USING SMARTPHONES TO CATALOGUE PLANTS IN TIBURON

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Dear Professor Young:

This is my submission of the technical report assigned to us at the beginning of the term. The title of the report is “Using Smartphones to Catalogue Plants in Tiburon.” I am confident to write that I believe my report meets the required criteria.

The report is a recommendation to the Board of Directors of the neighborhood of Tiburon. It proposes a system that allows employees of the management team to access detailed information about the flora. Information about the neighborhood comes directly from my mother, an active volunteer on the Board. Other information about the tagging system comes from various technology websites and electronics journals. My goal is to inform about the technology behind the tagging system while showing how to move forward with implementing the system.

I would like to thank Kevin Pintong for agreeing to be my technical reader. His background in the Embedded Systems industry makes his opinions invaluable. With his feedback I was able to properly proofread and edit my report to make it more professional. I would like to also thank my mother for being quick to reply to my emails while collecting information.

Sincerely,

Raymond Larzelere
WRI 227, Fall 2015

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ABSTRACT

Tiburon is a condominium neighborhood in Southern California. My mom volunteers to help around the neighborhood because she is on the Disaster Preparedness Committee. She came to me with a need for a handheld system to access information about the infrastructure and plants around the neighborhood. This system would make it extremely easy for employees to manage the neighborhood from their smartphones. With this system in place, future managers would be trained quickly and without a large equipment cost.

The proposed system would use Near Field Communication tags to store identification numbers or website URLs to create a network of tags for each plant in Tiburon. With this network, a database is created to track all information about trees or infrastructure (sidewalks, balconies, pesticide schedules).

If this system was implemented it would mean that employees could use their personal smartphones to work in the system. This makes any money spent on smartphones, or service, is tax-deductible because it is needed for work.

This report will detail all criteria need for the system to increase workflow. It will look at possible obstacles to creating the system as well as shortcomings of the system. There will be a section devoted to the design of the database.

INTRODUCTION

Subject

This report is about a system of tags, read by smartphones, stored on a database for plants in a certain neighborhood. The tags are fitted with antenna that reacts with smartphones over short distance. This communication is referred to as "Near Field Communication" as opposed to Far Field with encompasses all large wave transmissions like radio or television. This report will explain how this technology works. The next section addresses where information will be stored and how.

Purpose

The purpose of this report is to inform the Board of Directors of Tiburon that this system is feasible and a good idea. With this system, even contracted workers or visiting inspectors would have any needed information while they did their jobs.

Scope

This report focuses on only a single neighborhood, Tiburon. That is because this is a custom system. Tiburon will serve as a working prototype to demonstrate that the system can work and will show results.

Plan of Development

Research is being conducted to prove that this technology is proved to be reliable and feasible. Once this is done, design can begin on the database and user interface.

ANALYZING THE SITUATION IN TIBURON

Most neighborhoods in Orange County, California have some form of intentional vegetation in their borders. Tiburon is the neighborhood where I grew up. Careful maintenance by landscapers keeps these plants looking nice and residents happy. Having professionals take care of landscape maintenance is a bonus to residents but adds another layer of complexity to managing the neighborhood as a whole. Staff members have voiced interest in a system allowing them to access information about plants and trees from their smartphone or tablet while walking around the neighborhood. Neighborhood managers need to make inspections for the Homeowners Association annually, but the system would be used daily. This report will propose a solution to fulfill this request. Throughout this report, I will include some information that was obtained by email correspondence with my mother R. Larzelere, secretary to the Tiburon Board of Directors and head of the Disaster Preparedness Committee.

Tiburon is a condominium complex that sits on 57 acres of land. Twenty-five percent of this land is planted with grass and trees (R. Larzelere, personal communication, 2015). At the present time, there is no comprehensive list of trees or plants in the neighborhood. The landscape management company keeps basic records of when staff members trim trees or spray pesticides, but the company has many clients. This leads to slow data recovery and there is no insurance that the information is accurate. Moving the data management into Tiburon's infrastructure would be much faster retrieving and more accurate. When large-scale construction happens, such as when the Cable company upgrades infrastructure or a sprinkler bank needs to be replaced, knowing tree root systems is necessary. Tree roots are extremely destructive and

pose a threat to any part of the neighborhood infrastructure, especially sidewalks. Every year, there are at least twenty locations where sidewalks are fixed or replaced in Tiburon (R. Larzelere, personal communication, 2015). With the system, keeping track of these damages gives a complete list of repairs throughout the neighborhood.

Another landscape matter to track by the system is chemical treatments. Some of the plants and trees in Tiburon require certain procedures to ensure the plants survive in an artificial setting. Normally, the management schedules pesticide treatments once a year for grass and small plants, and twice for trees (R. Larzelere, personal communication, 2015). For example, the neighborhood has decorative olive trees. These trees need to be sprayed with a chemical to make them infertile so that the trees do not fruit and attract pests. If a list of which chemicals were in use was readily available concerned individuals could make informed decisions without fear of missing part of the information. Overspraying trees can hurt the trees or even kill them.

Of 515 units in Tiburon, 435 are two-stories (R. Larzelere, personal communication, 2015). Most two-story units have a balcony overlooking one of the many grassy clearings in Tiburon (figure 1). However, due to the proximity of the ocean, the wood used in construction of the balconies rots faster than normal. The air close to the beach is more humid, but the water evaporated is from the ocean. According to Shupe, Lebow, and Ring, the three conditions for wood decay are humid environment, a temperature range from 50 to 95 degrees Fahrenheit, and of course oxygen (2008). These conditions are ideal in Southern California making rot happen faster than non-coastal cities. To make the issue even worse, the rate of decay is not consistent

throughout the neighborhood, making replacement schedules erratic and difficult. To combat the rapid decay, balconies are repaired every five years. During this repair cycle, twenty balconies are fully replaced and forty more have some form of restorative work done. Usually ten balconies need some form of emergency repairs outside the five year cycle. By including the balconies in the catalogue of information, decay can be recorded and could make scheduling for repairs entirely automated.

Figure 1. A typical condominium unit in Tiburon (StarRealEstate.com, 2014)

Definition of Criteria

This report recommends a system to put plant information into a mobile-friendly application/database that multiple people could access and edit in real time. With smartphones becoming more powerful every new generation, the data storage system must be quick enough to

keep up with the user. Mobile Internet speeds should be taken into consideration. The database design should have a “custom entry” option to encourage user ingenuity. A custom entry would be similar to a template with spaces for users to click and add fields for input or drop-down menus.With flexibility in the design, this system can be adopted by other management teams or retrofitted in the future. The ability to work without an Internet connection would be a convenient feature but it does not have to be a necessity. The system also needs the be accessible from a traditional computer or laptop. This can be achieved by simply having a website that mimics the functions of the mobile app and is connected to the same database of information. Of these criteria, the custom entry is the most important, followed by the ability to work offline. These two are of most importance because they increase workflow the most. With custom modules the system, the user imagination becomes the inhibitor instead of the technology. Without an Internet connection, work is saved on the device and uploaded later. This saves time in the field waiting for the device to find signal, or if the mobile internet speeds are too slow to complete the transmission the software can try again later.

Planning the System Design

With these criteria in place, a designing this system is merely addressing all points in this report. Tagging each tree and plant with Near Field Communication tags creates an easy-to-use inventory system and store identifying information directly on the tag for plant it represents. Near Field Communication tags have seen use in other projects that parallel this system. This year, a system was implemented that used Near Field Communication tags to automate tasks like turning all the lights in the house on or off with one tap of the smartphone for the elderly

(Spinsante & Gambi). These tags are small, inexpensive, and take no power to read. Tags specifically designed for outdoor use are readily available in bulk. A website called Tagwave has an option to purchase tags by the thousand for $0.84 each. To access the data of a desired plant, one taps the phone against the tag and the smartphone with automatically open the application. If the application is already running and open to another plant, the application will save work and display the new plant. Data stored on the server is tied to the unique, physical tag that is installed on or in close proximity to the plant. Designated tag number ranges will correspond to parts of the neighborhood.

NEAR-FIELD COMMUNICATION

Near Field Communication (NFC) allows electronic communication with tags or other NFC devices simply by being placed next to each other. The technology allows Apple Pay and Google Wallet to work at any NFC-capable store around the country. In the city of Nice, France an extensive infrastructure is already in place at local universities to use NFC for tasks such as paying for tuition to getting recommendations for books from professors (Ok, Coskun, Ozdenzci, 2011, pp. 337-338). A drawback of NFC is that relatively close distance needed to create a connection. Most systems can operate only three centimeters away with some types being able to handle ten cm (Crespo, Aguilar, Escobar, & Torres, 2012). This technology seems like the answer for creating a handheld solution. Another drawback is the limited size of the information able to be stored directly on the chip. Because of this reason, the tags will function as identification for each plant with database stored in the cloud or on a server in Tiburon.

Technology Behind NFC

The two types of NFC are active receivers and passive receivers (Ok, Coskun, Ozdenzci, 2011, p. 118). Active receivers are other systems that have an NFC module built into them, making them able to transmit information over the connection between the two systems. This is analogous to using Android Beam to exchange phone number or email with someone on introduction. The other type is passive receiving, this is one system scanning a special tag to read the information off of it. These tags have small antenna arranged in concentric circles embedded in them.

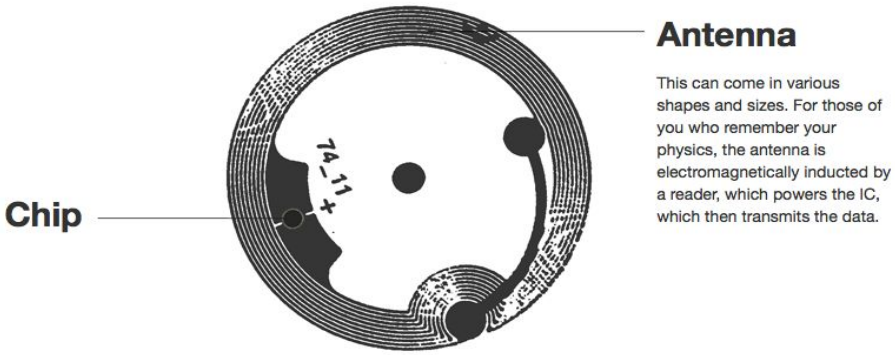

Figure 2. Exposed: The inside of a NFC tag. (tagwave.com, 2011)

The active NFC transmitter also has this coil of antenna that sends electronic pulses which resonate with the tag's antenna. As described by Ma & Jinlong E, "It works in the 13.56MHz band, with transmission a rate such as 106kb/s, 212kb/s and 424kb/s which can be chosen." (2014) This frequency resonance is enough to induce current which means the tags are powered by whatever device is reading it. This technique seemed like the perfect answer to the request.

Smartphones put a NFC reader/writer into owners' pockets. With these tags, making a database to log each tag is very simple.

Memory Constraints of Tag Types

The biggest disadvantage of NFC tags is how little information they hold. It is common for tags to only have one- to two-hundred bytes of memory, which means only ninety percent of that is usable. Being able to store large URLs and never worry about running out of tags. If it happens that there just isn't enough space to even store the URL, this project will never get off the ground. However, UNICODE characters can take anywhere from one to four bytes to store. One popular tag, the NTAG203, has 137 bytes of usable memory which converts to about 132 characters. If these 137-byte tags aren't big enough there are tags that come with over 800 bytes of memory. Another memory constraint comes from the nature of the handheld platform. Because most users will experience the website/database from their phone it would be a good idea to make the website plain with few distracting graphics.

Table I. NFC tags to consider for project

TAG NAME	MEM. SIZE	MAX URL length	NFC FORUM	COST/500 units
NTAG203	137 bytes	132 characters	Type 2	$470.00
NTAG213	137 bytes	132 characters	Type 2	$225.00
NTAG216	879 bytes	849 characters	Type 2	$445.00
Topaz 512	454 bytes	439 characters	Type 1	$500.00

information gathered from tagwave.com and tagger.ca

NFC forum type is a specification that tells developers and coders what kind of NFC Data Exchange Format, or NDEF, the tag has inside it. Type 1 chips use older but more robust data exchange practices, Type 2 have slightly more streamlined protocols because they were designed off of Type 1 (*NFC Forum Type Tags, 2009)*.

Multiple tags could fit the criteria of the system. The size of the memory chips means that more tag numbers in the number ranges. The tag names above actually the names of the chips imbedded into the tags. This means that in the event of a tag being lost, stolen, or damaged it will be easy to reorder a replacement. Without incident, tags can last up to ten years in the environment. Of the chips described, there are numerous different type of physical tags. Because of the nature of the system, these tags need to be weatherproof. Out of all the options, tags using NTAG216 are not weather proof. Confidex is an NFC tag company and they have a product called Steelwave Micro 2, a rugged plastic tag containing a NTAG203 chip. This tag can resist temperatures up to 140 degrees Fahrenheit, but is not weatherproof. The NTAG213 tags have many weatherproof choices. The website tagwave.com offers ID badges with imbedded tags. With more surface area on the tag, QR could be printed on the front making a backup for any smartphone without NFC capabilities. The last choice is a TAGGER brand tag. This tag has the Topaz 512 chip and is fully weatherproof. This tag seems the best choice for the system.

DATABASE DEVELOPMENT

Throughout this report, mention of an “application” might have raised some questions. When programmers refer to a finished, polished program it is called an application. For the proposed application, permanent information fields for most-used data with the ability to add custom modules should create a stable platform suited for natural expansion.

Speed Decision: Application or Website

Two options are available for the design of the database solution. The first option for the database is to be a mobile application with access from desktop computers. This would make accessing and editing information on the database easier than using a smartphone when a personal computer is accessible. Instead of loading the page of info with the phone’s default Internet browser, the new application would have most of the backbone of the interface saved to the smartphone. With Microsoft’s Universal Windows Platform, developing the application for smartphones means also developing for desktop. However, the initial design should be prototyped in Apcelerator. Apcelerator is generic mobile design platform which makes writing programs for multiple operating systems simple by using Javascript.

When laying out the format of the database, creativity may be stifled by using this design option. Because most of the backbone is static, creating drastically creative formats will be impossible. This can be remedied by having the user-defined modules allow deep customization,

allowing users to fill-in or choose templates. A "wizard" could be designed to guide new users through creating their first module or even advanced modules.

The second option would be to build a database purely in a website. This is not a difficult task, but it does bring some limitations when looking through the lense of mobile development. By eliminating the saved data on the phone, the time to load information of the server just got longer (figure 3). Instead of only loading which information the user wants to read, the user's phone loads all elements in that section of the database as well as the code information that tells the website browser how to display the information. Website development also limits the ways users can interact with the database. Without an application, users will spend time trying to read the data on the website instead of proving their point.

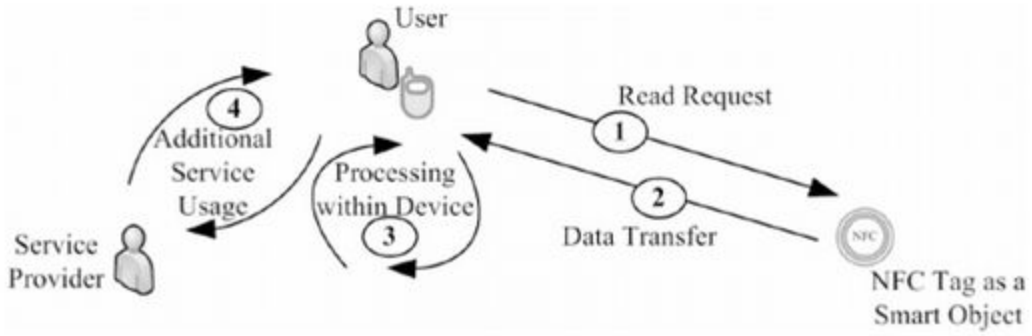

Figure 3. Loading a website after touching an NFC tag.

(Near Field Communication: from theory to practice, 2011, p. 122)

As seen in the figure, just the response process has to travel through the Internet a couple times to access the tag. If the website has to load graphics and other framework every time a tag is read it will heavily slow down the workflow this system set out to fix.

Database Features

One benefit of having the database connected to the internet is users would create an account tied to an email address, making email notifications intuitive and easy. On the database, there should be main structure of data fields that are manipulatable. These "permanent" fields would take care of the plants age or when it was planted. Using ideas of other popular applications, a "news-feed" could show which plants had been worked on up to the present. Each individual entry in the database would also track actions performed on the plant, such as the chemical treatments or last time the plant were trimmed. To make finding each tag easier, the closest condominium unit address will be included in the database. Tiburon has an extensive system of irrigation including smaller sprinkler devices for watering in individual potted plants. A sprinkler bank is the control valves and water pipes that operate the water sprayers in the area. To have a section in the database to log which sprinkler(s) is/are watering the plant would make diagnosing sick trees easier. Having an accurate mapping of sprinklers allows for an automated response for repairing the system. When it is deduced what is wrong with plant or sprinkler, a single button could be pressed by the observer to send an email repair order. (R. Larzelere, personal communication, 2015)

The highest priority feature is the modular-addition capabilities. This feature would allow any moderator of the database to add a new section for data entry and storage. Having this feature makes the system a little bit future-proof, meaning the users of the system can adapt it to meet the needs that arise out of learning and using the new system. To see a diagram of the proposed interface, refer to figure four.

This interface design makes it easy to learn by using drop-down menus and intuitive control. This page is what a user would see if they wanted to make a new entry to the database. The first field would open the smartphones built in calendar interface to make selecting a date simple and calculate the age of the plant the next time its file is accessed. The “plant type” field would be a drop down menu with options like grass, tree, bush, flower, or vine. The “specific plant name” field is used to record the plant’s name, for example, a liquid amber tree. If the plant needs additional chemical treatment the nest field is used to denote which treatment. Again calling upon the built-in calendar functions, the user can input a schedule for the routine maintenance to vegetation. Under these two fields are two more options: “Auto” and “Notify”. These options function as checkboxes and would give the user the chance to decide if they want the process to be completely automated or only notified when maintenance tasks are nearing scheduled time.

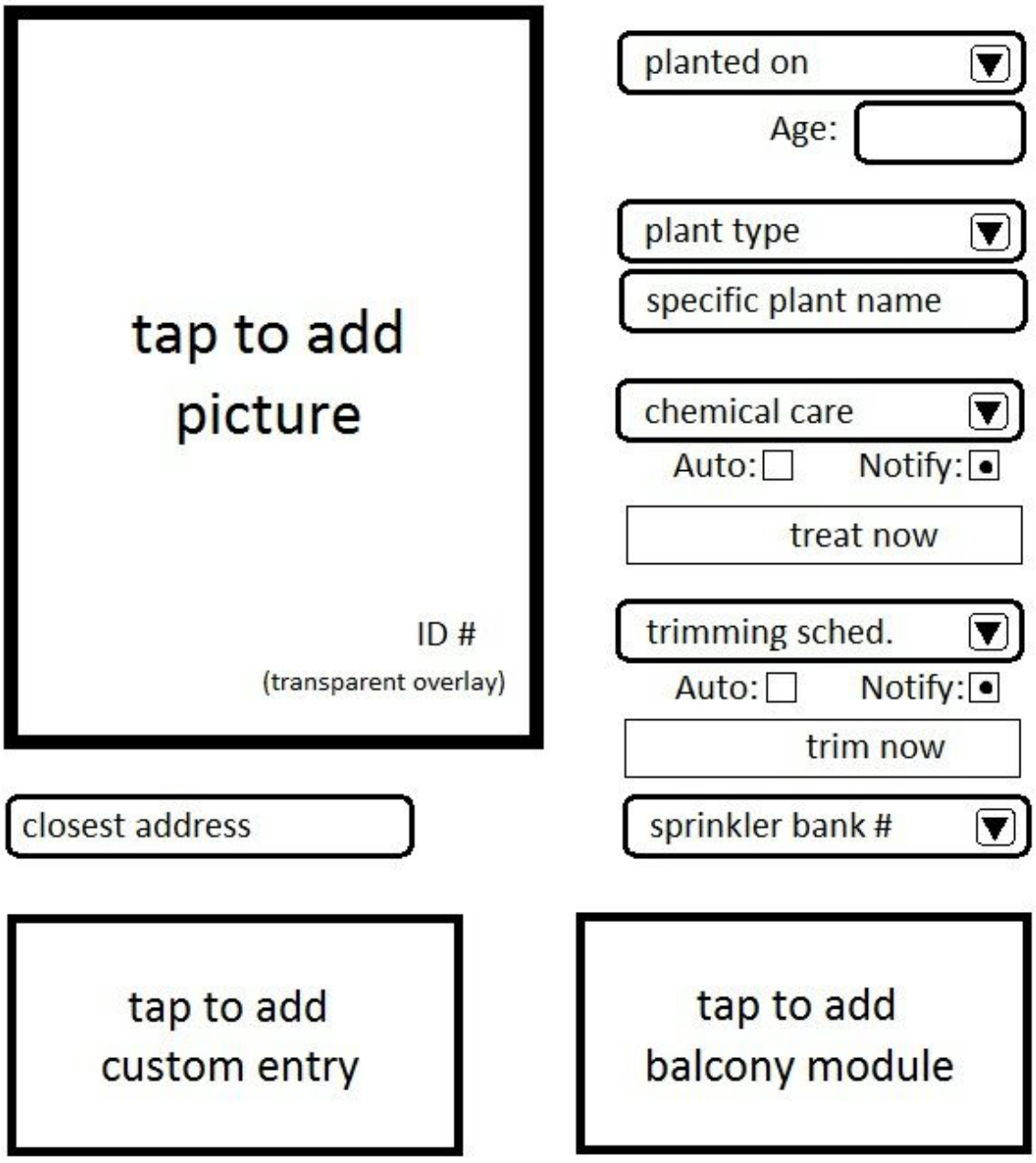

Figure 4. Proposed design of the new-entry screen for the database.

IMPLEMENTATION CONCERNS

If the Tiburon management team did enact this recommendation, here are a few considerations to keep in mind when the time comes to fully transition to digital information storage.

Tags

If by the time the application has been coded the tags do not have enough memory to accommodate the launch command for each individual tag then there will be lots of wasted money and effort. When rolling out a large system swap like this it is important to have all information before making an executive decision. For some locations an adhesive tag is the correct answer to the geography. Plan tag purchases based on how the tags will be installed. For trees, a tag that doesn't use adhesive might be a better way to secure the tag. For large planters, consolidating to only one tag could save time and money. Most planters have homogenous plant-types and this practice would save tags in case of memory concerns. If the tags are grouped together in clusters, there needs to be a visual distinction to discern tags easily at a glance. According to Pyykkönen, "users [visually] scan their local environment, recognize the tags present, and select among them the tag to touch. The locations have to be recognized accurately, as a tag has to be touched with a phone in order to read its data." (2012)

Smartphones

Due of their NFC capabilities, most smartphones could become a required part of the job for the management team. Because of this, any money spent out of pocket by staff towards a replacement smartphone or data plan could be considered a tax write-off. As long as the smartphone is NFC-capable, theoretically any phone can be used to access the database.

Different smartphones might handle NF communication slightly differently resulting in varied power draw. This could result in dead smartphone batteries if there is no recharging station. In the event of a non-working demonstration device, simply ask one of the participants for their smartphone, log into the database again, and finish the presentation. Back in 2010, a group of professors from two German Universities made an app that integrated a location service into an instant messaging application (Kobler, Koene, Kremar, Altmann, Leimeister). This might be another feature that is implemented into our system application.

RECAP

To summarize: Near Field Communication devices can be used to read and maintain a system a tags connected to a server to store location-specific information about vegetation in Tiburon. This information would be accessed through a custom mobile-application. The information stored can be standard things like age of plant, pesticide treatment schedules to custom repair scheduling modules.

REFERENCES

Köbler F., Koene P., Krcmar H., Altmann M., Leimeister J.M., LocaTag—An NFC-based system enhancing instant messaging tools with real-time user location; Proceedings of the Second International Workshop on Near Field Communication (NFC); Monaco. 20 April 2010; pp. 57–61.

Ma, J., & E., J. (2014). An NFC-based scenic service system. *Journal of Networks*, *9*(4), 850+.

M. Pyykkönen, J. Riekki, I. Alakärppä, I. Sanchez, M. Cortes, and S. Saukkonen, Designing tangible user interfaces for NFC phones, *Advances in human-computer interaction*, vol. 2012, 12 pages, 2012.

NXP Semiconductors. NFC forum tag types white paper v.10, (2009) p.11

Ok, K., Coskun, V., & Ozdenizci, B. (2011). Near Field Communication : From Theory to Practice (2nd Edition). Hoboken, NJ, USA: John Wiley & Sons.

Ok, K., Coskun, V., & Ozdenizci, B. (2015). The Survey on Near Field Communication, *Sensors (Basel, Switzerland)*, *15*(6), 13348–13405. http://doi.org/10.3390/s150613348 xShupe, T., Lebow, S., Ring, D., (2008) *Causes and Control of Wood Degradation, Decay, and Stain*. retrieved from www.lsuagcenter.com

Spinsante, S. & Gambi, E., (2015) NFC-Based user interface for smart environments, A*dvances in human-computer interaction*, vol. 2015, p. 12