



EXPLOITING OF RFID FOR ADS TRANSLATION AND CONVERTING TO AUDIO FOR VISUALLY IMPAIRED AND UNLETTERED

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Abstract— one of the important characteristics of smart cities is to access the information for residents and visitors alike. Language barriers, impairments and presence of crowd should not influence the context-awareness of the visitors in such cities. In this paper, we propose Smart ads- RFID based system for real time retrieval and translation of public advertisements. The system offers both real time and off-line text/voice translation into user's preferred language and communicates the translated contents to user's smart phone. The system also provides real time GIS map visualization of the RFID enabled advertisements in the city. The next idea added with this, usually ads is posted by many different departments. The employees, classmates and colleagues in addition to the university administration can post ads. Students use all types of ads materials (printouts, posters and displays). The ads are posted in particular language so both students and university staff who can't speak that specific language are unaware of the posted contents. And, in the most useful manner for the visually challenged people that particular ads displayed in the notice board will be translated to preferred language. We described our developed pilot project and we investigated its usability, validity and usefulness using Fuzzy Rule-based System. We believe that such system could provide promising services within the context of smart cities.

Keywords— RFID; Signs recognition; Advertisements; Mobile application, Smart cities, visually challenged, fuzzy rule.

I. INTRODUCTION

Utilizing RFID for various kinds of applications is well-known due to the ease of use and the low cost associated with the RFID technology. RFID is believed to be one of the most important enabling technologies for Internet of Things (IoT) which facilitates developing smart cities. Increasing context-awareness of users is one of the goals of smart cities. Some factors that



reduce context-awareness in tomorrow's smart cities are language barriers, impairments and crowd. Real world ads in smart cities should be highly accessible and this factor should not hinder the context-awareness of visitors in such cities.

Today, public advertisements in most of the cities are usually written in the local language of the country. A number of cities attract millions of visitors each year due to their popular tourist destinations and cities that organize huge social, ritual and sport events. The visitors to these cities have diverse background languages and levels of education. Additionally, there are large number of elderly people and people with different disabilities. Hence, it is imperative that such cities should involve modern communication technologies in the advertisement mechanisms by all possible means. In this direction, technologies such as Near Field Communication (NFC) and Quick Response (QR) code are in use for a while. However, these technologies have some limitations if considered for city level advertisements due to the line of sight requirement. They usually require tapping or scanning and have limited reading range. Moreover, they cannot support multiple reads. On the other hand, RFID does not suffer from these limitations so it could effectively facilitate accessing the contents of physical world advertisements in crowded cities and allow for real-time translation to multiple languages and voice.

Visually challenged persons face constraints in independent mobility and navigation. Mobility means the possibility of liberally moving, without support of any supplementary person, at home and unfamiliar scenarios. People with visual impairment tackle enormous limitations in terms of mobility. A system which guide or assist people with vision loss, ranging from partially sight to totally blind, by means of sound commands is referred as Navigation assistance for visually impaired (NAVI). Many researches are being conducted to build navigation system for blind people. Most of these technologies have limitations as its challenge involves accuracy, usability, interoperability, coverage which is not easy to overcome with current technology for both indoor and outdoor navigation.

II. RELATED WORK

Utilizing RFID for various kinds of applications is well known in the literature. The ease of use and low cost makes it a favorite technology in many fields such as management, tracking and control among others. In this section, we have narrowed down our discussion to only those applications that we believe they are related to the proposed application such as traffic sign recognition and document management. QR codes and NFC [1] are well known techniques in marketing. A number of advertising campaigns for popular products have been using these codes to direct users to special web offers and have been very successful [2]. When users scan QR codes with their Smartphone's camera a number of actions can be triggered with the encoded information like: sending an email/text, getting contact details, view a website and/or dial a phone number, etc. However, these technologies have a number of limitations when compared to RFID. They require line of sight so the user can tap or scan the code. Moreover, they have very limited reading range and cannot support multiple reads. Over the past three decades, research has been conducted to design new navigation devices for the visually impaired. Benjamin et al. [3] built a laser cane that uses optical triangulation with three laser diodes. The first laser points at the ground detecting a drop in elevation, the second points straight in front of the user parallel to the ground, and the third points straight ahead at an angle of 45° from the ground to protect

the user from overhanging obstacles. Bissit and Heyes [4] developed a hand-held sonar device that gives the user auditory feedback with eight discrete levels. Shoal et. al [5] developed the Belt, an obstacle avoidance wearable computer for indoor navigation. Na [6] proposed an interactive guide system for indoor positioning, and Farrah [7] proposed the virtual reality technology to capture images of the house using cameras, and uses this information for indoors navigation.

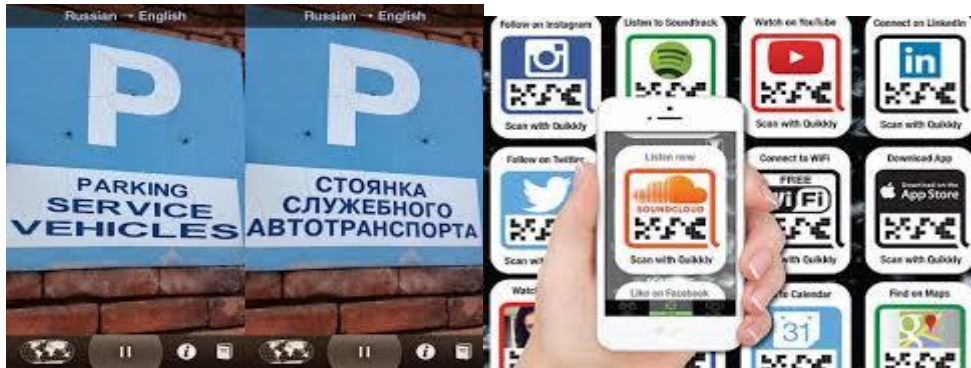


Fig. 1. Related Solutions (a) NFC/ QR ,(b) Word Lens/ Image Processing. [Source: Google images].

Kulyukin [8] proposed a closely related work, the robot-assisted navigation method for indoor environments. A system “Roshni” determines the user’s position in the building, navigation via audio messages by pressing keyson the mobile unit. It uses sonar technology to identify the position of user by mounting ultrasonic modules on ceilingat regular intervals. This system is portable, easy tooperate and is not affected by environmental changes. Butthis system is limited only for indoor navigation because itrequires detailed interior map of the building. [9]RFID based map-reading system which provides technicalsolution for the visually impaired to pass through publiclocations easily using RFID tag grid, RFID cane Reader,Bluetooth interface and personal digital assistance. But itsinitial development cost is quite high and chances ofinterference in heavy traffic. A voice operated outdoor navigation system developedusing GPS, voice and ultrasonic sensor. It can alert user’scurrent position and provide verbal guidelines fortravelling to a remote destination but fails to give obstacle detection and warning alert. There is very little research literature speci_cally related to improving the relevance of mobile advertisements, and most of that has focused on using location to increase the relevancy of the advertisements shown. In the AdNext sys- tem , authors propose to use mobility patterns to predict which store the user is likely to visit next, and show him ad- vertisements related to that store. In , authors consider using various physical contexts such as location and user activities to serve ads. These works are orthogonal to Smart- Ads; SmartAds could incorporate such additional signals to further increase ad relevance.

III. SYSTEM DESCRIPTION

In this section, we describe the architecture of the proposed system. For the purpose of our system, we define two types of advertisements. The first type is of temporary advertisements that

usually have no restriction on where to be posted, hence are called portable ads. The other type includes those which are posted at fixed boards whether passive (posters) or electronic displays. Traffic signs belong to this second type as their contents and locations are usually fixed and not expected to be changed.

Whether the advertiser is a private/public company, organization or a person, the advertiser needs to register to the Smart ads service via the department of public advertisements in the city. In most cities, there is a similar department which is responsible for permitting customers to post their ads in public areas. The department of public advertisements enables the smart ads by attaching a RFID tag and acquiring an electronic version of the content from the user to be archived. The stored contents are associated with tag identification for retrieval when needed.

The proposed system provides services such as allowing translation of contents of the ads into different languages and voice. This makes the content accessible by large number of visitors of the city. The ads are categorized based on their significance. Some possible categories are: guidance, informational, services, marketing and warning etc. A priority level is assigned to each category, for example a warning ad has higher priority than an ad from other categories. Warning ads are pushed to the user’s smartphone while ads of other categories are queried by the user based on his interest. The system notifies the user about the presence of the RFID enabled ads and their categories. The user can choose the language of communication so that the content would be delivered in the preferred language whether as voice or text. Images associated with the ads and the expiry date is also given to the user. The user can also store the ads locally on his smart phone to explore them afterwards. Once the expiry date is reached, the system dynamically marks the archived contents as expired.

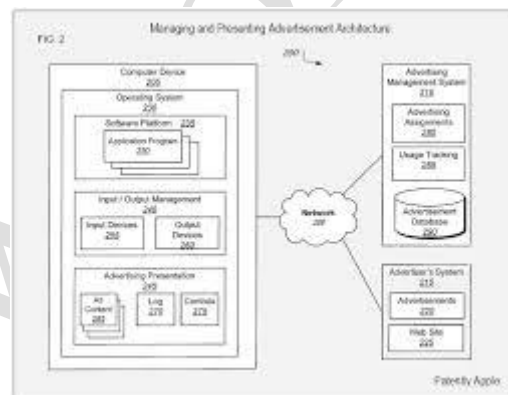


Fig. 2. Smart ads system architecture.

Fig. 2 shows different components of the proposed system. The system incorporates RFID tags to identify the ads, RFID readers and a backend database. Real world ads are affixed with RFID tags of suitable kind. Portable RFID readers are used to communicate the tag information back to management system via the smart phones of the users. The software architecture of the application is divided into frontend component that would be installed on smart phones and backend component that resides at the central server that is managed and administrated by the department of public advertisements.

We have carefully explored the current RFID specifications for tags and readers. We found a large variety of suitable and easily available tags and reader types for our system.

A. RFID Tags

Radio-frequency identification (RFID) is a technology to record the presence of an object using radio signals. It is used for inventory control or timing sporting events. These are small transponders that will transmit identity information over a short distance, when asked. Tags can be classified into passive, semi passive and active types. This means that one type that is suitable under some conditions may not be suitable in another situation. Based on our investigations, some commercial RFID tags are available that could be attached to paper, plastic, metals and other kind of materials. UHF RFID tags that may be passive, semi passive or active. Passive tags identify temporary ads while active tags are for fixed long lasting ones.

B. RFID Readers

RFID uses electromagnetic fields to automatically identify and track tags attached to objects. The tags contain electronically stored information. Passive tags collect energy from a nearby RFID reader's interrogating radio waves. Active tags have a local power source such as battery and may operate at hundreds of meters from the RFID reader. RFID is one method for automatic identification and data capture. User carries a portable RFID reader that has ability to communicate with the Smartphone.

One of the main factors that greatly affect the success of the proposed RFID system is the reading range of the reader. The system should only allow the user to be aware of the presence of RFID enabled ads within the proximity of his current position. Since, RFID tags can be attached to cash, clothing and possessions, or implanted in animal and people, the possibility of reading personally – linked information without consent has raised serious privacy concerns. This concern resulted in standard specification development.

C. Backend and Frontend Components

The frontend App is installed on smart phones of the end users. It communicates with both the reader and the backend management system. This piece of software provides ads accessing services to the user based on his preferences (language: text/voice, storage, interests).

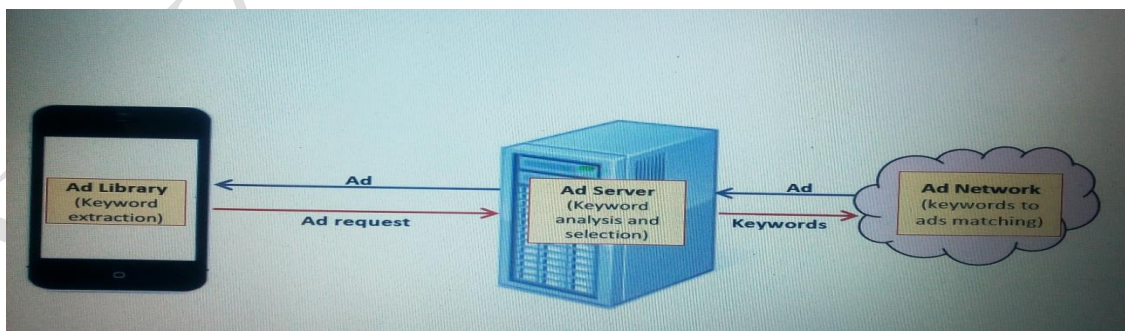


Fig. 3. Smart ads backend application.



We have developed a smart phone application that allows the user to interact with the system. It receives basic information about the tagged ads directly from the reader. It notifies the user about the categories of discovered ads and queries the ads database which is housed at the central server over the Internet. In addition to tag information, user preferences in terms of preferred language and voice/text choice are sent with the query. It receives the response from the server and renders it to the user, on demand. This ensures that only required data is pushed to the user. The user is also allowed to archive any of the ads for future use.

The backend service is a more complex piece of software. It provides full administration of ads acquisition and management in addition to a visual map representation of the locations of the users currently accessing the ads and the contents of these ads. Moreover, it collects statistics such as number of users, preferred languages and most frequently accessed ads locations. It also keeps history for the purpose of analyzing and mining to support decision making process regarding best time and locations to distribute ads and languages to be supported.

The backend service consists of the following components as shown in Fig. 3: Aggregator, Analyzer and Translator. The aggregator is a preprocessor that receives the content of the advertisements and adjusts the input to be correctly stored in the system database. Different tools are used for acquiring ads content from printed materials like Optical Character Recognition (OCR), scanners of different types etc. Electronic materials are acquired and adjusted automatically to fit the database structure.

The analyzer is an adaptation component that analyzes the user preferences, fetches the queried content from the database and calls the correct translator API. This component is responsible for keeping track of the history of the archived ads to collect useful factors related to the performance of the system. Some of these factors are: common locations for different categories of ads, time of high frequency of ad reading, and most used language, etc. Finally, the translator is a huge set of APIs by which ads content is translated into multi language text and voice. These APIs are called on demand and cached for further requests. However, based on the analyzer feedback, the system could learn what to perform on demand in contrast to what needs to perform proactively. The management component is responsible for ensuring the synchronization and coordination among different system components. In addition to the above main components, user interface is meant to provide complete control of the system functionalities to the responsible authorities.

D. Usage Scenario: RFID-enabled Mobile Variable Message Signs

As a usage scenario that highlights the significance of the proposed system, the city is overcrowded which adds to the challenges that visitors may face during their visit.

KSA government is looking for providing optimal services to its huge number of visitors. Many efforts have been put in to manage and optimally guide the crowd. The houses have huge number of marketing, guidance and informational advertisements that provide significant information to the visitors. However, these ads are generally written in Arabic language. Thus, people have great difficulties to understand them for reasons such as unfamiliarity with language, illiteracy, disability or even because of the presence of overwhelming crowd. Increasing the context-awareness of the 3.5 million pilgrims and safely guiding them during the evacuation process from the ritual places is one of the main goals of the smart city. The proposed Smart ads solution



could effectively enhance the process of evacuation and guidance of millions of pilgrim's seasons as RFID enabled ads and electronic displays would play a great role to achieve this objective.

In [13], we proposed a Wireless Sensor Network WSN deployment model to monitor and enhance the evacuation process of millions of pilgrims. The model determines anchor positions within the ritual areas. These anchor positions are periodically visited by small authority vehicles for purpose of monitoring and guiding of the pilgrims. The anchor positions build a logical coordination system which facilitates the evacuation process and help guiding the pilgrims on the surrounding areas. We not only propose to enable the stationary ads by RFID, we also propose to augment the operations of these vehicles by affixing electronic displays or different message signs that are RFID-enabled on the roof of these vehicles. This will allow effective groups guidance during the evacuation process. The information displayed by these displays are controlled and customized based on the time and the geographic location of the vehicles carrying them. Communication with such message displays could be over short-range wireless communication (if controlled for example, by Smartphone of the vehicle driver) or long range wireless communication if directly controlled by the management site). Pilgrims in surrounding areas of such vehicles will be able to access the displayed information in different voice/languages regardless of the crowd, language barriers and visual impairments

IV. PROTOTYPE AND EVALUATION

The pilot project targets the translation of ads in a particular language based on the location. In advance it converts the ads or data's posted on the electronic board to the audio format for the visually impaired people and the illiterate people. Both tags and readers have their own antennas because they are both radio devices. A tag antenna, which is only a few centimeters (or less) long, attaches to the integrated circuit (IC, or just chip) to absorb a signal and then transmit out a slightly modified signal. The reader antennas range in size but are generally about the size of a computer flat screen and are specially tuned to transmit and receive RF signals. Antennas are how readers communicate with the outside world. Reader antennas send radio signals into the air to activate a tag, listen for an echo (or backscatter) from the tag, read the data transmitted by a tag, and, in some cases, write data onto a tag. Antennas act as conduits between the tag and the transceiver and can function continuously or on demand. Continuously active antenna systems are used when tagged items are present on a regular basis or when multiple tags are passing through the antenna's detection field. On the other hand, an antenna's detection field can be activated only when needed by a sensor of some kind. The on-demand method can be triggered by optical, pressure, or other kinds of proximity sensors. Antennas come in a variety of shapes and sizes; this diversity in size and shape allows antenna placement in a wide variety of locations — from warehouse doors to highway tollbooths.

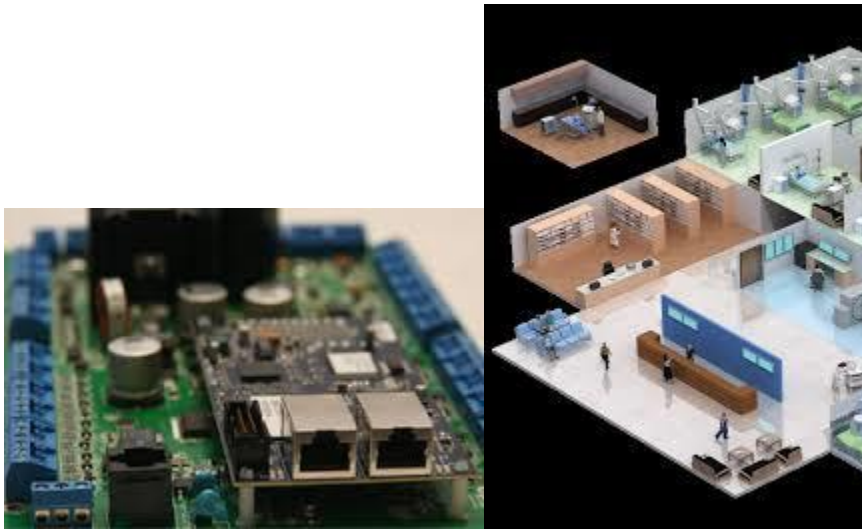


Fig. 4. Selected snapshots of user interface of the front App, the TSL 1128 Bluetooth UHF RFID Reader and IRIScan.

Middleware is a generic term used to describe software that resides between the RFID reader and enterprise applications. It's a critical component of any RFID system, because the middleware takes the raw data from the reader—a reader might read the same tag 100 times per second—filters it and passes on the useful event data to back-end systems. Middleware plays a key role in getting the right information to the right application at the right time. Companies will need to buy tags and have them tested. There are many RFID middleware products on the market. All do some basic filtering, but many also perform additional functions. Some middleware manages RFID readers: It monitors their health, configures them, sends software updates and so on. Other middleware may manage the data recorded in databases for enterprise applications to use. And some middleware has its own applications, often for a specific industry. One application might be confirmation of shipment and receipt. When a product is sent to a retailer, the middleware confirms the shipment and sends an electronic message to the retailer with the EPCs in the shipment. When the retailer receives the goods, receipt is confirmed and a message is sent to the supplier. The retailer doesn't need to be running the same middleware because most RFID middleware is based on standardized Internet languages, such as XML, and protocols, such as Simple Object Access Protocol. (For an in-depth look at RFID middleware and the leading providers, subscribers should read *RFID to ERP: The Land Between*). The cost of middleware varies from vendor to vendor and is usually based on the number of locations where it will be installed, the complexity of the application and many other factors. Forrester Research put the cost of middleware at \$183,000 for a \$12 billion manufacturer looking to meet the RFID tagging requirements of a major retailer. Companies will also need to purchase servers to run middleware within a warehouse, distribution center or production facility. These servers are sometimes called edge servers, because they are close to the edge of the network where the digital world meets the real world. Edge servers are standard computer servers. They typically do not have any special hardware, and they connect to readers using serial or Universal Serial Bus (USB) ports.

The input parameters have the following term sets, each term having a Gaussian membership function:

$$\begin{aligned}
 TUsability &= \{Low, Medium, High\} \\
 TValidity &= \{Low, Medium, High\} \\
 TUsefulness &= \{Low, Medium, High\} \\
 TPerformance &= \{Bad, Medium, Good\}
 \end{aligned}$$

For performance evaluation of the system, the FRBS uses rules of the form: IF x_1 is X_1 AND x_2 is X_2 AND x_3 is X_3 THEN \square is A

Where $X_1 \in TUsability$, $X_2 \in TValidity$, $X_3 \in TUsefulness$, $A \in TPerformance$

The output of the FRBS indicates the performance of system. Fig. 5 is of the surface viewer of the rule base of the Performance Evaluator, which shows that the system has good performance whenever 2 out of 3 inputs have high value. The collected data from the users indicated good performance of the system based on Performance Evaluator for more than 94% of the students, where 40 students were asked to provide input.

Table 1. Criteria of Reported Data		Required Responses	Rating (1 —5)
Usability		A. Ease of use of the equipment	1=Very Difficult 5=Very Easy
B. User friendliness of the system		4=Very User Friendly 2=Very Unfriendly	
Overall Usability		<i>Average of A and B</i>	
Validity	C. Reader read the required ad	2=Never 4=Always	
D. Reader read the ad correctly		3=Never 5=Always	
Overall Validity		<i>Average of C and D</i>	
Usefulness	E. Received information was useful	2=Not at all 5=Very Useful	
F. System recommendation in terms of usefulness		4=Not required at all 2=highly recommended	
G. Effectiveness of the voice feature		1= Not effective at all 5=Highly Effective	
Overall Usefulness		<i>Average of AB and C(only if applicable)</i>	

V. CONCLUSIONS AND FUTURE WORK

The paper describes the use of RFID for real time translation of physical world advertisements and Translates the text to audio for the blind ate people. The system is intended to increase the context-awareness of foreign visitors in smart cities. We have also described our pilot project to assist visually impaired students to know what is posted in the notice board in an audio format. By capturing the text images it translate the text into required language in order to guide foreign people. In addition for the illiterate people the text will be converted into audio format in required language. The initial investigations of the proposed system show promising outcomes.



These initial outcomes encourage customization of the system to increase the awareness of surroundings to millions of pilgrims and to facilitate guidance and evacuation processes.

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