Naksha - Indoor Navigation App

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Abstract

Indoor positioning systems help in the localization of objects or spaces inside a building, where Global Positioning System (GPS) and cellular network don't work effectively. We have lot of outdoor navigation applications already in use which help us when lost in the outdoor places. But there are times when we get lost inside big spaces/buildings like airports, malls, etc. Hence, there is a need for indoor navigation applications (apps) and there are only a limited of them in use today with limited features. This paper demonstrates, with prototypes (paper and digital) and describes our application, Naksha an indoor navigation app developed by our team, right from target user interviews to an interactive high-fidelity prototype and its evaluation.

Keywords: Indoor positioning systems, Indoor navigation apps, Naksha, prototypes

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1. Introduction

Indoor Positioning refers to locating objects or spaces inside a building. Global Positioning System (GPS) does not work accurately indoors due to signal attenuation and reflection caused by roofs and walls [1]. Today, there are a lot of outdoor navigation apps like Google maps, and phone specific map applications, Buzzclip, Blindsquare etc helping us get through any kind of unknown location, but we can also get lost inside big spaces/building like airports, museums, malls, etc and there are only few indoor navigation apps like Google Indoor Maps, Infsoft, etc with limited features.

User experience is critical in indoor navigation systems. There is a need for some clear visual indicators to create an appealing and a convenient experience for the users of such indoor navigation systems. We tried to build an indoor navigation app, Naksha using cues from existing applications and improved its features gradually with feedback received.

In this paper, we discussed on building our app, Naksha, from low-fidelity prototype (paper) to high-fidelity prototype (digital), right from target user interviews to an interactive one and its evaluation. The Literature Review section gives an overview of the various technologies used in indoor positioning systems and the existing landscape (key players) in this market. It is followed by describing our app, Naksha, with the first step, *Low-Fidelity prototype* – Paper prototype, which is basic prototype drawn manually on paper, followed by its feedback through face-face interview and evaluation. The next section describes the *High-Fidelity prototype-Digital prototype*, which is the digital interface of the app on the mobile phone, followed by its feedback and evaluation. Then the *Future work* and *Conclusion* section which summarizes the paper and briefly discusses possible future work in this area.

2. Literature Review

2.1. Technology

An overview of some of the most popular technologies used in Indoor Positioning Systems – WiFi, Bluetooth, Global Positioning System (GPS) and Ultra-Wideband (UWB) are discussed in this section.

WiFi

WiFi is the most commonly used technology for indoor positioning. Most of the current smart phones, laptops and other portable user devices are WiFi enabled, which makes it an ideal candidate for indoor localization and one of the most widely studied localization technologies in the literature [2]. Since existing WiFi access points can be also used as reference points for signal collection, basic localization systems can be built without the need for additional infrastructure.

Bluetooth:

Bluetooth is a wireless technology standard used for exchanging data over short distances. It uses radio waves in the range of 2.4 to 2.483 GHz [3]. Using Bluetooth is highly secure, cost effective and low in power consumption [3], but it works over short distances only. Hence a large number of receivers are required to cover a wide area.

GPS

The Global Positioning System (GPS), is a satellite-based radio navigation system, more suitable for positioning outdoors. It does not work well in a relatively closed environment due to signal attenuation. GPS-enabled smartphones are typically accurate to within a 4.9 m (16 ft.)

radius under open sky, and their accuracy worsens near buildings, bridges, and trees. Reflections across different indoor surfaces further reduce the signal accuracy [4].

Ultra-Wideband (UWB):

This technology has been primarily used for short-range communication systems, such as PC peripherals, and other indoor applications. It is immune to interference from other signals, and hence an attractive technology for indoor localization. In UWB, ultra short-pulses with time period of 500MHz, in the frequency range from 3.1 to 10.6GHz, results in reduced power consumption. Moreover, the very short duration of UWB pulses make them less sensitive to multipath effects and hence has been shown to achieve localization accuracy up to 10 cm [5].

2.2. Industry Landscape

We studied few prominent indoor navigation systems such as Infsoft and Google Indoor Maps and below are few details of them.

Infsoft

Infsoft offers indoor navigation and indoor positioning systems for various industries. It uses Bluetooth beacons for indoor positioning or set up the indoor positioning system with Wi-Fi. Furthermore, it realizes high-precision solutions based on Ultra-wideband (UWB). It has a special hardware for indoor tracking – the infsoft Locator Nodes and infsoft Locator Tags – which helps to find assets and people in buildings in real time.

Fig 1.1 :InfSoft UI

Google Indoor Maps

Google Indoor Maps have been activated for over 10,000 floor plans throughout the world [6]. With indoor Google Maps, visitors can spend less time searching for building directories and more time discovering new points of interest. These indoor spaces include airports, malls, museums etc. Its indoor navigation algorithm is based on Wi-Fi access points and mobile towers to determine user's location [5].

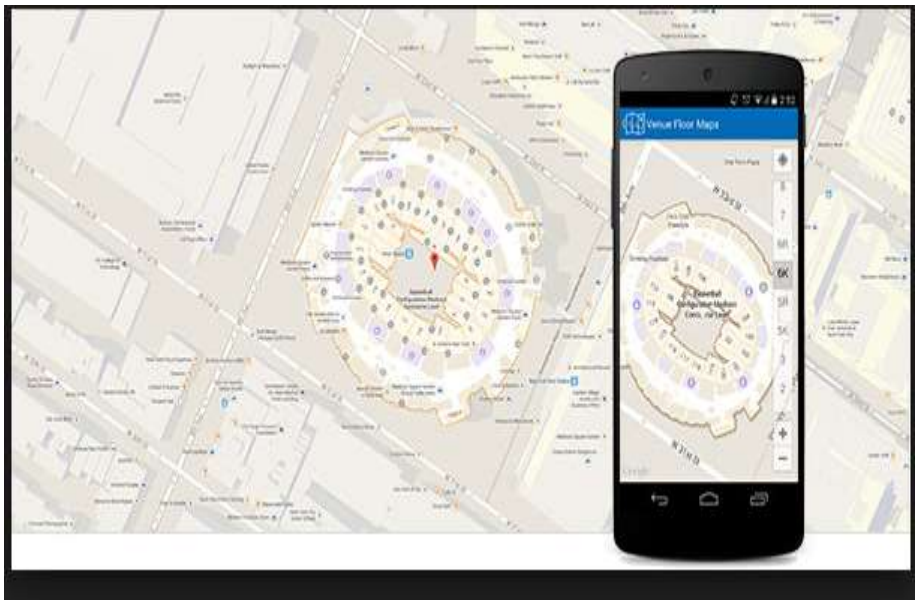

Fig 1.2 Google Indoor Maps

3. Low-Fidelity Prototype – Paper Prototype

In our application development, Naksha, the first step is creating a low-fidelity prototype, for which we used paper-based prototype using sketches. Low fidelity prototype is crucial as it helps in giving the user an overview of how the design works, early visualisation of the system and also helps in detecting and fixing the design features, functional issues of the system in early stages of development. The goal of using low-fidelity prototype is to build a basic model of our system and use it as a base for building digital system, to add features and improve the design.

We used paper prototype for the low-fidelity design of the application as it is easy to create, effective and cheap. We can also make last minute changes in this prototype without incurring extra costs.

Below are the step by step description and screenshots of the paper prototype of our Indoor navigation app, Naksha.

1. The first sight of the app, when clicked on the mobile, asks for logging in or to sign up to open the application

Fig 2.1: paper prototype 1

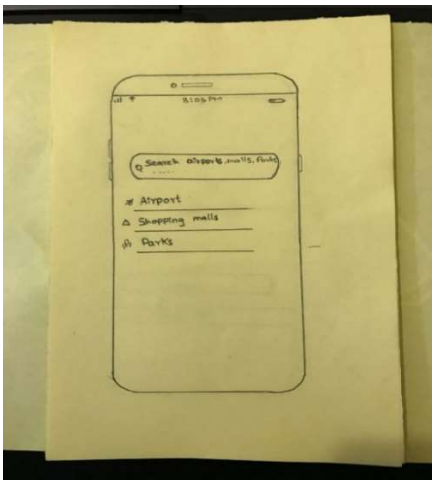

Fig 2.2: paper prototype 2

2. When logged in, a page appears asking for, where to navigate. You can either search the name in the search bar or click on the options provided like Airports, Shopping Malls, Parking.

3. When clicked on one of the option, the respective page gets opened. Here when clicked on Airports, it asks for the destination address too be entered when from the current location. We have different options for mode of navigation.

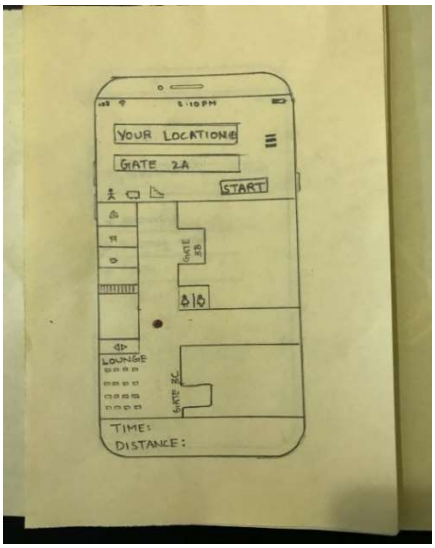

Fig 2.3: paper prototype 3

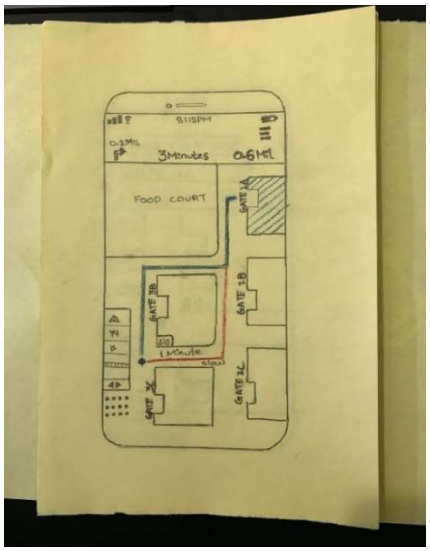

Fig 2.4. Paper prototype 4

4. The destination address is given as Gate 2B, and clicked on START button in step 3, and then the navigation starts from current location to the destination location as shown in the below screenshot in the next page.

5. The below screenshot shows different other features/options of the app.

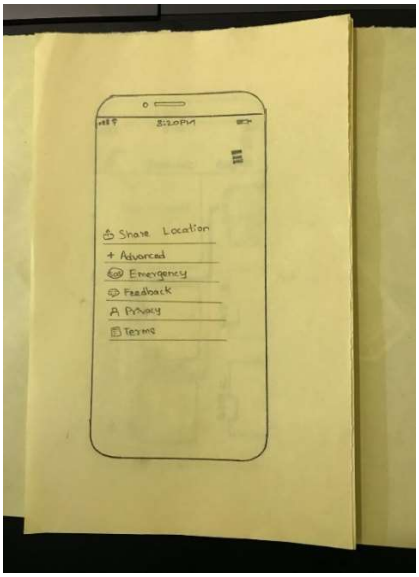

Fig 2.5. Paper prototype 5

3.1. Model Evaluation

For this paper prototype model created, we considered two different approaches to evaluate – Face-to-Face evaluation and a Remote evaluation.

3.1.1. Face-to-Face Evaluation

In Face-to -Face evaluation, an interview was done with few participants and collected their response. Below are few questions that were asked to them.

- Did you ever used an Indoor navigation app on your mobile? If so, which one?
- Is the paper prototype of the app easy to understand?
- Is the navigation flow understandable?

- How much do you rate the paper prototype model in a scale of 1-5, 1 being poor and 5 being extremely good?
- Do you like to add any feature/option to the design?

From the response of the interviewees to the questions asked, the model was evaluated and resulted in few recommendations to the app regarding the graphical interface and understandability.

3.1.2. Remote Evaluation

In remote evaluation for paper prototype we sent the video of paper prototype and online survey request to 10 students for university of Cincinnati. Survey was designed with some multiple choice users as well as descriptive questions. So that users can freely provide their feedback for our prototype.

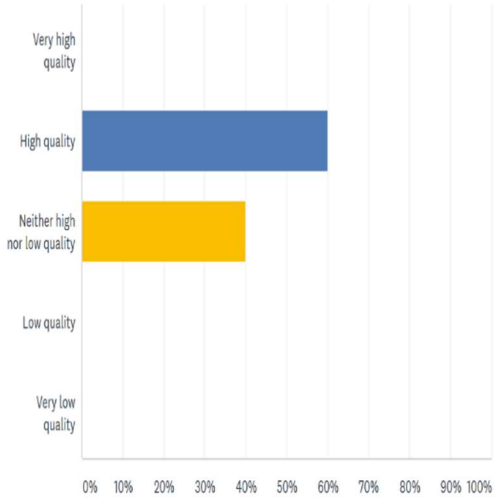

Fig 3.1: Quality of User Interface

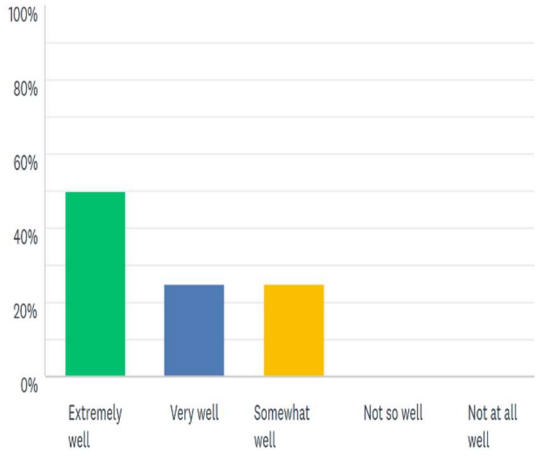

Fig 3.2: How well UI meets your needs

From the above graph, 60% of the users responded with question saying its high quality and 40% saying its neither high quality nor low quality. To verify the user satisfaction: How well UI meets your needs? From the above graph, different responses were given by different users.

4. High-Fidelity prototype – Digital Prototype

The next step in the process of building the application is developing a High-Fidelity prototype which is the interactive prototype for the design. A digital interactive prototype is developed for the Indoor navigation app, Naksha based on the feedback given for the paper prototype model. The improvements that were made for the digital prototype are listed below:

- A logo for the navigation app, Naksha is been introduced.
- A back button on the top of the screen is been introduced
- Some extra features with decent UI components are introduced like Settings option in Menu.

To come up with this digital design to be interactive, we studied pre-existing navigating apps and their basic UI. Since our app is an indoor navigation system, we took help of 360 view images. The mockups are developed using **Balasmiq** tool.

The Logo used for our model may suggest that the app is targeting some audience, but the word used in the logo simply means “map” in Hindi. The arrow above the word is a symbol of navigation which represents the functionality of our application.

We faced few challenges while working with mockups. The digital prototype was designed in two phases. In first phase, we implemented basic User Interface and full-filled the user’s recommendations given from the paper prototype survey. After first phase, some usability

tests were carried out from which we improved the design further. For example, the background, when user enters destination, it was dark before and it was suggested to make it same as of home page. Also, the sign-out feature was totally missing from the design, which was later introduced.

The diagram below shows the flow design of our product and the link to this video is: *https://youtu.be/BUi6h2wrR2c*

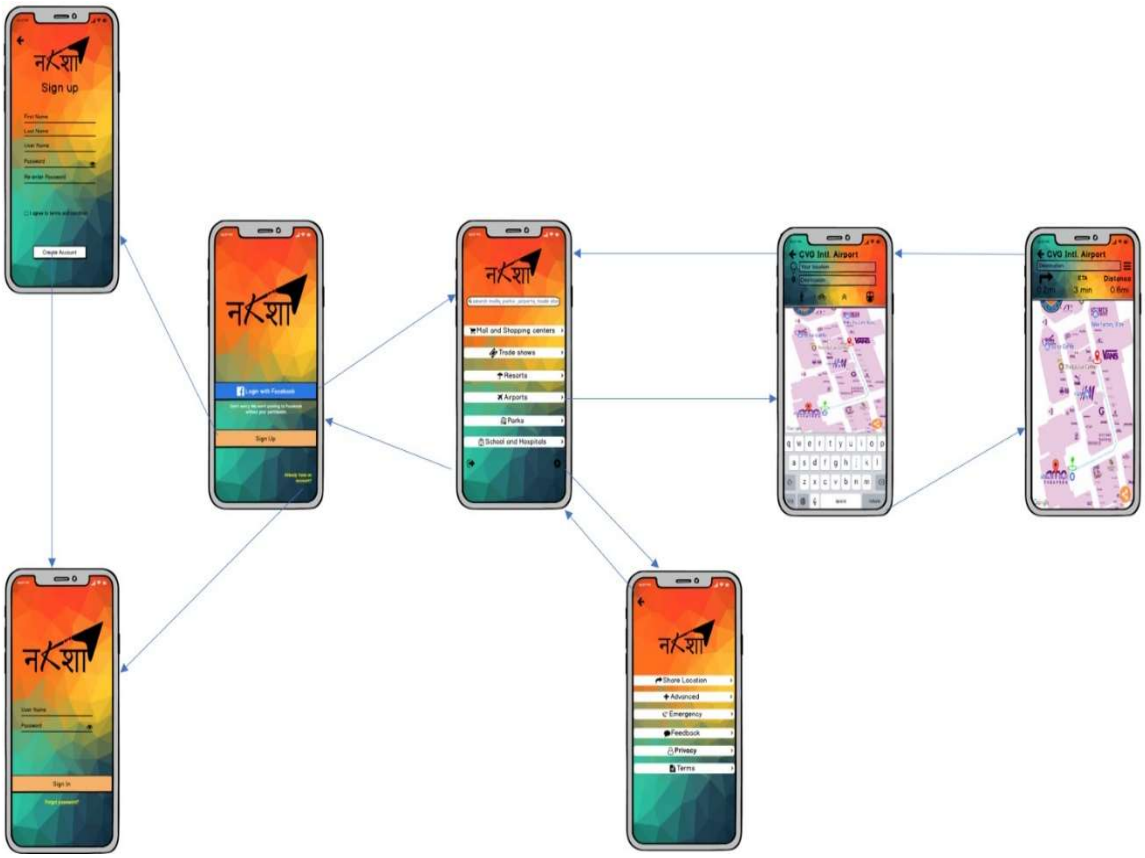

Fig 4.1 Design flow of digital prototype of Indoor navigation app, Naksha

4.1. Model Evaluation

For this Digital prototype, the interactive design developed also, we again considered the same two different approaches to evaluate – Face-to-Face evaluation and a Remote evaluation.

4.1.1. Face-to-Face Evaluation

In Face-to -Face evaluation, an interview was done with few participants and collected their response. Below are few questions that were asked to potential users and the response of the interviewees is collected for the model evaluation.

- What kind of smart phone do you use?
- How do you rate this application based on the experience of using it?
- Is the Indoor navigation app designed easy to use?
- Do you have any experience of using the similar application? Can you tell the name of it?
- Did the Indoor navigation app help solve your problem/achieve your goal?
- How much would you pay for this app, given a full version?
- What function/feature of the app is the most important one to you?
- Which features of this app are least and most useful?
- Any feature that you want to add in the app?

4.1.2. Remote Evaluation

In remote evaluation, both paper prototype and digital prototype was evaluated with the help of online surveys. We used the results of paper prototype survey to improve our next model, which is digital prototype. For conducting survey, we randomly choose students from university of Cincinnati and we asked set of 10 questions to each of the user.

Some sample questions we asked users are:

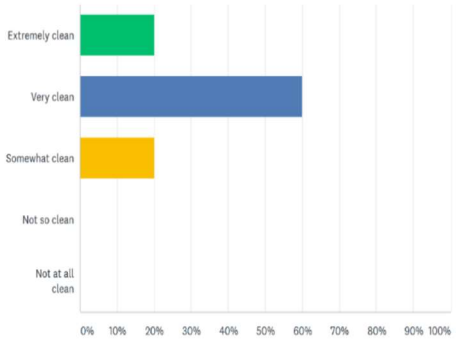

Fig 5.1: How clean and easy was UI design

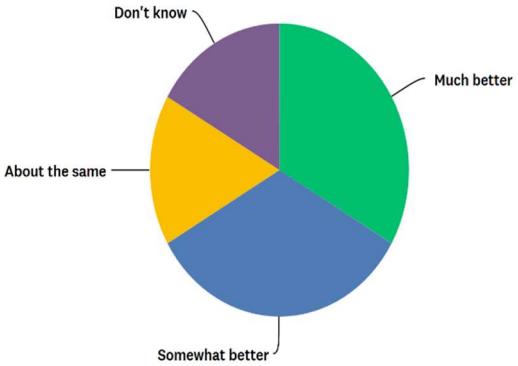

Fig 5.2: Quality of UI design

We also asked users about quality of our UI design as compared to our competitors and we got following results. From thses results we could say that many people liked our idea and UI design still there were many recommendations for adding and removing certain features. For example, there was demand of interactive logo, where logo can act as a link for pages.

5. Observations from Model Evaluation

From the model evaluations of both paper and digital prototypes, below are few important observations.

Face-to-Face Interview

- We found that while conducting face to face interview, we can easily engage user into performing tasks.
- There is always a factor of looking good, hence users did not find much faults in the system rather they suggested improvements. We also found that the Users are more hesitant to offer opinions - feed off of moderator's energy

Remote – Online Survey

- While conducting the remote UI evaluation, we selected survey method. We found that user was not interested in going though entire documentation and provide feedback, also we cannot verify if user has gone through the content or not hence it is harder to build a relationship with user over web.
- We got many responses with lot of interesting ideas. Users in a more comfortable environment offer opinion more freely.

Conclusion and Future work

Upon building the application Naksha, and doing the model evaluation, the design imposes several challenges for the future design which includes, Mobile/web consistency, where design interfaces with the same icons/layout has to be improved for user efficiency. Also, the icons in the interactive application, must be improved so that it conveys a clearer message of their function. Improving layout and placement of the Menu option is another challenge that must be addressed so that users are more aware of it and also the Nearby feature has to provide updated information pages of places with more user reviews to gain user trust of the feature.

The design application, Naksha has to be improved in terms of its features and layout. From the final model evaluation, issues identified in both remote and face-to-face evaluation in both the prototypes, paper and digital appeared consistent and users were more familiar with the mobile interface, but yet, a demand for web interface was identified. The operating features within Naksha maps was challenging for most users of all experience levels. Naksha app can be made more efficient by including additional features and it is completely generic and can be tuned to work with any indoor space such as malls, museums, airports etc.

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