An intelligent RFID system

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Abstract: RFID tags are miniscule microchips, which continue to get smaller and cheaper every day. This paper introduces IPURSE, an intelligent system built on a mobile platform which keeps track of items a user carries in their purse/handbag and also alerts the user when any item is missing from the purse/handbag. IPURSE is a unique project that brings the RFID and NFC technologies together into a single system by 'cleverly' monitoring, reminding and alerting users about their missing items based on the current weather, reminder messages and daily items usually carried by the user. We discuss the methods, equipments and technologies used to successfully implement such an application. It includes the design evolution and technical design of the system, followed by a working prototype and experimentation. The pros and cons of the application are also discussed towards the end of this paper.

Keywords: RFID application; near field communication; NFC-enabled mobile phone; radio communication; radio frequency identification; radio waves; RF signals; intelligent systems.

Reference to this paper should be made as follows: Watfa, M.K., Kaur, M. and Daruwala, R.F. (2011) 'An intelligent RFID system', *Int. J. Intelligent Systems Technologies and Applications*, Vol. 10, No. 4, pp.377–395.

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1 Introduction

Humans cannot multitask – the human brain can focus only on one thing at a time; even if the focus is for a very short period (like a nanosecond). It is virtually impossible for the human brain to pay quality attention to all tasks – it eventually forgets everything that is not committed to long-term memory. As a result of which, people often tend to forget and loose things. A purse/handbag is used to contain all the personal items that one needs to carry while travelling. By keeping all items in a single container, the chances of loosing things are lessened. However, it is difficult to monitor all the items in the carrier at all times, especially when people are engaged in other activities. This research project is committed to the forgotten items and to an apparatus and method for reminding forgotten items. This project implements a computerised system that will assist in monitoring all the items carried in a purse/handbag.

At present, people set reminders to remember to carry items, check the items they are carrying (especially when taking along important documents like passport, contracts, etc. or even expensive objects like branded wallet, watch, diamond ring, etc.) at regular intervals to monitor the items and check if all items are present in the carrier. To resolve this issue, a software/hardware application was implemented which would automate the monitoring process and also incorporate additional 'smart' features such as the alert system, weather check and reminders, which would help enhance the functionalities of the overall system.

The system utilises Radio Frequency Identification (RFID) and Near Field Communication (NFC) technologies. RFID technology comprises two components: a tag and a reader. The RFID tag is an IC chip that can store and send information over radio frequency signals and can be applied onto different items. The RFID reader acts as an antenna for receiving and transmitting signals. The NFC technology is a short range wireless connectivity technology that enables simple and safe two-way interaction among electronic devices. NFC establishes faster connections compared to Bluetooth and it also provides a degree of security due to its short range communication. An NFC reader is also capable of reading RFID tags. The RFID and NFC technologies are incorporated in our system to make it act intelligently in monitoring all items inside the purse and also in alerting users when any item is forgotten or misplaced and its whereabouts accordingly.

The rest of the paper is organised as follows. In Section 2, we provide an overall summary of the system. In Section 3, we discuss the methodologies used in implementing the proposed system. Sections 4 and 5 discuss the working application and the testing and analysis results. Section 6 provides the motivation behind our work and the related research work. Section 7 concludes this paper.

2 Summary of the proposed system

IPURSE was developed with the intention to lessen the burden of all those who forget to carry or lose items. This project is unique in its own self to the best of our knowledge – there has not been any system made earlier similar to this application in the context of carrying purses and smart alerts connected a web portal. The present system is a computerised system built on a mobile platform which will monitor all the items in the carrier and alert the user on their mobile phone if any item is absent from the purse/handbag. However, the proposed system is also an intelligent purse and has the following evident features:

- Firstly, it acts as an *asset management* system which will remind the users to carry their valuable assets. This part of the application allows users to create lists of items by stating a specific date and/or day(s) of the week. It also enables the user to set a priority for each item and also to edit the list at anytime. The system performs an automated check and if any item (that is on the day's list) is missing from the purse/handbag, a reminder message is displayed on the user's mobile phone.
- Secondly, it acts as an *anti-losing system* that monitors all the items in a purse/handbag and sends an alert if an item is absent from it. This part of the system keeps a watch on all items in the carrier at all times. When an item is taken out of the purse/handbag, the system checks the priority value assigned for the item by the user. If the item is not placed back inside the purse/handbag within the set priority time, an alert message is sent to the user's mobile phone after the time has passed, informing them about the missing item; else if the item is placed back in time, no alert message is sent to the user.
- Finally and most importantly, it acts as an *intelligent alert* and reminder system which extracts information from the web, like the weather forecast of the day or reminder messages posted by users' friends and family, and then manipulates it appropriately. This part of the system gets weather information of the day for a given city (set by the user) from the Yahoo Weather RSS feed, sets the item(s) required in that day's item list depending on the weather data retrieved. Similarly, the system also retrieves the reminder messages posted for the users by their friends and family on the IPURSE website and adds the required item(s) to that day's item list. In both cases, if any item is absent from the purse/handbag, a reminder/alert message is displayed on the user's mobile phone.

3 Method and apparatus

For the successful working of this system, it was important to jot down the specific requirements that the application would need to meet. The requirements of this application were categorised into functional and non-functional requirements.

The functional requirements included:

- providing a monitoring system to keep track of the items in the carrier
- providing a web interface to allow users to access and modify their item lists

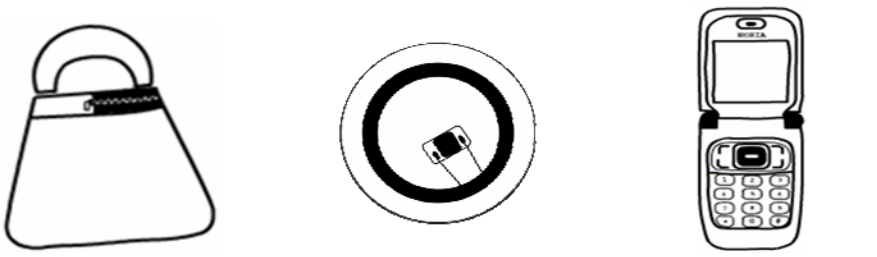
- providing an intelligent weather check system that updates the weather of the day at regular intervals
- providing an intelligent reminder system for the user's friends and family to post reminder messages for them
- sending alert/reminder messages at the correct time to the mobile phone of the users informing them about the missing items.

Whereas, the non-functional requirements from the project included:

- user friendliness (mobile phone and web interface)
- reliability in terms of retrieving information and sending alert messages
- performance, that is, the application (mobile phone and web interface) should have a fast response time
- error-free application to offer best results
- accessibility with regard to be able to create/view/modify the item list(s) at any point of time and from anywhere.

IPURSE makes use of the RFID and NFC technologies as mentioned earlier in this paper. A special purse/handbag (see Figure 1a) was made that would help the users in carrying their item(s) and mobile phone without hassle and also enable easy interaction between the tags and NFC mobile phone. The entry/exit point of the purse has been made in such a way that it is half-open and half-closed so as to restrict the reading space between the tagged item and mobile phone. The purse also has a pocket to hold the mobile phone at the front of the purse/handbag which allows the users to have fast access to the mobile phone and also easy communication with the tags. Mirfare 1K (S50 type) RFID tags (see Figure 1b) were purchased and also the Nokia 6131 NFC-enabled mobile phone (see Figure 1c) which was the only available phone in the developing market for the application. Apart from the hardware, software and support was also looked at – Nokia 6131 SDK Kit and Nokia 6131 emulator were available for download at the Nokia website. JRE 1.6 and J2ME Wireless Toolkit 2.1 were downloaded as well along with Eclipse 3.1.1 and MySQL.

Figure 1 Apparatus used for the IPURSE system



(a) Purse handbag designed for the application

(b) RFID tags used for the application

(c) NFC enabled mobile phone used for the application

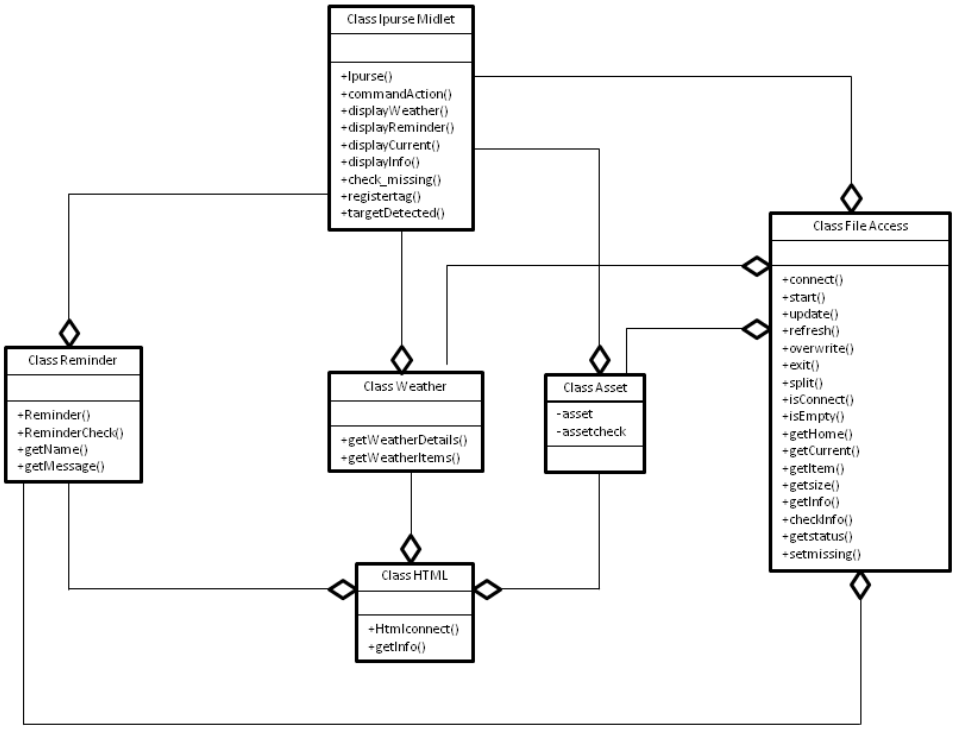
A few compatibility issues were faced in the start as the NFC based mobile phones and support for them was discontinued in the Middle East and many other countries. When designing the system, all the requirements and functionalities of the system were taken into consideration. Since the system was meant to interact with elements (RFID tagged items) lying outside the system boundaries, separate functions were created to deal with it. Different classes were defined to handle different functionalities of the system – asset management is handled by class Asset, weather management by class Weather and reminder alert by class Reminder. Another class was defined which performs the checks if any item went absent from the purse/handbag. However, a few difficulties were also faced while designing the system:

- One of the difficulties was to decide how frequent should the automatic scan be. The user generally would need to be reminded about the missing items before they leave their home. Hence, it was decided that the user's entry and exit points of the house would be monitored.
- Another difficulty faced was how often the anti-losing alerts be sent. Questions like: would the users be alerted as soon as an item was taken out of the purse; what if the users remove an item from the bag, use it for some time and then forget to keep it back in purse/handbag, then after how long would an alert be sent; how often would the alerts be sent if the item was outside the purse/handbag – once or more than once; would the alerts annoy the users, etc. were considered.
- Finally, after brainstorming and research, a design was sought wherein every item in the carrier would be associated with a priority and the priority would define a timer for each time, so when the time went off, the users would be alerted. Three types of priority – high, medium and low were discussed, each type associated to a timer of 15, 30 and 60 minutes, respectively.

The design of the system is modular and function-based. It is designed in such a way that the system can easily be extended to include new functionalities. As mentioned in the earlier sections of this paper, different classes were constructed to handle the different functionalities of the system. Please refer to Figure 2 that represents how the classes are linked with each other, to understand the functioning of the classes and their member functions. Class IPURSE Midlet is the main midlet class that consists of all GUI objects and alerts as its class members. Besides acting as a user interface, the main midlet class also accesses static member functions of all other classes to perform operations that are selected by the user through mobile phone.

The midlet class also has a child class – missingcheck(), which is a timer class. IPURSE() function is the most important member function of this midlet class. IPURSE() function initialises all GUI objects and also registers the RFID tags with the tag listener such that whenever an RFID is read by the application, it invokes the targetDetected() function to perform certain operations.

Figure 2 UML class diagram of the system representing the relationship/links between the custom made classes



The following code snippet shows how to register a type of tag to the tag listener:

```
DiscoveryManager dm =
   DiscoveryManager.getInstance();
try
{
  dm.addTargetListener(this,
            TargetType.RFID_TAG);
}
catch(ContactlessException ce)
{
  displayAlert("unable to register
TargetListener: " + ce.toString(),
AlertType.ERROR)
}
```

Listed below are the member functions of class IPURSEMidlet:

- commandAction() – this function is a midlet function which is called whenever a button is clicked on the mobile phone.
- targetDetected() – this function is automatically invoked whenever a tag is read by the mobile phone. Whenever a tag is read by the mobile phone, the application

assumes that an item has either entered or exited the carrier; hence an update commence is invoked to update the status of the item in the purse/handbag.

- registertag() – this function allows the user to record a tag by providing the name and the priority level. When the button 'ok' is clicked, the register tag accesses FileAccess.getInfo() which write the new information.
- displayInfo() – this functions calls the update() function from class FileAccess whenever a registered tag is read by the mobile phone. The update() function changes the status of the item accordingly and displayInfo() checks if the variable 'setmissing' is true. The automatic scan checks the items present in the carrier and does an asset, weather and reminder check. If any item is missing from the purse/handbag, it will send an alert to the user on their mobile phone.
- setmissing() – this static function is called by update() function of class FileAccess to set static global variables missing_id and missing_priority in case any item is taken out of the purse/handbag when the user is away from home.
- check_missing() – this function adds the item's id and priority to the vectors called missingitem_id and missingitem_p, respectively. An item can have three priorities: high (15 minutes), medium (30 minutes) and low (60 minutes).
- displayAsset() – this function displayed the missing items one by one to the user.
- displayWeather() – this function calls two functions of class Weather, that is, getWeatherDetails() to get the current weather and getWeatherItems() to get a list of weather items that the user should carry for the day depending on the weather for the day. It then displays the weather details along with the missing weather items that the user needs to carry in a communicative way to the user. If there are no missing items, the application skips the weather alert and directly goes to the reminder alert.
- displayReminder() – this function calls remindercheck() which returns a list of items that the user's friends and family has reminded them to get, but the user has forgotten to carry them. When the application displays to the user the reminder alert, it gives the user two options: Why and Ok. If the user is confused as to why they are supposed to carry these items, the user can click 'why' and the original message from the sender is displayed to the user along with the name of the sender. Like the above two, reminder alert will also be skipped if the user is carrying all the items that they are supposed to carry.
- displayCurrent() – this function invokes the getdetails() function from class FileAccess which displays the name and status of the object so that the user at any time knows what are the items inside or outside their purse/handbag or which are missing from it.
- startapp() – this is a midlet function which is invoked automatically when the application is started. It invokes two functions of class FileAccess: connect() which loads all the persistent data saved in the file into dynamic vectors for modification and display.

The member functions of the class FileAccess are:

- connect() – this function is invoked when the application is started through the startapp() of the main midlet class.
- Isconnect() – this function checks if there are any tagged items registered with the application. It returns false, if there are no items.
- getHome() – this function returns the status of the home and is called in two occasions. Once when 'home' tag is read by the phone, and the other time is during the missing item check wherein a string 'ok' is passed.
- Start() – this function is invoked when the application start by the startapp() function of the main midlet class. It initialises all the registered items in the carrier to 'innactive' and sets the home to 'in' assuming that whenever the user starts the application fresh, they are in their house and their bag is initially empty.
- getCurrent() – this function returns all the items that are present in the purse/handbag at any point of time. It can be viewed manually by the user when they choose 'list current items' option from the main list display.
- Split() – this function separates a string with a delimiter specified by the user and stores the string values in a vector.
- getItem() – this function reads the id of the registered item and returns the name of the item.
- getsize() – this function returns the number of items that are registered in the system.
- getmissing() – this function returns the item that are missing from the user's purse/handbag.
- getInfo() – this function is called whenever a user registers a new item. Whenever a new item is registered, its initial status is always 'inactive'.
- getstatus() – this function takes in the id of the item and returns its status.
- setmissing – this function takes in an id and updates its status to missing.
- isEmpty() – this function takes in a vector and checks if it is empty or not.
- refresh() – this function updates the status of the tag whenever the phone reads a tag. The status of the tags alternate between the 'in', 'out', 'inactive' and 'missing'.
- update() – this function reads the UID of the tag and checks if the tag is registered in the system or not. If it is registered, then it calls the refresh function to update the details of the tag.
- overwrite() – this function overwrites the existing tag when a user registers an already existing tag. It then sets that status of the overwritten tag to 'inactive'.
- Exit() – this function is called when the user exits the application. It saves all the volatile data stored in the vectors to a file stored in the phone's memory card.

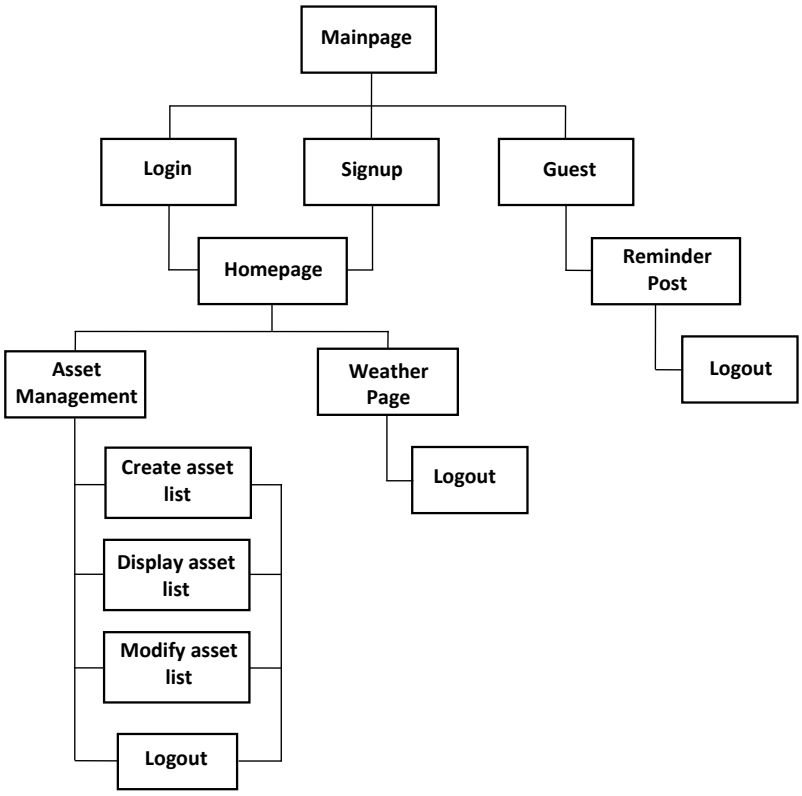
Class Asset keeps a check at the items required according to the item list set by the user. The asset class contains the function assetcheck() which accesses class HTML and gets information about the items that the user is supposed to carry for the day. assetcheck() then compares the asset list to the current items in the user's bag and sends the list of the missing items (if any) to the main midlet. It then displays it as an alert.

Class Reminder keeps in store the reminder message, name of the sender and receiver. Remindercheck() member function of class Reminder gets the message and name of sender from HTML class, retrieves needed information like items required from the message and then sends the appropriate information to the main midlet which displays it to the user.

Lastly, class HTML consists of the functions – htmlconnect() and getinfo(). Htmlconnect() functions connects to the online web server and loads information like the asset list, reminder list and weather information of the day from the today.html page and updates the information every day automatically through the update.php stored on the web server. The getinfo() function of class HTML converts the data received from the web server into meaningful information and returns it to the various functions of class Asset, Weather and Reminder.

To enable the users to access their information, a web interface was created so that this information is available to the users at all times an everywhere. Figure 3 represents the sitemap of the web interface for the application.

Figure 3 Sitemap of the website created for the application



The web interface has an aesthetic and minimalistic design. Easy navigation and simple language has been made use of throughout the website so that users do not find any heading or functionality ambiguous. The website has been coded in HTML and PHP languages.

The following snippet makes a connection to the MySQL server with the server name, username and password provided.

```
$conn=mysql_connect("sql308.byethost31.com",
"b31_6688367", "ipurse");
die(mysql_error());
mysql_select_db("b31_6688367_ipurse", $conn)
or die(mysql_error());
$pwd=md5($password);
```

After the connection is made, the application checks if the username and password provided by the user is valid. Similarly, a new user clicks on the 'Sign up' button on the main page of the website and they are taken to the 'signup.php' page where the user is required to choose a username and password and also enter their mobile phone's IMEI number. The entered details in the form are extracted later and then added to the database.

After a successful login or signup, the users are directed to the homepage of the website which contains an embedded flash video and links that allows the user to create/view/edit asset lists (Asset Management) and set a city to get its weather (Weather) page. The asset management page of the website includes links that allows the users to create a list of items (Manage assets), view existing list of items (View assets) and make changes to the existing list of items (Modify assets). If the user wants to create a new asset list, they click on the 'Create asset list' button, which directs them to the 'assetlist.php' page. The users need to enter the items, along with the priority and date and/or day for which they would want to carry the items. On submitting the form with the required details, the application saves the details in separate files based on the specific date and/or day. For instance, if the user specifies to carry their conference folder on 26 October 2011, then the system stores the item name – conference folder to 'specialdates.txt' file. The following piece of code illustrates the PHP script for the same:

```
if(isset($_POST["day"])) and (isset($_POST["month"]))
and (isset($_POST["year"])) )
{
  $day=$_POST["day"];
  $month=$_POST["month"];
  $year=$_POST["year"];
  $file2=fopen("specialdates.txt", "a+");
  fwrite($file2, "$list;$day;$month;$year\n");
  fclose($file);
}
```

The website also includes a weather check page. If the user wishes to be reminded about the items required depending on the weather of the day, the user should click on the weather link of the main page which directs them to 'weather.php' page. The users need to enter only city name of the country on the weather webpage. The application extracts the city name from the form and stores it to 'city.txt' file that sits on the server.

Another feature available at the website is the 'Guest Entry' wherein the friends and family of the user can leave reminder messages for them. The application establishes connection with the database and checks if the name of the user entered by the guest is valid or not. The application 'intelligently' extracts important information like items required or event details from the message posted by discounting articles, prepositions, etc. from the message and looking for synonyms for bring like get/carry/fetch, etc. or synonyms for going like coming/travelling, etc. For instance, if a guest posts a message to 'Bring a camera to beach on December 12', then the application extracts 'camera' and the date from the message and adds 'camera' to the item list of December 12. Similarly, if a guest posts a message like 'Come for football on Wednesday', then the application adds required items for the that day like ball, football shoes, towel, water, etc. to the list of items for Wednesday.

4 Application in action

The system needs the user, tags and mobile phone to interact together for its smooth working. The basic process flow of the complete system can be seen in Figure 4. At the onset, the users need to write the item's identification data, that is, name of the item onto the RFID tags and then apply these RFID tags onto the respective item(s). Once the users have tagged the item(s), they need to specify to the system which item(s) they would want to be reminded about to carry and also on which date(s) and/or day(s) of the week. The users would need to visit the website of the application and register in order to make use of the application. Then, the users need to create an asset list – specify item names along with their priority level and the date(s) and/or day(s) for which they want to carry them. Now, when any item is absent from the purse/handbag at any point of time, the application will check for the corresponding priority time set by the user for the concerned item. If the users fail to place the item back inside the purse/handbag within the priority time, then once the priority time passes out, the application will send an alert message to the users' mobile phone, else no alert message is sent to the users. This system has two different scenarios that it needs to deal with – one is when the users just leave home (see Figure 5) and the other is when they are away from home (see Figure 6).

The user needs to place every item that should be carried into their carrier before leaving house. When an item is placed inside the purse/handbag, the status of the item changes from 'out purse' to 'in purse' and vice versa when it is taken out. An RFID tag named 'home' must also be applied to the user's main door at home so that the system can know when the user leaves or comes home. As shown in Figure 5a, when the user passes through the door, the NFC mobile phone will interact with the 'home' tag, and the status of the user will change from 'in home' to 'out home', thereby notifying the system that the user has left home. If the status of the user is 'out home', then the application performs different checks – asset check, weather check and reminder check one at a time. In the asset, reminder and weather check modules; the application checks the list of the items for that specific date or day as set by the user and cross checks the item(s) with the item(s) that are present in the carrier at that time. If any item is absent from the purse/handbag and needs to be carried according to the user's asset list for that date or day; then an alert message is immediately sent to the user on their mobile phone (see Figure 5b and 5c). The user can either ignore the message or collect the item from their home and place it in the purse/handbag, as shown in Figure 5d.

Figure 4 Process flow diagram of the complete IPURSE system

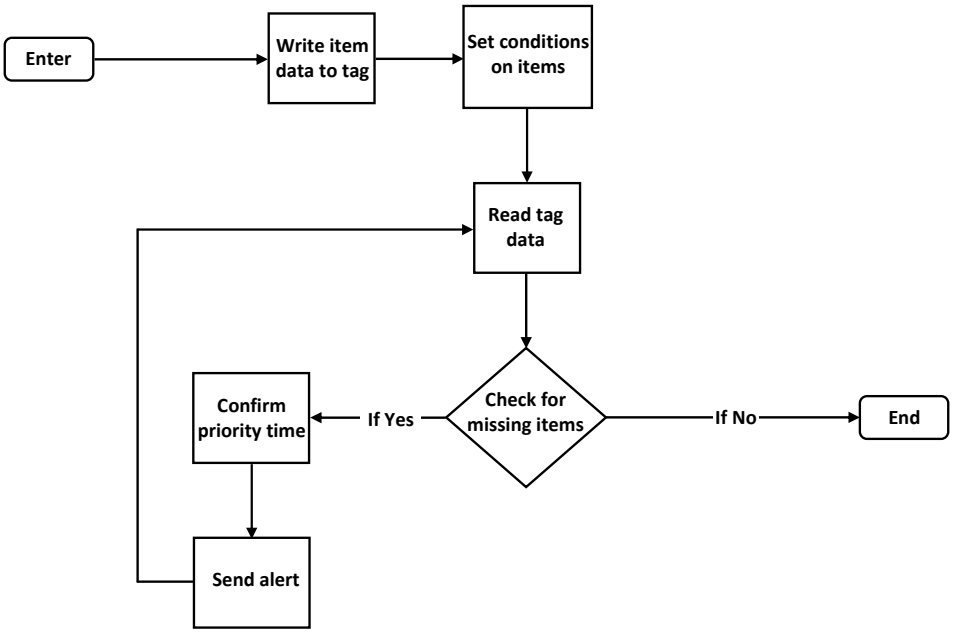


Figure 5 System view when user leaves home

(a) Mobile phone communicates with 'home' tage

(b) Alert sent to user's mobile phone

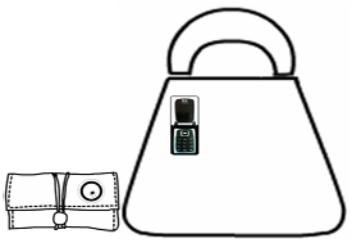
(c) Alert message displayed on user's mobile phone

(d) User places item back inside purse

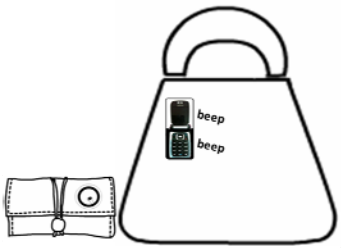
In the other scenario, when the user is away from home (see Figure 6 for the graphical representation of all the steps), all the items that the user placed into their carrier are monitored at all times. Since the items are inside the purse/handbag, their status is assigned as 'in' and when an item is taken out of the purse/handbag, the status is changed to 'out'.

Figure 6 System view of the application when user is away from home

(a) User takes item out of purse/handbag



(b) Item not placed back within priority time



(c) Alert sent to user's mobile phone

(d) Alert message displayed on the user's mobile phone

The application then instantly checks the priority time that the user had set for the item, for instance, the user took out their wallet for which they had set high priority (15 minutes). The application keeps track of the time and waits for the user to place the item (wallet in this case) inside the purse/handbag before the priority time, that is, 15 minutes runs out. But if the user has not placed back the item in the carrier within that time, then the system sends an alert message to the user on their mobile phone informing them about the missing item. However, if the user places the item back into the purse/handbag in time, then no alert message is sent to the user at all.

5 System analysis and results

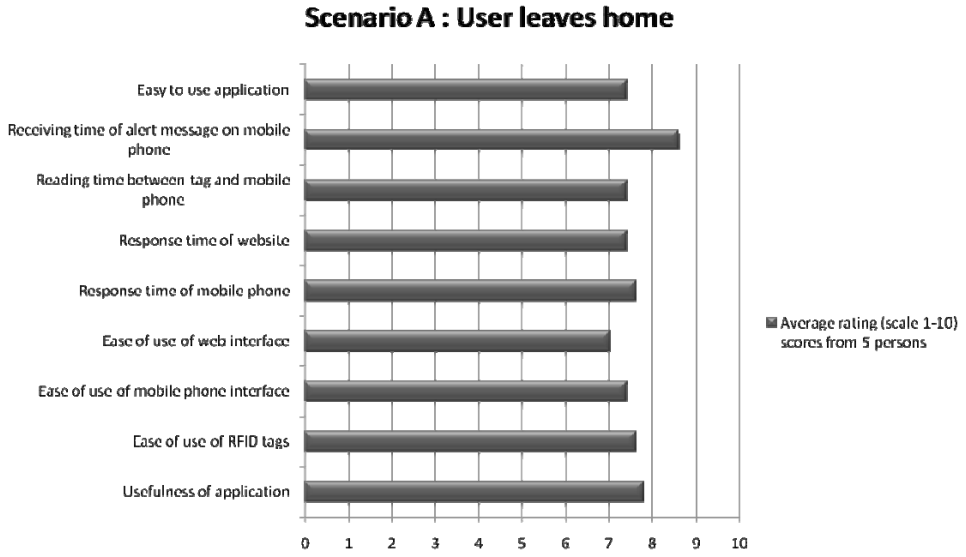
Testing was carried out for the application in two different scenarios – one when the user is at home and the other when the user is away from home. Five participants were selected of varied age groups, two of them being males and three females. For each scenario, same participants were called in for testing the software application. At the end of the session, the participants were asked to comment on the innovation and creativity of

the idea and application. They were also asked to fill in a questionnaire based on the tasks they performed in their scenario. The answers from all the participants were collected and analysed to get the results described in following sub-sections.

5.1 When the user leaves home

For this scenario, participants were asked to write identification data to the tags provided to them and apply them to the respective items. Then the participants needed to create an asset list and specify the requirements as mentioned on the website. Later, they were asked to place their tagged items into their carrier and leave home, once by forgetting an item at home and the other time taking all items along with them. At the end of the session, the participants were asked to fill in a questionnaire which included rating (on a scale from 1–10) questions shown in the Figure 7.

Figure 7 Average scores got from five persons analysed for scenario: when user leaves home



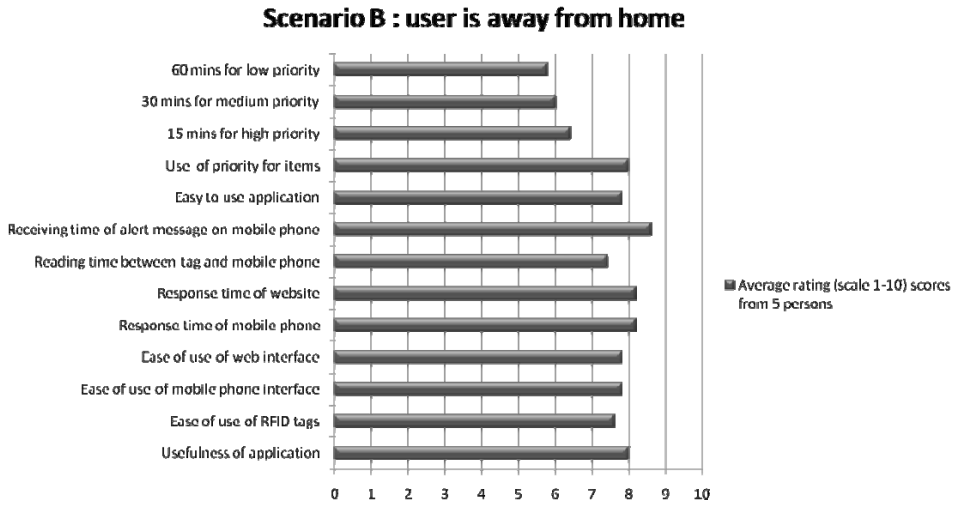
The results (refer Figure 7) showed that on an average all participants found the whole application to be easy to use including the writing data to tags and putting the items inside the bag. The *receiving time* of alert messages scored the highest on the questionnaire, while the *web interface* scored the least. When asked as to what they found missing in the web interface, the participants simply said that they were not accustomed to using a website as a reminder source for their required items. While the experiment was in progress, the time each participant took to put the items in to their carrier was noted, to give an *average time of 20 seconds* for placing five items in their first attempt. Overall, from the results it was known that the participants found this system to be very useful and user-friendly in terms of daily use.

5.2 When the user is away from home

For this scenario, the same participants were told to purchase something at any shop/restaurant and leave the place, once by forgetting behind an item (each time a different priority type) at the cashier's and the last time not forgetting anything. At the end of the session, the participants were asked to fill in the same questionnaire as in the scenario A with a few added questions like (10) use of priority for items, (11) set 15 minutes for high priority, (12) set 30 minutes for medium priority, (13) set 60 minutes for low priority.

From Figure 8, it can be clearly seen that the results for the repeated questions in this scenario were almost in sync with those in scenario A. The questions related to the priority time were given a little more importance during analysis of the questionnaires and it was found from the scores that participants were pleased to have a priority timer that would allow them to assign importance levels for their items. However, the default time set for the each priority type was not liked by almost all participants.

Figure 8 Average scores got from five persons analysed for scenario: when user is away from home

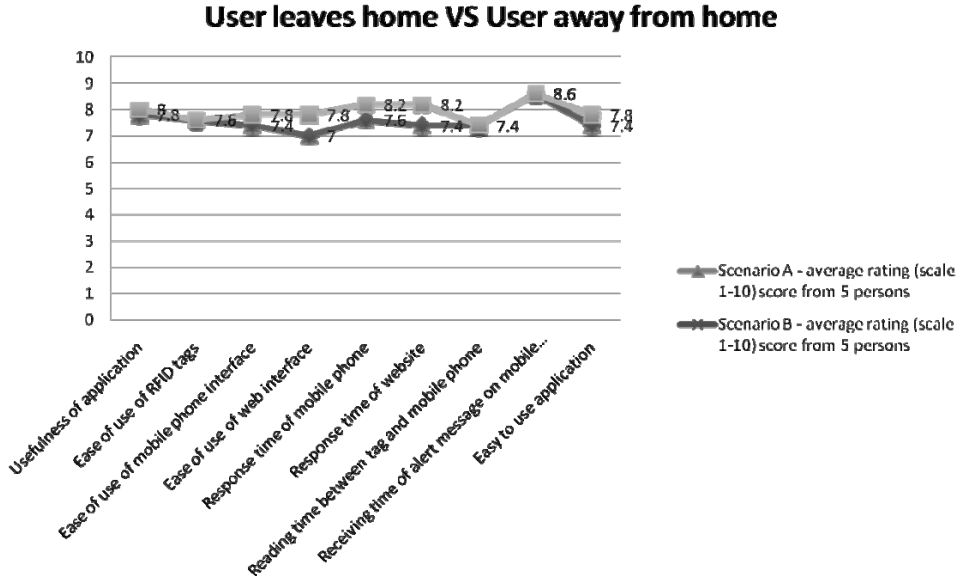


When asked for their reasons for scoring low the last priority type questions, the participants said that the time set was too long a wait. One of the participants, a female, aged 22 suggested that the high priority time should be between 5 and 7 minutes since that item is of high value to the user and would want to be notified at the earliest if it was missing. The participants were pleased with the accuracy in the receiving time of the alert messages depending on the priority level of the item they had forgotten, thereby rating it the highest in this scenario too. Overall, every participant believed that the application was very easy to use as a whole and also proved to be very useful for people with forgetting tendencies.

5.3 User leaves home vs. user away from home

For this experiment, the results received from both the scenarios were compared so as to find which participants were more comfortable at using the application. From Figure 9, it can be seen that the scores plotted in scenario A and scenario B are similar for most of the questions. The major difference in the scores among the two scenarios can be seen for questions (4) web interface, (5) response time of mobile phone and (6) response time of website. This variance in response time could be due to the difference in the network speed as the venues were different for both the scenarios. Also, the time for each participant was recorded in both experiments as discussed before and it was found that as the participants used the apparatus more, they felt more comfortable while using the application every next time, as a result of which, the average time of putting items in carrier improved over time. Additionally, the participants seemed to be pleased with the results of scenario B than of scenario A as shown in Figure 9. The reason deduced for this could be that people felt vulnerable of loosing items when away from home than when they are at home. Overall, the line graph of Figure 9 proves that the participants got used to the application and received good results in scenario B when compared to scenario A when the application was new to them.

Figure 9 Line graph showing the comparison between the two scenarios used for the evaluation of the IPURSE application



The participants were also asked to suggest functionalities that they would like the application to have. All the participants who took part in the evaluation of the application, found it to be a very innovative idea.

6 Related works

Nokia and Apple informed in the year 2010 that they would integrate the technology into their future handsets, with NFC-enabled smart phones expected to be available by 2011 (Ghee, 2010). The co-CEO of RIM, Jim Balsillie, had said in the Web 2.0 conference held in November 2010, that all Blackberry phones will soon be getting NFC chips in the future (Rosoff and Yarrow, 2010). Besides blackberry, Apple has also disclosed that its next iPhone will feature built-in NFC technology (Beaumont, 2010). As predicted by many researchers in the last two years (Clark, 2010), the production of NFC phones have drastically increased and there is already a good selection of NFC phones available in the market including the Google Nexus S, Samsung Galaxy S, Blackberry Bold 9900 and 9930, and the Nokia C7.

Alternatively, if users do not want to purchase an NFC-enabled mobile phone separately, then they can purchase NFC stickers for the same. NFC stickers when applied to any mobile phone turns the standard phone into an NFC-enabled mobile phone which can now read NFC and RFID tags just like the NFC phones that have a built-in NFC chip. MyMax, the mobile NFC sticker created by TWINLINX says that any Bluetooth phone can be turned into an NFC terminal by simply placing the thin NFC sticker on its back (TWINLINX, 2010). RFID tags come in a variety of shapes and sizes, so the user can choose any which would suit them. There are many types of RFID tags available in the market and any type would work just the same as expected for this application. A user can buy these tags easily as they are readily available and normally buying in bulk is always cheaper. However, the cost of an RFID tag starts with only about $0.50.

IPURSE brings with itself a lot of benefits to its users. The most important advantage of this application is the intelligence part of it which 'intelligently' monitors, reminds and alerts users about their missing items on the basis of the weather, reminder messages received by the user and the daily items carried by the user. Moreover, the IPURSE application is cost-effective in the long run since forgetting and losing items will lessen than usual, thereby allowing the users to save money which they would normally spend on replacing the lost or misplaced items. The users adopting this application will definitely feel a sense of security while carrying their items away from home, because in case any item is taken out by anyone from the purse/handbag and not placed back in time, the system will send an alert message to the user. Along with advantages, IPURSE also has a few shortcomings – most people feel the application is completely dependent on the mobile phone since the tags can only be read through the NFC mobile phone and the alert messages can also be read only via the handset. People argue on this point that if the mobile phone is lost or stolen, then the entire application collapses. However, this is not a grave issue because all phones can be tracked down and found easily with the help of technology nowadays.

Some existing works with similar concept and functionalities that were found during the research phase of this project are as follows:

- Lost Item Locator (Stump and Ferri, 2006) – this system helps in locating lost items by using a passive RFID tag and a portable reader transceiver.
- Method and System for tracking objects using GPS receiver built in active RFID (Chan, 2009) – this system tracks objects using Global Positioning System receiver that is built in the RFID receiver.

- Electronic tether for portable objects (Light et al., 2006) – this system issues an alarm when the distance between the monitoring module and the alert module increases by a certain value.
- LadyBag (Eric, 2008) – this system uses RFID technology to detect items in the bag and sends out alert with the help of LED lights if an item goes missing.

From the above stated works, it is clear that many applications have been developed revolving around the same idea as this project. Although most projects list the use of RFID technology, IPURSE is a unique project that brings the RFID and NFC technologies together into a single system. In addition to that, none of the mentioned systems incorporate any intelligence into their system aside from the basic alert system. Along with all the reviews obtained from the participants during the evaluation about the procedure and usability of the application, the participants were also asked to suggest their opinions and additional features they would want to be a part of the application.

7 Conclusions and future directions

In this paper, we present the design and development of a system which can make the life of forgetful people easy by reminding them of required items for the day and also alerting them about any missing item from their carrier. All users liked the innovative idea and collaboration of the two different technologies, to produce something so distinct, yet useful and efficient. The application was successfully tested with promising results. The users rated the application to be user-friendly and very effective.

In the future, the proposed application can include a tracking feature that would enable the users to track their missing or lost items. Other features that could also be added into this application would be – linking the users social networking sites with the application's system so that reminder messages posted by the user's friends and family could be retrieved and intelligent reminder messages could be sent to the user in case they have missed to see the posts. From the networking site, the users' friends' birthdays can also be retrieved (of course with the permission of the user's friends and family to avoid privacy infringement issues) and the users can be intelligently reminded about their friends' birthdays easily without the user having to set reminders on their mobile phones or marking them on their calendars.

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