Independent Study: Route Planning

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Abstract. An application is developed that helps the user in visualizing the shortest path he/she needs to travel to reach from one point of interest in a building to the other point. The choice of development engine is Unity 3D version 5.4.2[3].
Keywords: 3D, Route Planning, Shortest path.

1 Discussing the input format

- The 3D model of the building can be downloaded into the application as Assetbundles. An assetbundle of the 3D model has to be created adding high level details (Points of Interests and Hidden Interests) for Unity to work on it (more details on it is provided in the project's github repository readme). When 3D model is imported the tool will help the user in visualizing shortest paths in the imported building.
- 'Points of interests' and 'Hidden interests' in the building serve as the vertices in the graph.
- 'Points of interests' are the doors of rooms in the building that a user can go to and 'Hidden interests' are locations where a diversion can be taken in the building.
- An edge in the graph means that a straight line can be drawn between the vertices.

2 Prototyping

The application will work correctly for any model of building with some tweaking (tweaking by- developing the assetbundle of the 3D model with Points of Interests and Hidden Interests at well defined locations). The prototype is made on a default OurBuilding and the 3D model is developed using the ProBuilder asset from the Unity Asset store.

[3] www.unity3d.com

3 Open source, demo and tutorial links

1. Github: https://github.com/raghibrm/Walkin
2. Demo: https://drive.google.com/open?id=0B7-5956pGxPVd3dMdVZ1SDZLVEk
3. Basic Tutorial on adding points of interests and hidden interests:
https://drive.google.com/open?id=0B7-5956pGxPVSHlwVGpfQ0ZmT2s

4 Work Progress

1. 24 Jan- Used ProBuilder asset from Unity Asset store for fast prototyping of OurBuilding. Started with developing prototype for third floor. Also added provision for manually moving on the floor using keyboard controls.
2. 31 Jan- Added the option for the user to manually change the speed for manually navigating on the floor. Also added the provision for relocation of user position to any position in the building according to the point he wishes to go to. Furthermore made updates to the third floor design of OurBuilding adding 'Points of Interests' too. Stairs have been designed.
3. 14 Feb- Stairs have been modified adding proper slope for user to walk on it. Started learning Physics Raycast system to analyse and store edges between the vertices in the building.
4. 21 Feb- All the edges are properly retrieved from the graph generated from the vertices. Used Physics Raycast system for the same.
5. 28 Feb- Implemented Priority queue and Djisktra algorithm. The user can walk in the building properly. However there are few bugs to be fixed for the navigation.
6. 7 May- Removed Pro Builder advanced and imported Pro Builder Basic because the advanced version wasn't properly compatible with the unity version being used for development. Transported work from the old one to the new. Fixed many bugs in the 3d model of the building. Fixed many other bugs, like gameobjects for vertices weren't acting expectedly for raycasting.
7. 14 May- The navigation is fully functional and bug-free. One can walk from any desired point of interest to the other. Edited the building model, having correct room number being displayed in front of each room and having respective Point of Interest vertices for them. Also added Hidden interest vertices wherever needed.
8. 28 May- Learnt using creating Assetbundles of a 3D model. The 3D models of building would be saved as assetbundle which would be uploaded and used in the application.
9. 5 April- Implemented caching of Assetbundles. The idea is to not download the 3D model again which is already used before, just get it from the cache. By default unity has 4GB of cache which is updated according to LRU technique.
10. 12 April- Completed adding the provision of allowing users to upload their own building's 3D model.

5 Discussions

1. 21 Jan 2017: Discussed about points of interests and hidden vertices, how both of them are useful for getting the shortest path. We cannot neglect hidden points as we need them to take diversions ie moving left or right in the building.
2. 2 Feb 17: The shortest path from one point to another point in the same level (floor) can be done using Djikstra. For shortest path from a point in the building in a level to another point in some other level has two parts to solve:
   i): The shortest path from the point to the staircase, escalator or lift.
   ii): The shortest path along the staircase, lift or escalator to reach from the previous level to the next level so as to reach the level the destination is in.
   iii) which is similar to i): The shortest path from the level, escalator or lift to the destination point.
   Also we need to note that the shortest route concerning to travelling through the escalator, lift as well as staircase can be different in case of all the three.
3. 25 Feb 17: As the project helps user in visualizing the path he needs to walk, helping him know the distance he needs to cover in meters can be a good addition too. For this building can be designed taking care of proper scaling. To help user visualize the path properly, bird view display can be shown too to locate him in a 2D view as well.
4. 19 April 17: Feedback of the work was collected by evaluation of the work done by Shivram Dubey sir and Odelu sir along with the supervisor, Ramakrishna sir. There were a few points made by them. The application helped the user in changing their location to any point of interest. But the orientation of the change of point wasn't that appealing. The user could manually walk but the app should tell them that there is a wall in front, or not let them cross a particular threshold distance from a wall, as pointed by Odelu sir. Since the application is for 3D, the user may not get understand the clear picture, on how many floors they really walked down, or miss some other high level details. A low level visualization (visualization in 2D too, alongwith the 3d visualization) simultaneously would help.

6 Criticism

The application is less helpful for user to grasp the path when the path is long and takes a number of turns. In fact 2D visualization does a better job here, however the same application can be far more intuitive than just a 2D one when it includes a layered 2D visualization at the same time too. It will be very useful for the user in that setting.

7 Other existing works on the subject

Some existing works have been done 2D setting. One such outstanding work is Google's Indoor Atlas: https://www.google.co.in/maps/about/partners/indoormaps/

It is available for Android, MAC and PC as well. With indoor Google Maps, visitors can spend less time searching for building directories and more time discovering new points of interest. Simply zoom in and out of a building and go floor to floor with indoor maps.
However Google's Indoor Atlas is purely 2D and is not close to what we tried to do. There is an another outstanding work on the subject done by the 'navvis'. It helps visualization in 3D setting. And it also shows a layered 2D visualization of the same. Refer to: http://www.navvis.com/products/indoorviewer/ and watch the demo below at the end of the page. You need to have webgl supported in your browser to check out this. However we note that we don't have 3D building there, all we have are images, and we are zooming in and out of on the images. The limits of work done by navvis is that they can't give the user a sense of walking since it is not a 3D model but images which has to load zooming everytime.

8 Future Works

We understand the limits of work done by navvis and this independent project and a tool can be developed that checks both. Walking inside a building and get the feeling of walking in shortest path (navvis isn't good at it since they use images) and getting layered 2D visualization of the same (not done in this independent project).
Further extension of the project can be of much more use. We can get the location of the user using their gps (hint for development: latitude and longitude mapped to coordinates of the 3D building) and using their present location we can help them walk according to the shortest distance.