

MICHIGAN STATE UNIVERSITY

iNODE and iDOCENT Design Issues

Product Lifecycle Management, Universal Design,
and Product Liability/Standards

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Introduction

The iDOCENT phone application and iNODE hardware supplement work together to create reliable Wi-Fi based indoor navigation. The iDOCENT phone application, currently on Android's OS platform, triangulates user location based on Wi-Fi access points and standalone iNODEs. These iNODEs are easy to implement and are able to be put in areas with low or no Wi-Fi signal strength to enhance iDOCENT's navigation accuracy and building coverage. The iDOCENT application downloads the iNODE and current access point's location and transmitting information from a database, which is held on a server application to perform its triangulation.

Buildings and different areas that were once subjected to paper maps for directions can integrate iDOCENT and iNODE to create easy navigation for people who may be unfamiliar with the respective building or area. This application of iDOCENT can provide routes through out an area and can even provide navigation to blind users using its user-friendly menus that provide vocal feedback.

This paper will examine some key design issues that come with the mass production of iNODEs and mass distribution of the iDOCENT application.

Product Lifecycle Management

The Product Lifecycle Management (PLM) is a process of managing and guiding a product from the early conceptual stages of development, through design and manufacturing, to the point of retirement. To achieve this management, PLM is broken down into the following stages: design , production , distribution, consumption and retirement. For the most efficient management of the iNODE and iDOCENT product, all stages of the PLM were carefully considered, but the most crucial and relevant to our specific products were design, production and retirement.

Design

The beginning of the concept creation process for our design started with a major design issue in choosing the best radio frequency (RF) technology that the iNODE would transmit for our navigation application, iDOCENT. The first step in choosing the best RF technology was to understand the limitations that the average smart phone has in detecting RF signals and the ability to utilize the given sensors within the application. These limitations brought the decision down to three main RF technologies: Bluetooth, Wi-Fi and 3G. From these three options it was determined that the three most important criteria in the decision making process were the reliability of the signal, the ease of use and overall cost to implement. Other contributing factors involved were the range of detecting the signal with the average smart phone and the ease of implementing within the application.

Bluetooth technology is very common and readily available for use in smart phone applications, but was decided not to be a viable option because of drawbacks such as very limited range compared to the other RF technologies, pairing that led to ease of use issues and a very low number of users being able to connect to the same module at once compared to the other technologies. The cellular network, specifically the 3G signal was also not a viable option because its drawbacks were that the service is not free, the signal is not as reliable as Wi-Fi and Bluetooth indoors and the cost of implementing a hardware module would be substantially larger than Wi-Fi or Bluetooth. Wi-Fi was chosen because virtually all smart phones today are Wi-Fi capable, users can use public Wi-Fi with no additional costs, it is the most reliable signal indoors and it is easy to utilize within the application code.

Given the decision to use Wi-Fi as the RF technology, It will be important to research the best Wi-Fi chip producers for lowest cost and best power consumption efficiency before mass production. Research in other RF technologies that are becoming more popular (such as Zigbee, MiFi or 4G LTE) is also necessary to make sure that Wi-Fi remains the best option.

Production

The cost of production, as mentioned above, is a very important criteria for the iNODE. This is because the iNODE would be in direct competition with other wireless routers or access points that could also potentially expand the use of iDOCENT application to areas with low or no Wi-Fi signal strength. For the iNODE to be more cost efficient than a wireless router or access point, it will take advantage of the fact that it does not need to supply the means to communicate large pieces of information. The hardware will just need to be recognizable by the phone and operate at a constant transmission frequency. All routing capabilities and extra software or operating systems are not needed with the iNODE, and will help keep the costs much lower than a typical wireless router. The amount of power needed to supply the iNODE will be significantly less than a traditional router for these same reasons, and cheaper or more efficient ways to supply this power will be constantly in research.

The majority of customers of the iNODE hardware are speculated to be organizations with large buildings or areas that will need large numbers of the hardware unit. This will also allow for an advantage in manufacturing costs of the iNODE as large orders would be common. It will be important to produce the iNODE in large quantities whenever possible, and to be involved in the outfitting of iNODES to ensure enough are ordered for each building to eliminate the need of smaller orders due to mistakes in planning.

Retirement

The Android operating system along with all smart phone operating systems, development options for application writers and smart phones themselves are constantly updating and adding new features. These updates would require careful monitoring of possible improvements for the iDOCENT application, and may call for an update in the application version and retirement of the previous version. One particular example of this would be the continuous upgrades of the voice recognition software. Once this feature becomes more accurate and usable, the universality of iDOCENT would benefit greatly to have this feature. The user would be able to give commands to iDOCENT with their voice for room selection, as opposed to navigating the menus through the graphical user interface. Another example of

where upgrades would be necessary is keeping up with the recent trend in the tablet market. Applications are commonly updated to run efficiently and take advantage of the features found on new tablets and not necessarily on phones. These updates can include the need to take advantage of larger/different screen sizes or greater processing power.

Buildings also change over time with new construction and room add-ons. One of iNODE and iDOCENT's speculated customers would be universities, where new buildings and construction would be a constant factor. This would mean an ongoing relationship with customers would be needed for instances where more iNODEs are required for navigation within the add-ons or new buildings. Maintenance of the server would also be an important factor in times of construction and destruction. If a building no longer exists, valuable server space would be freed up by deleting data bases for the specific building. The possibility of a "buy back" program or transfer program would also be looked at, as iNODEs could be reused in other buildings for cases of building demolition or buildings no longer in use.

Universal Design

Three main areas are key to the iDOCENT's and iNODE's ability to be universal. First, and most importantly is the user who will be able to access the application. The main goal of this project is to not just provide navigation but to be pleasing to all types of users whether handicapped or not. In this way blind users will be able to use iDOCENT and be able to navigate buildings with ease. As mentioned in the above section, newer features like voice recognition are planned to be implemented within the application to continually add to the ease of use. The second main area is the operating system platform that iDOCENT will run on. Currently, iDOCENT is fully functional to the Android OS user, but is restricted to just this OS. In order to broaden iDOCENT's usability it will need to be capable of being integrated to other platforms like Apple's iOS and other OS's such as Blackberry and WebOS. This will allow for universal access to all types of users who have these qualified smart phones. Lastly, this combination of iDOCENT and iNODE will need to be able to be implemented and be able to calculate its algorithm in other buildings to provide usability in multiple buildings. To do this iNODEs will be small and compact and be able to be placed in areas of the building without access point to

substitute in for the lack of signal strength. These iNODEs and the current access points in the given building will be downloaded to a database and stored on servers for the iDOCENT application to access and receive information in performing its navigation. In all, iDOCENT is a very user-friendly device that will be able to be implement into any building for all kinds of users to access.

Product Liability and Standards

The issue of liability with the iNODE and iDOCENT application is one of major concern, which is due mainly to its market toward limited sight users. In order to reduce chances of accidents involving such users, the iNODE and iDOCENT design should follow “CEN/CENELEC Guide 6: Guidelines for standards developers to address the needs of older persons and persons with disabilities”. This means the iNODE module and iDOCENT application should not provide users with inaccurate location and instructions, and should be designed with high integrity. Furthermore, in order to prevent security breaches, all knowledge of user locations should be stored only in memory on the phone. In the iDOCENT configuration, the user location is computed by the phone and only the wireless access points and building layout information are stored on the server.

Additionally, the product is also liable for conformation to known standards. The IEEE 802.11 protocol standards for WLAN computer communication in the 2.4 GHz frequency band ensure proper communication with the iNODE and the iDOCENT application. To comply with these standards, the iNODE uses an IEEE 802.11 standardized device. The iNODE should also conform to the Federal Communications Commission (FCC) standards on the effect of emissions from radio frequency transmitters on human health. These standards include regulations on microwave radiation and non-ionizing radiation, which include concerns of thermal heat that can damage human cells, as well as other biological effects still under study. In order to comply with these standards, the iNODE module uses an FCC certified transmitter, ensuring that the human quality will not be affected.

By using the CEN/CENELEC and FCC as guidelines, liability of accidents and misuse of the iNODE and iDOCENT application can be greatly reduced and legal accusations can be prevented by including a disclaimer exempting iDOCENT and iNODEs for injuries and damages resulted from their use/misuse.

Conclusion

In order for a product to be suitable for mass production, several aspects of its design must be scrutinized, including project life cycle management, accessibility through universal design, liability of its operation, among others. In this paper, we have discussed the three aforementioned aspects in detail in relation to the iDOCENT application and the iNODE module.

The application and module's lifecycles have been broken down into sections of design, production, and retirement. Analysis of radio frequency technologies steered our design toward a Wi-Fi implementation because of its ease of use and its low cost. In line with low cost, production of the iNODE module should be executed using a minimalist perspective, using only parts that need to be produced. In terms of retirement, the iDOCENT application should be updated with new releases of the Android OS, and buildings remapped and outfitted when changes to the structure occur.

The iDOCENT application and iNODE should also maintain a universal design for accessibility by all types of users, including those with handicaps. The application should be accessible on all types of operating systems, such as Apple iOS and WebOS, and should vocalize instructions as well as receive and translate vocal instructions from the user. Furthermore, the module should be compact in size to allow for use in tight spaces throughout buildings.

Finally, due to the product's market toward handicapped users, concerns regarding liability must be thoroughly evaluated. Guidelines for design of products for handicapped users should be followed, such as "CEN/CENELEC Guide 6: Guidelines for standards developers to address the needs of older persons and persons with disabilities", and standards for FCC emissions and IEEE standards should be noted and followed.

By analyzing these design issues closely, the iDOCENT application and iNODE module can be manufactured to correct specifications for a successful product.