched.

Manhattan distance

h(n)=|n.x-goal.x|+|n.y-goal.y|———————— (3)

Diagonal distance (uniform cost):

h(n) = c·max(|n.x-goal.x|,|n.y-goal.y|)———————— (4)

here C in the cost movement.

Diagonal distance:

h(n) = c_dd_min + c_n(d_max-d_min) ———————— (5)

d_max = max(|n.x-goal.x|,|n.y-goal.y|————————(6)

d_min = min(|n.x-goal.x|,|n.y-goal.y| ———————— (7)

Euclidean distance:

h(n)=√(n.x-goal.x)^2+(n.y-goal.y)^2 ———————— (8)

h(n)^2 =(n.x-goal.x)^2+(n.y-goal.y)^2 ———————— (9)

F score:

The f score is simply the addition of g and h scores and represents the total cost of the path via the current node.

f(n) = g(n) + h(n)f(n) = g(n) + h(n) ———————— (10)

4.1. Path finding Algorithm:

I'll concentrate on A*. A* is the most used pathfinding algorithm since it's versatile. A* finds shortest paths like Dijkstra's Algorithm. A* uses a

heuristic, like Greedy Best-First-Search. It's as quick as Greedy Best-First-Search:

Combining Dijkstra's method (which gives preference to adjacent vertices) with greedy best-first-Search is the key to its success (favoring vertices that are close to the goal). The real cost of traveling from the origin to vertex n is denoted by g(n), whereas the heuristically predicted cost from vertex n to the goal is denoted by h(n). The diagrams above show far edges in yellow (h) and distant origins in teal (g). The forward movement of A* maintains a steady equilibrium between the two. The lowest f(n) = g(n) + h(n) vertex is investigated at each iteration of the main loop (n).

Here we talk about heuristics in pathfinding, including how to make them, how to use them, and how to describe maps. Some of it is finished, some of it isn't.

4.2. pseudocode for Path Finding Algorithm

```
border = PriorityQueue()
border.put(start, 0)
came_from = dict()
cost_so_far = dict()
came_from[start] = None
cost_so_far[start] = 0

while not border.empty ():
    current = border.get ()

    if current == goal:
        break

    for next in graph.neighbors (current):
        new_cost = cost_so_far [current] + graph.cost (current, next)
        if next not in cost_so_far or new_cost < cost_so_far [next]:
            cost_so_far[next] = new_cost
            priority = new_cost + heuristic (goal,  next)
            border.put(next, priority)
            came_from[next] = current
```

4.3. The Preprocessing Process of Path Finding Algorithm:

From a maze location, there are four movements (left, right, up, and down). Red squares are off-limits (like in start position only down motion is available since up and left move are blocked by the wall while for the right is a red square position thus no movement allowed). I've used code from this blog and this one. Patrick Lester's A* article has further theory and explanation.

First, build the following class and function: Class "Node" may be used to generate an object for every node with parent, location, and cost values (g, h, and f). Define a route function that returns Astart-to-End's path. The coding logic will be driven by a search function. Initialize variables (3.1). (3.2) Add the beginning node to "to visit." Avoid endless loops by defining a stop condition. Position defines movement. Repeat until all stop requirements are fulfilled. (3.3) Find the cheapest "yet-to-visit" square. This square is current. We also check the maximum iteration. (3.4) Compare the current and desired squares (meaning we have found the path). (3.5) Update the child node using the current square and four nearby squares. Ignore non-movable or "visited" items. Otherwise, make the new node's parent the existing node and adjust its location. Check all the generated child nodes. If it's not there, add it. Make this square's parent. cost of the squares f, g, and h. Whether it's on the "to visit" list, determine if this route is better using g cost. This route has a lower cost. Changing the square's parent to the current square recalculates its g and f scores. Main Program: Define maze, start, and finish. Then we'll utilize search and, if a route exists, the path function.

Now I'll go through the above-mentioned code step-by-step (refer to the bracketed number). First, we'll build a node class that has its parent, position, and three costs (g, h, and f). We initialize the node and create an equality checker.

4.4. Path-finding algorithms and energy-saving technology for sustainable landscapes:

Energy-efficient gardening plays a crucial role in both popularizing the scientific notion of development and fostering the development of landscapes that are both environmentally friendly and economical to maintain. Building an energy-efficient society, of which energy-efficient gardening is a part [12], is crucial. Site selection, zoning, orientation of buildings and roads, building orientation, building body design, building spacing, dominant directions of winter and summer monsoons, solar radiation, and other elements should all be examined in connection to the major content. An analysis of the factors that influence the local climate will be performed, and those factors will be heavily incorporated into the residential area's design and layout in order to provide a comfortable living environment and a microclimate conducive to energy saving. Nonetheless, domestic cold landscape development and building are only getting started, so haphazard growth, cultural theft, and a rush to the top are to be expected. Planting seedlings out of season, planting in unfavorable conditions, bringing in a wide variety of exotic plants, and even draining lakes to make way for gardens are all instances of such strategies. Currently [13], there are not many research or theses on the issue of ecological landscape design in cold urban populations that have been conducted in domestic settings. The design of cold urban landscapes should combine ecological design from a holistic viewpoint to enhance the livability of cold urban areas and to encourage respect for nature and the conservation of nature. Because of this, designers will be able to integrate environmental considerations into their work.

4.5. Experiment and Analysis:

Here we are using three algorithms, of which one is Dijkstra, another is BFS, and the third is the A* algorithm. Using these algorithms, we can see that some algorithms take more time and some algorithms take less time. We will discuss the comparison of these three algorithms and the data shown below.

Table 1
Time and count routed area for case 01

Case :01		Dijkstra	BFS	A*
	Length	18	18	15
	Time	1.01ms	0.4ms	0.3ms
	Operation	137	134	62
Case :02	Length	25	25	22.07
	Time	0.5ms	0.3ms	0.5ms
	Operation	220	223	67
Case: 03	Length	24	24	19.9
	Time	0.67ms	0.5ms	0.4ms
	Operation	236	110	229

Now we use three algorithms. The first is A*, second is BFS and the third is Dijkstra. We have done a comparative analysis of these three. First, we have done how many paths are required. We see that Length takes 18 for Dijkstra, 18 for BFS and 15 for A*. So in the first case we can say that A* takes the least length among the three algorithms. Similarly, for case 2 Dijkstra takes 0.01ms, BFS takes 0.4ms and A* takes 0.3ms. So here also we can say that A* takes less time among the three algorithms. Dijkstra's distance required for the operation is 137, BFS requires 134 and A* requires 62. So, comparing the three algorithms here, it can be seen that A* requires less distance to operate.

5. Conclusion

Green landscape architecture and the A* Pathfinding algorithm may both accurately depict local traditions. This not only represents a shift in the trajectory of progress, but it also helps ensure that humanity continues to advance in a sustainable manner. Reasonable green landscape planning and design may successfully emphasize the development concept of green buildings, adopt a people-oriented approach to development, and stay on the road of sustainable development, all while keeping the notion of natural ecology at the forefront of the design process. This exemplifies the core principle of development that it is possible for people and their built environments to live in peace and harmony.

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Graph

Graph 1. Time and count routed area for case 01

Figures

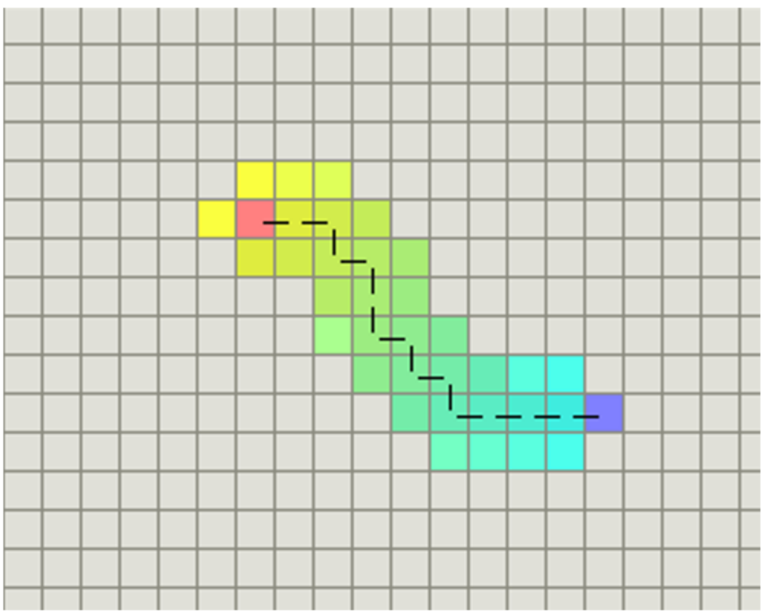

Figure 1

Path Finding

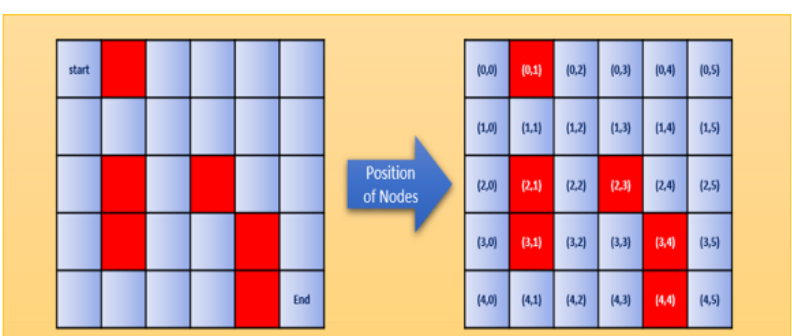

Figure 2

Optimize site planning

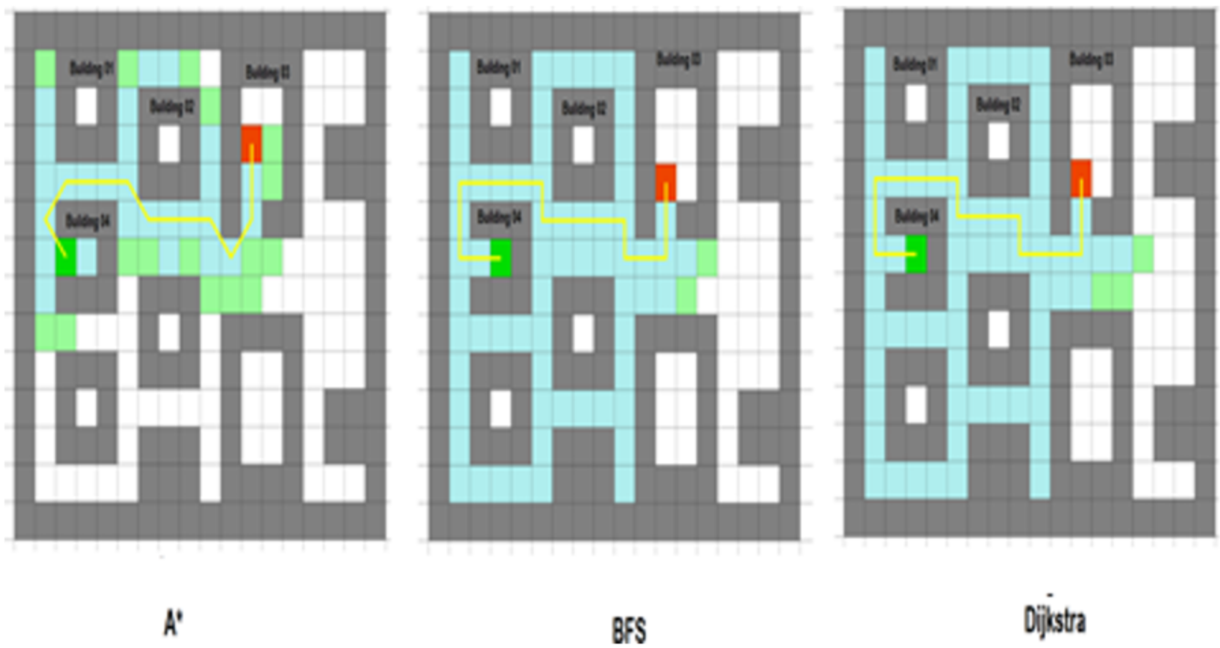

Figure 3

Time and count routed area for case 01

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- soducode.txt
- Graph1.png