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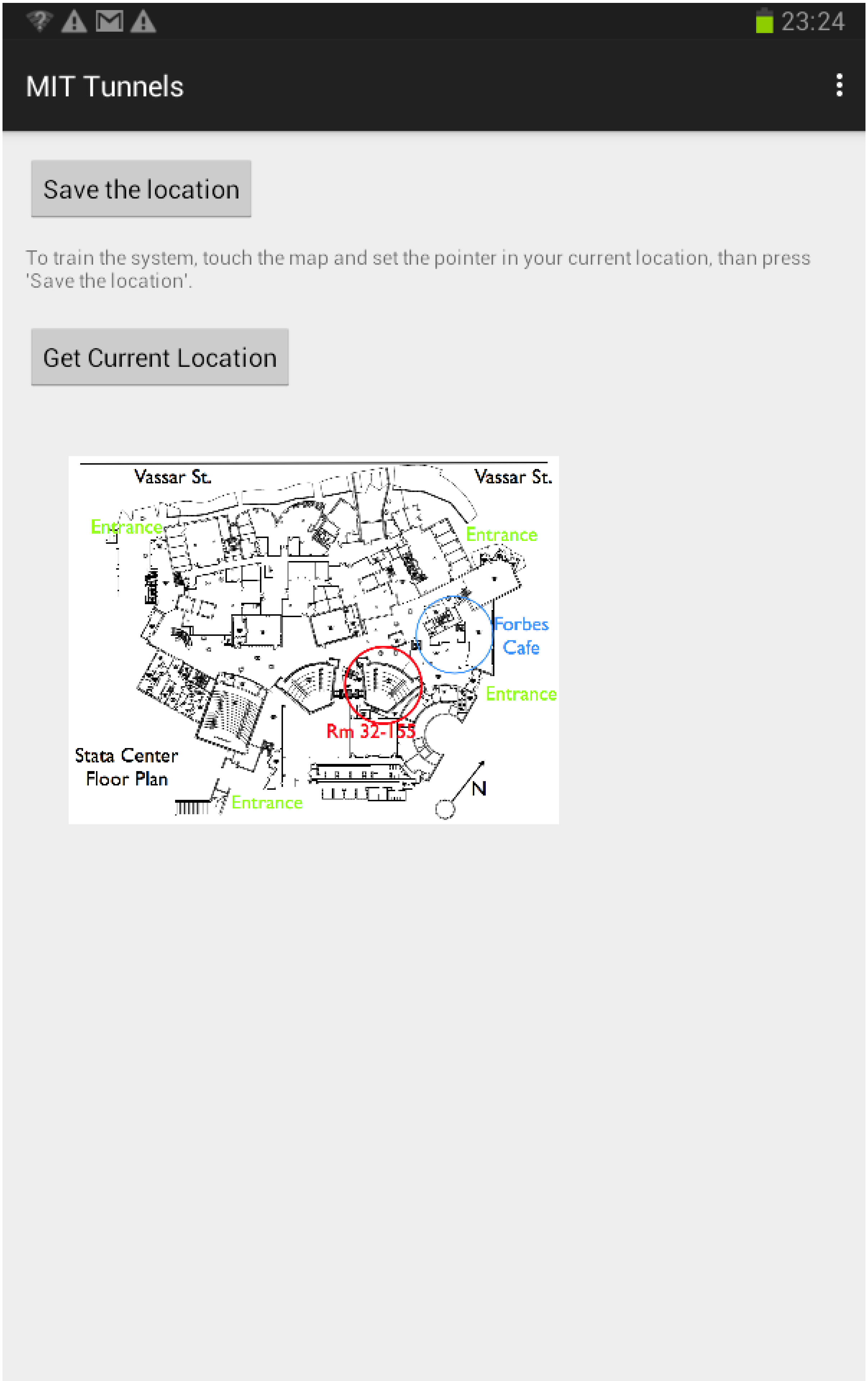
As we explained in the project proposal, the aim of our project is to implement a basic WiFi localization system for navigating the MIT campus. We believe this would be something useful to have for the main floor of buildings given how many confused tourists walk around every day. As far as people who are familiar with MIT, we believe our system could help them navigate through the tunnels faster. Note that GPS can not be used to locate yourself underneath the buildings, but there are enough access points to enable localization with our method.

Recall that we saw our project evolving in 4 stages, namely (1) an offline phase that involves creating a database of the MAC addresses and the locations of the different access points on the ground floor of few buildings of the MIT campus (or something similar to this). (2) at testing time, find the MAC address of the WiFi access points within range, and pull them out from the database. (3) write a localization algorithm that gives you a rough location estimate based on the WiFi access points detected. (4) write a GUI that would display your location on the floor map.

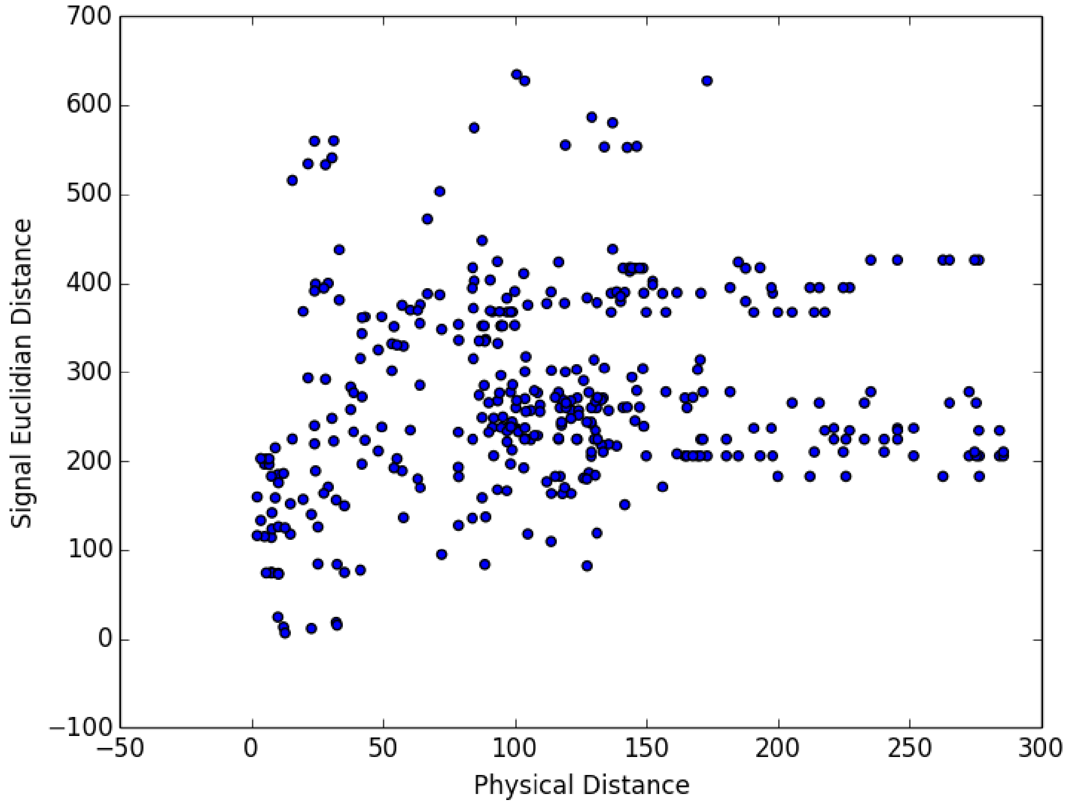
For the initial exploration of our project, we built a small database containing the MAC addresses/signal strength and locations of different points on the first floor of the Stata Center. The main problem we ran into was getting a good estimate of the exact physical location of the point for which we were storing the MAC addresses. To solve this, we created an app that displays a map of Stata, enables the user to click on a point on the map and save to the Cloud the location of that point in x,y coordinates based on the pixels of the image. Please find attached below a picture of how this interface looks like:


23:24
MIT Tunnels
Save the location
To train the system, touch the map and set the pointer in your current location, than press 'Save the location'.
Get Current Location
Vassar St.
Vassar St.
Entrance
Entrance
Forbes Cafe
Entrance
Rm 32-155
Stata Center Floor Plan
N
Entrance

For the future steps of our project we expect to enhance the quality of the map and add multiple buildings. For part (4) of the steps described above, we plan to use this same interface and display a red dot on the most likely location on the floor map. We need to experiment more with possible algorithms for estimating location, however we tested that as long as the algorithms works, the GUI also does so. In particular, we tried a simplistic idea: if at your current location access point X has the strongest signal then display a red dot at the (x,y) location corresponding to the first point in the database who has access point X as strongest.

Our experiments were mostly aiming to test the accuracy and consistency of the type of results we could get based on our method of gathering data. Using our app we collected data on 22 locations around the first floor of Stata, including points physically close and far, and with different orientations of the Android device. Initial observation suggests that there is significant noise in the signal strengths received by the Android device; however, moving a few meters away has a stronger impact than the noise observed. We have not checked this against the android phone being held in different orientations at the same location. Knowing whether we have a larger signal than noise is critical to the success of the project.

After that we took the data points and plotted the physical distance against the euclidian distance in the space of the signal strengths over the MAC addresses. If there was a strong correlation here, it would tell us that different physical locations have points in the signal space that are separated by a comparable amount. The results are given in the figure below:



As we can see, there is a difference; however, we do not have the strong correlation we had hoped for. This doesn’t rule out a separator or mean the project is infeasible, we will just need to examine more sophisticated methods. For example, we currently don't’ directly take into account the presence or absence of AP’s. We also don’t attempt to correct for the orientation of the phone, which could be a significant source of noise. It’s also possible that the L2-Norm is not appropriate measure here, perhaps we should be looking at L1 or examining the actual signal strength rather than decibels. Finally, we haven’t characterized the variance of the noise in our system. It’s possible taking more samples will help cut down on the noise observed. Code and gathered data are available upon request.

Our next step here will be to try to better characterize the noise in our system and their causes. We will then investigate mitigation techniques and more sophisticated algorithms for location detection.

Our next major step, from the software standpoint, is getting better, more detailed maps of the buildings at MIT. This might involve both trying to look more for better quality maps online and scaling up + adding more details to the existing ones by hand. We would also want to add in the option of zooming in/out on the pictures; this would enhance the accuracy of the collected data too. Once we decide on the maps we can go ahead with a second stage and collect a lot of data to map the MIT floor plan. Finally we plan to implement a few ideas about how to generate the location based on the dataset, for a set of MAC addresses+signal strength that you observe at some unknown physical point (x,y).