Chapter 1

RFID Applications and Challenges

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Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/53368

1. Introduction

Radio Frequency identification (RFID) is the popular wireless induction system [1-7]. The same as the general bar code identification, each RFID tag in an RFID system is assumed that equips a unique ID (UID) itself. A standard RFID system is consisted of Tag, Reader, and Application. When an independent RFID tag approaches the RFID antenna, the induction between RFID tag and antenna happens. The RFID antenna reads the information and content recorded in the tag. Then the information is translated into the computational data by the RFID reader. Due to the portable RFID tag and untouched data transmission, many local or small area wireless applications for track and trace based on RFID systems were proposed.

RFID today is the popular wireless induction system [2-3,8-11]. Each RFID tag in RFID system is given a unique ID (UID) which records the on demand information. When an independent RFID tag approaches the RFID antenna, the induction between RFID tag and antenna happens. The information and content recorded in the tag is transmitted to the RFID antenna and translated into the computational data. Following up the data translation, the tag recognition can be completed and related applications are provided.

The RFID applications about agriculture that are now in widespread use such as the Animal Identification, the Product Record, and the Manufacturing process management. First, users identify products or materials via the tag and the reader of RFID system, and followed that recorded the data of products or materials on database in foregoing proposals. In a subsequent process, an especial function chose some suitable data from databases for analyzing, integration and description. This process helps users to understand the position and situation about products or materials. Therefore, by using the RFID, the main contributions in agriculture can be described as follows:

1. The data of manufacturing record was transformed from artificial process to electrical process.
2. Increased management (such as Inventory or Supply Chain) and production planning and scheduling efficiency than before.
3. Reduced the cost of operation and increased the economic effect.
4. Supply product safety information to customers to refer.

Many tracking applications based on ubiquitous computing and communication technologies have been presented in recent years such as RFID systems [4,5,7]. Therefore, RFID can be used to trace objects and asset worldwide. In addition, some warehouse systems or supply chain management systems can be combined with RFID to form goods tracking systems. The tracking systems help enterprises to manage their raw materials and products that reduce the cost of operation budget. However, more and more applications of RFID system that were introduced by people, and that the agriculture is the one of them.

Due to the popularity of RFID, many local or small area wireless applications were also proposed. The RFID tags were proposed to be used in hospital or health care [12-15]. Patients should always wear the RFID tag is designed for identification. The patient's current location and condition is monitored every time and everywhere within the hospital. It means that patients are under cared even an emergency state happens. Some entrance guard systems are also based on RFID system. The RFID ticket or RFID card [2, 3, 8, 10] is used to identify that a user is legal or not. According to the short-distance wireless signal, the RFID tag users can be monitored within the specific area. In other words, the RFID systems are generally used to be the hardware identification in many applications. In opposition to using the RFID system as the hardware identification, many software applications adopt software encryption as the identifications to protect the intellectual property of the applications or files. Considering the serious situations of pirate, intellectual property protection is important and becomes a famous issue.

Password protection is the popular encryption method to protect the applications. Each application or file of software is assigned an on demand given serial numbers or calculation function. People who use this application have to input the correct serial number then enable the application. Considering today's applications, personal multimedia services or software applications are popular. Customers use the personal multimedia devices such as MP3, PDA, iPod, Laptop, etc., to download the multimedia or application files from the server or website via Internet. In other words, many files or data are disseminated and exchanged via Internet. In addition, many hackers can crash the software encryption with fewer costs (Only program tools or applications needed). It makes that the piratical files are transmitted widely and the protection of intellectual property exists in name only.

For the purpose that the right of intellectual property and the right of the valid users are further protected and maintained, integration of the software and hardware encryption is needed. Since each RFID tag with a unique ID (UID) which records the on demand information can be used as the individual identification, the small and cheap RFID tag can be

considered as the hardware/software encryption/decryption key corresponding to the files or applications. In the next section, we give some descriptions for related RFID application and system.

2. Related application and system

Some researchers presented that the embedding RFID can be plugged into a small device such as handheld host [1]. The handheld device users can plug in the SD or CF interface of reader card. Hence, the users can scan and induct the RFID tag everywhere. In other words, to integrate the RFID system hardware into the mobile devices is practicable. Furthermore, the RFID system including RFID induction antenna, RFID parser and reader, RFID tag, etc., today is cheap. In addition, the RFID hardware including antenna and reader is not only cheap but also can be a PnP device. It means that the RFID hardware can be used as a normal user device such as the card-reader.

2.1. RFID encryption and decryption for intellectual property protection

2.1.1. Application

Since the RFID systems are popular and ripe for distinguishing treatment of individual target [16, 17], the unique characteristic or identification of RFID can be the solution of intellectual property protection. Many researches proposed the possible way to protect the intellectual property, products, or applications. In some applications [18], the RFID chips are embedded in the cap of bottle. The medicine can be differentiated between fake and true. In addition, the RFID chip can be placed in the CD or DVD disk. The CD-ROM can accesses and reads the information of the RFID for valid identification check. Only the CD or DVD with the authorized RFID can be played. Although the content is protected, the self-made content that burned in the CD-R/RW or DVD-R/RW may not provide the authorized RFID information. In other words, the private, non-business, or free digital content made by the individual may be limited and cannot be transmitted free. In addition, even the CD or DVD disks are protected, the digital content such as files or data still can be copied from the disk to other devices such as hard disc or MP3 player. Therefore, how to separate the right of the digital content for each user and how to protect the digital content from illegal use become the important issues.

Due to the demand of existed system integration, some applications related to *RFID Encryption and Decryption for Intellectual Property Protection* includes: PnP Middleware, RFID Hardware, End User RFID Device and End User RFID Tag, and Encryption/Decryption Procedure. The system framework is shown as follows.

For a normal user, there are two types of RFID devices for the encryption/decryption on RFID system (E/DonRFID system): End User RFID Device for digital content or multimedia information gaining, and End User RFID Tag for indentifying the legal user.

E/DonRFID not only provides the RFID based protection procedure but also includes the Encryption/Decryption method based on RFID character. The encryption and decryption can be implemented by hardware or software solution. The original digital data is encrypted by 1) hardware, 2) software, or 3) combination of hardware and software. Corresponding to the encryption method, suitable RFID tag of user for decrypting is needed.

Since three possible ways to protect the digital content are proposed, for the end users, there will be at least three possible states and method of *E/DonRFID Encryption/Decryption*, to gain the protected digital data, shown as follows:

1. Encryption and Decryption by Hardware and Software combination,
2. Encryption only by Hardware with Hardware and Software combination Decryption
3. Encryption only by Software with Hardware and Software combination Decryption
4. Encryption only by Hardware with Hardware Decryption
5. Encryption only by Software with Hardware Decryption

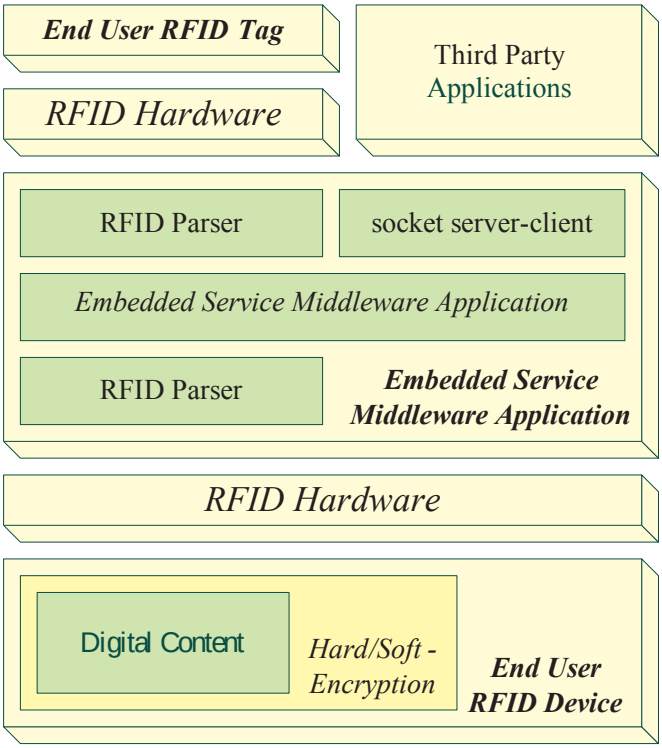

Figure 1. The framework of RFID Encryption and Decryption for Intellectual Property Protection

2.1.2. Method

First, depending on the digital content storage hardware such as CD-ROM disk, the commercial RFID tag can be embedded into the disk when the disk is made. According to the characteristic of RFID tag, each RFID tag can be set with different individualities. The different encryption code, unique ID, information of the digital content, or authentication serial number can be recorded in the RFID tag. In addition, the RFID tag embedded in the disk is not rewritable. Hence, different disks equip the different IDs of RFID tag. When the RFID reader inducts the tag, the information about this storage can be scanned and presented. In other words, only the digital storage with the valid RFID tag is legal and true.

Second, since the content or data are digital, these software, content or data, can be encrypted as the secret codes or cipher. The key for encryption and decryption can be recorded in the RFID tag. Without the specific key, these secret codes or ciphers cannot be recovered as the original data. In other words, the digital content that recorded in the storage device (such as CD-ROM disk) can be secured. The decryption key can be recorded in the RFID tag embedded in the storage or a palm RFID tag (such as a RFID toy).

For the end users, *End User RFID Device/Tag* is used. The storage, whether hardware (CD-ROM) which includes the encrypted digital content, or software (files or ciphers), is called *End User RFID Device*. If the *End User RFID Device* is hardware, the third party *RFID Hardware* can induct the RFID tag embedded in the hardware. After identifying the *End User RFID Device*, the application or user can execute and read the digital content if only *Hardware - Encryption/Decryption* is used.

According to three possible states, the end user must have the decryption key for executing the digital content. In this paper, the hardware (RFID tag) or software for the decryption key is called *End User RFID Tag*. After identifying the *End User RFID Device*, the end user has to provide the *End User RFID Tag* for the *Embedded Service Middleware Application*. Only the information or password of *End User RFID Tag* is correct and can be used to gain the secured decryption key which recorded in the *End User RFID Device*, the digital content recorded in the *End User RFID Device* can be presented.

Considering that the three possible states are based on the RFID induction, the *RFID Hardware* is divided into two types of equipments: for *End User RFID Device* and for *End User RFID Tag*.

According to the three possible ways to protect the digital content, when the protection is based on the combination of *Hard/Soft- Encryption/Decryption* and Only *Hardware-Encryption* with *Hard/Soft –Decryption*, the *RFID Hardware* for *End User RFID Device* is needed. Due to that the digital content is protected by the RFID tag embedded in the hardware, the information recorded in the tag has to be inducted before using. For example, if a tag is embedded in the CD-ROM disk, the user should have a CD-ROM driver with the *RFID Hardware* when reading the disk. In other words, if the protection is based on the hardware belongs to *End User RFID Device*, the corresponding reader with *RFID Hardware* is necessary. The *RFID Hardware* can be embedded in the CD-ROM driver, reader, or other multimedia devices.

In opposition to *End User RFID Device*, when the decryption is based on the *End User RFID Tag* key, end user has to own the valid RFID tag for decrypting the digital content. For example, the decryption code is recorded in the RFID tag of *End User RFID Device*. However, the decryption code is secured by the password which locks the data slot of RFID tag. Without the correct password, end user cannot gain the decryption code that secured in the RFID tag of *End User RFID Device*. To provide the password, the end users should have the *RFID Hardware* such as the USB-RFID reader, etc.

To manage the RFID information, *Embedded Service Middleware Application* is proposed to parse the information from the *RFID Hardware*. Due to that there are different RFID product, an RFID parser is needed for analyzing and parsing the information from *RFID Hardware*. After gaining the requirements or response, the *Embedded Service Middleware Application* searches the corresponding applications and passes the information. Figure 2 presents the framework of *Embedded Service Middleware Application*.

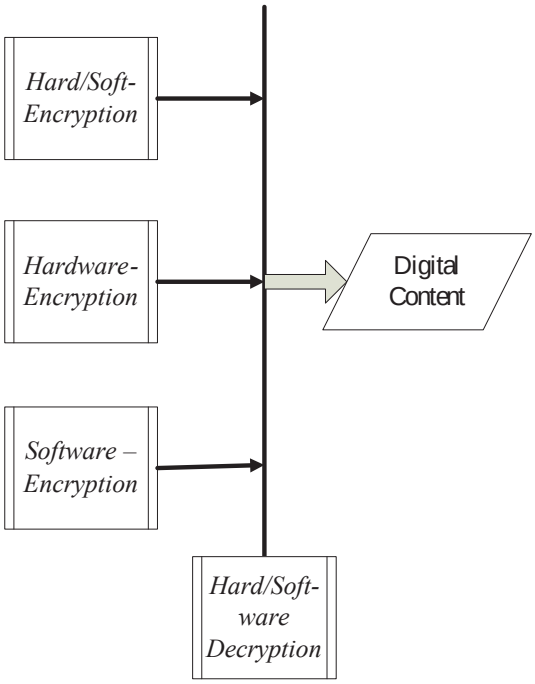

Figure 2. Possible ways to gain the protected digital data

The *Embedded Service Middleware Application* implements the socket server-client structure for communication with other existed or third party applications. The information comes from the *End User RFID Device*, such as specific password-requirement, will be recorded in the database of middleware application. The requirement will be maintained based on the on de-

mand limitation of the period of validity or when the *End User RFID Device* is removed. In addition, when an end user tries to gain the digital data from the *End User RFID Device*, the middleware application request the end user for the password. After receiving the password, the middle application transmits the password and tries to gain the decryption code. If the password is correct, the decryption code will be transmitted to the user application such as multimedia player, etc. Otherwise, the digital content cannot be decrypted and used. Therefore, only the two conditions: 1) the key information of *End User RFID Tag* matches the password requirement of *End User RFID Device*, and 2) the decryption code is correct in decrypting the digital content are satisfied, the user can gain the information from the *End User RFID Device*

2.2. Location aware public/personal information services based on embedded RFID platform

2.2.1. Application

Many researches proposed before presented the importance of providing information and services related the user's location to each person. Some researches assume that there are GPS devices or module included in the users' mobile devices. Then, according to the information of GPS (GIS) [19-22], the location aware or related information or services are provided to the mobile user trough the wireless network. Although the GPS provides the accurate location of users, most users indeed needs the approximate local-area-aware information. The accuracy of location such as longitude and latitude is not the main issue. Furthermore, not everyone can equip the GPS.

Hence, in addition to GPS, according to the orientation made by the station of wireless cellular system [23], the related information according to the user's location can be given to the user via cellular system. Each cellular phone user can be served directly by the telecommunications companies. If a user is served by the specific wireless base station, the information related to the coverage area of this base station are given to the phone user.

Since the RFID system is popular and generally implemented, many researches [24-30] tried to integrate the RFID to and applied RFID technology to context-aware systems. However, in [31], what kind of the context, the corresponding context services, and the context-aware RFID system are important to be provided for user is still an issue of the existing system. In addition, to integrate the existed system such as information service and payment system become the important topic.

Not only supply the public services but also give the personal services, the context aware researches [32-34] were also proposed. Research in [35] was proposed that considering the user's related location. Hospital or health care RFID systems [12-14,34] for monitor the tag users were also proposed. A designed RFID tag is given to each user such as a patient. Each patient should always wear the RFID tag every time and everywhere. Hence, the patients' current information such as location and health conditions are monitored by the hospital. In addition, some entrance guard systems are also based on RFID system. The RFID ticket or RFID card [2, 3, 10, 36] is used to identify that a user is legal or not.

The services and information of user-location-related public places such as the museum [37] are provided. According to the requirement of users, different services are given through wireless network or cellular system to different users even they are in the same places.

Hence, a realistic application such as Location Aware Public/Personal Information Services based on RFID is proposed. By using the location-aware RFID application, the main contributions are :

1. Users of location-aware RFID application can communicate and gain the information corresponding to the users' location through the RFID tag. The handheld devices with RFID reader can also manually obtain the extra or required or local information and services.
2. The efficiency of system management and service utilization can be improved, information can be the digital multimedia and updated immediately,
3. The location-aware RFID application can be embedded in other similar service systems and hardware. The proposed service system can be included in the existed information center or server. The additional cost for integration can be reduced.
4. The service object and function can be various. For example, the location-aware RFID application provides not only the public or general information services to every system user, but also the deferential personal service to individual location-aware RFID application user.
5. The ticket and payment services can be integrated into location-aware RFID application service system. Users needn't to bring too many identification devices or cards. All method of payment and public or personal services are integrated into one RFID tag and location-aware RFID application service system.

2.2.2. Method

The system structure is shown as Figure 2. The *Embedded Service Middleware Platform* is the main system to manage the internal and external system connections. The RFID API and parser are included and provided to communicate with the third party RFID system. The *Embedded Service Middleware Platform* also makes the information connection to other business management system or database via software API. In addition, the related information to the RFID tag inducted is presented by user interface.

For the end users, *End User RFID Handheld Facilities* consists of two appliances: *end user RFID tag* and *end user device with RFID System*. A user can use a given readable and re-writable RFID tag or a handheld device such as PDA which equipped a RFID system to gain the required public/personal services. In Figure 2, the user handheld device also equips the RFID system, RFID API, and parser to scan and induct the commercial RFID tag. The communication and the data transmission between the handheld device and server can be established via 1) Internet, 2) server-client socket, 3) a user RFID tag, or 4) a readable and re-writable RFID tag. A user can view the information or obtain the services via user interface (UI) presented by server or the user handheld device.

The other business management systems in the framework can be the third party developments and independent of the whole system. When the user approaches the RFID system at the specified area, the induction and communication between end user RFID tag and antenna of *RFID System* is automatically established. A RFID reader will parse the signal into the digital and computing content. Then, the *RFID System* transmits the information obtained from the tag to the *Embedded Service Middleware Platform* via Internet. According to the RFID information, the *Embedded Service Middleware Platform* searches for and provides the specific personal service recorded in local area server according to the on demand conditions of the user. Moreover, the information or services can be updated or provided from the main database via Internet connection. Then, the user can obtain the public/personal information from the user interface.

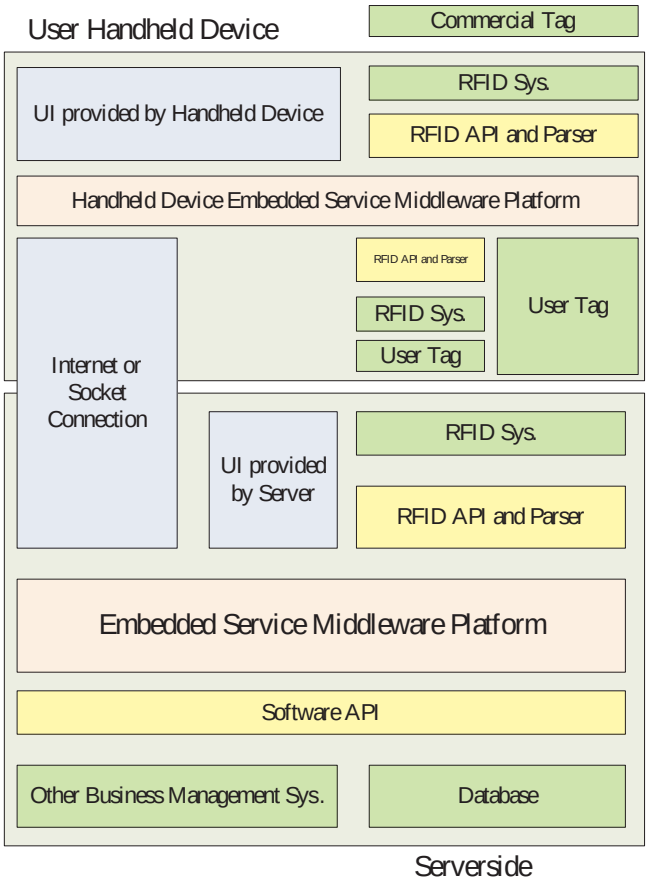

Figure 3. The whole framework of location-aware RFID application service system

In the location-aware RFID application service system, the RFID antennas and reader are deployed 1) at the specific area or location such as the entrance of the rapid transit system or the information service machine, or 2) within the handheld devices such as PDA or mobile phone. When a user is given a readable RFID tag, the related information or the user's on demand service conditions about the user is given by himself and on demand recorded in the database. When the user requires the local area public or personal services, the user should be at the tiny induction area such as a local area information center or a service station. Then, the RFID system placed in the specific area inducts the RFID tag and gain the information such as UID from the RFID tag. The reader of RFID system then sends the information to the local area server via Internet.

After receiving the information and parsing the message from RFID system, the content of RFID tag can be identified. If *end user RFID tag* is used, the *embedded server service middleware* can search and present the local information such as local area shopping information, traffic information, or the customization information, recorded in local database that match the on demand conditions of the RFID tag user. In other words, the RFID user can be directly served with sufficient local area related information. If other further information needed, the *embedded server service middleware* can send the user's request to the remote main server to obtain the requested service or to the other business applications via Internet for extra service obtaining. At last, the user can gain the location-aware information or services via user interface. In opposition to *end user RFID tag*, when a user of *end user device with RFID System* actively scans the RFID tag of the commercial advertisement, the handheld device can send the scanned RFID tag information via wireless network or cellular mobile system to the local area server with *embedded server service middleware* embedded. Then, as the procedure of *end user RFID tag*, the *embedded server service middleware* searches for the requested services and transmits these services to the user's handheld device by wireless network or cellular mobile system.

In addition, the users can use *handheld device middleware application* to select the tag content recorded in handheld device database if needed. Then, the RFID API controls the RFID system embedded in the handheld device to re-write the content (such as UID) of the tag of the handheld device. At last, the RFID content requirement from other business applications or systems can be provided through the RFID tag of the handheld device.

In addition, the database can record the history of the user's requirements. The statistic user requirements can be used to classify that what kind of the service the user requests most. Next time the system can provide the personal services according to the classified results. In other words, the users can be served with the services they most pay attention to.

The real test and verification is implemented as Figure 3. The implementation shows one shoot of the verification. When the user approaches the on demand placed RFID system, the *Embedded Service Middleware Platform* automatically presents the information corresponding the content or user's related information recorded in the RFID tag. For example, if a Taiwanese uses the RFID tag, the presentation of local area server will be based on traditional Chinese. But the local area server will provide English when a native English speaker user his own RFID tag respectively.

Figure 4. The environment of test and verification

2.3. RFID applications on supply chain management

2.3.1. Application

Existing RFID applications on supply chain management (SCM) can record something about materials, goods, and products during production [38, 39]. An integrate system with RFID and SCM also can supplies new value-added services such as products secure protection and to query products record [40]. And integrating promising information technologies such as RFID technology, mobile devices-PDA and web portals can help improve the effectiveness and convenience of information flow in construction supply chain control systems [41]. In addition, RFID can be use in a lifecycle of a product to reduce the time which spend to find a product. Therefore, RFID is a technology to reduce the time to identified objects that can improve automation in the traceability management of Supply Chain.

In Warehouse management, many companies have used RFID technology replaced the Bar Code or QR Code as recognition of the key features. Because of the Bar Code and QR Code are limited in existing format companies decided to select a solution improving automation in warehouse management. Then the RFID technology is an efficient technique to solve that problem. Company integrated RFID technology with warehouse management that is not only an electronic process solution but can provided customers with new services such as location information of products, search stock of products, and provide inventory information [42, 43].

In healthcare, RFID also can use to trace patients, blood sampling, drop management, etc. Kumiko Ohashi, SakikoOta, LucilaOhno-Machado, and HiroshiTanaka [44] developed a smart medical environment with RFID technology. This research used two types of frequency on tracking system for tracking clinical intervention such as drug administrations and blood tests at the patient bedside. Furthermore, Chung-Chih Lin, Ping-Yeh Lin, Po-Kuan Lu, and Guan-Yu Hsieh [45] proposed a healthcare integration system for disease assessment

and safety monitoring of dementia patients. The proposed healthcare integration system provides the development of an indoor and outdoor active safety monitoring mechanism.

Hence, due to that the RFID technology could provide some services with auto-identify such as administration of drops and samplings, safe monitoring of patients, process control in medical. These new type services can reduce the search time in administration of drops and samplings and human error in medical process. The major advantage of using RFID technology in medical is reduced the human error.

However, RFID applications on Supply Chain Management and Warehouse Management were provided static information as previously noted which helped to deal with problems after accidents. Information on RFID systems was lacking warning data of preventing accidents [5]. To summarize, both Supply Chain Management and Warehouse Management are increase economic values of product. Those operations of management can be help to support product safety information and attribution of responsibility information for customer and enterprise. When enterprise want reduce possible impaired factors to improve the value of product, the first thing should to do is disease management. In addition, disease management has two important methods which to find out the initial pathogen and reduce the spread of pathogens and the infection rate. The spread of pathogens and the infection rate decide the effect areas and damages. Because of enterprise can economic damage control by detect symptoms of product at early stages that will help to reduce cost of operation by itself.

For example, to improve the efficiency of management in cultivation, an *RFID Based Fuzzy Inference Algorithm for Disease Warning and Tracking via Cloud Platform* is proposed. Users could manage the cultivation history, related bio-information, and possible disease tracking. The proposed system modifies the traditional cultivation management system by several fields: 1) first, to shorten the processing time of object recognition in production operation; 2) second, to establish electronic records of production in production management systems; 3) third, to integrate supply chain managements with a central server and provide real-time environment monitoring and plant disease management services for users; and 4) last, to establish an information platform to share with users.

Due to that the contents storage in the memory of RFID tag can be changed when users need. Furthermore, RFID can apply in recognition and also can work in hostile environment such as wet and dirty [26]. RFID provides large read range (or induction range) than Barcode and QR code. Therefore, the RFID system can help to efficiently identify object which equips RFID tag even in non-uniform position. Besides, RFID tag is rewritable. User can remove or rewrite the content of RFID tag when the induction happened between the RFID tag and the RFID reader. In order to overcome the environment factors of cultivation and the objects size, RFID is the solution that can suitable to solve these problems.

In recent years, transportation becomes faster with long distance and also causes more areas infected by disease more easily. After infectious disease influencing a mounts of areas, disease management is more complex and ineffectual [6]. Therefore, quick disease control and prediction is important since it could help to reduce the cost and complex of disease management. Hence, effective disease data tracking and collection of pathogens is necessary.

Due to portable RFID tags and non-touched transmission, local area wireless application about disease management for tracking and collection data based on RFID system is proposed. In addition, an information platform which collects data from everywhere and stores the data in its database for the members of supply chain is needed and important. Every platform user can query and access some information from an information sharing platform via network. An information platform can store a lot professional data of a particular field. The platform also can integrate information from each region and has more powerful computing for more information services.

2.3.2. Method

The proposed application system structure is shown as Figure 4. The system infrastructure includes RFID system such as RFID tag, RFID reader, mobile RFID device, etc., and software framework such as database, *Environmental Affection Evaluation Method*, and *Disease Tracking Service* in cloud. The user application layer indicates the mobile RFID device which is used for inducting the RFID tag of local objects such as crops or livestock. The information read from the RFID tag by the RFID reader will be transmitted to the corresponding application and database in cloud. Considering the real implementation, *Environmental Affection Evaluation Method* and *Disease Tracking Service* can be established as the middleware of the whole system or the corresponding applications in cloud. When a user wants to query the information or obtain the disease warning, the proposed *Environmental Affection Evaluation Method* and *Disease Tracking Service* can notify the client user via network from cloud platform.

Generally, an RFID system includes RFID Tags, RFID Readers and Application programs. An RFID tag is a digital storage device that used for identification and information recording. A Reader can access, read, or write data into RFID tags through electromagnetic induction. A user can only use the RFID tag without power consumption. In addition, the mobile device used in RFID system can be a Person Digital Assistant (PDA), a Person Computer (PC) or a laptop (Notebook), which executes the reading and writing actions via RFID systems (include software API and hardware). The middleware mainly manage and deal with the RFID event such as the RFID information sent to or from other systems. After receiving the message from RFID readers, the content of RFID tag can be identified. Then the RFID information will be transmitted and recorded in the database in cloud by *RFID Event Processing*. In addition, the corresponding information sent by *RFID Event Processing* is also presented by the user interface. The *RFID Event Processing* also properly manages and provides the information service for *Environmental Affection Evaluation Method* which analyzes and evaluates the affection degree of the environmental factors.

After inducting the RFID, the information can be transmitted to the corresponding applications and recorded into database in cloud. Each RFID tag will establish an individual object history about the location, resident time, environment state of the RFID tag when it was storaged, etc. To trace and track the potential diseased objects, the *Disease Tracking Service* for client users is needed.

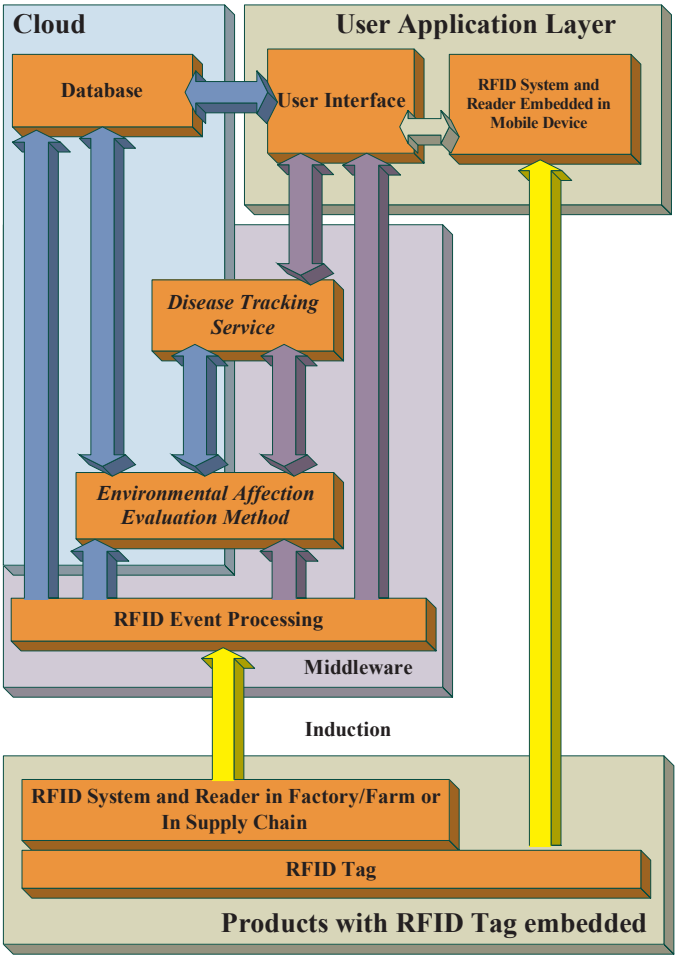

Figure 5. The structure of RFID system with Cloud environment

Via *Disease Tracking Service*, customers or client users can obtain active and passive warning message. First, when a customer or client user uses the mobile RFID system to query the information, the corresponding record in the past will be checked and sent back from the database in cloud platform. Then, the members of the supply chain can monitor and manage the state of objects. Second, if the specific object (crop or livestock) is found to be diseased, this object will be marked as the dangerous object. Then, according to the object history, the route, location, etc., where this dangerous object ever passed will be traced back. According to the structure presented in Figure 2, since the object history is established in cloud, the members of the supply chain can exchange the information via cloud. Therefore, the history of the dangerous object can indicate the information about place, location, resident time, etc.

Therefore, if the *Disease Tracking Service* finds the dangerous object, the corresponding history, members of supply chain, and the potential diseased that evaluated by *Environmental Affection Evaluation Method* can be notified and traced. In other words, no matter where the objects are, the *Environmental Affection Evaluation Method* can always give the probability value of objects which indicate the potential diseased probability. By using the *Disease Tracking Service*, the location, warehouse, manager, etc., will be notified that how many objects with the different and individual potential diseased probability currently reside at or ever passed the place. Therefore, the object with high potential diseased probability can be discovered in early phase. Figure 5. presents the implementation of the system.

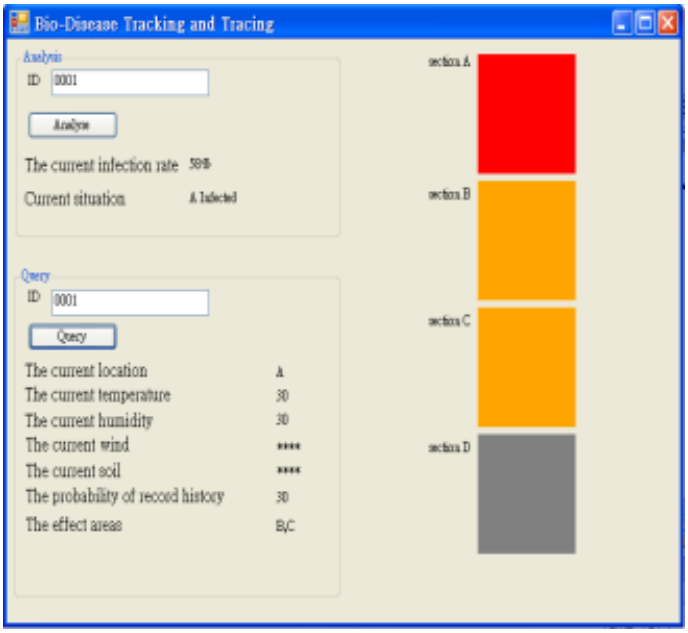

Figure 6. The implementation of tracing and tracking system based on RFID

The tracing and tracking system based on RFID system not only provide original services in supply chain or warehouse which includes the records of products for managing and querying, but also provide new services such as to obtain the potential probability of diseases and send the warning sign for users. Furthermore, the system can derive the possible disease infecting area for users to control and update the latest information of production for users to track and trace. In addition, the verification shows that the proposed system is realistic and can provide the public and personal services automatically. By using this innovation RFID system, users could get most information to prevent disease in agricultures that helps users to reduce the cost of production, control the range of disease occurrence, and providing a warning for disease prediction.

3. Discussion

Radio Frequency identification (RFID) is the popular wireless induction system [7] [2, 3, 8, 30]. Each RFID tag in an RFID system is equips a unique ID (UID) itself. UID can help to shorten the identification time for individual object recognition. In general, there are several methods to achieve aim of Automatic Identification such as Barcode and QR code. However, due to that the Barcode and QR code have the limitation in environmental affection such as wet or water, to maintain the usability and the reliability of the Barcode or QR code is too difficult. Therefore, using RFID can be the solution which provides the distance induction with better characteristics such as anti-water and rewritable memory.

A standard RFID system consists of Tag, Reader, Middleware, and Application. When an independent RFID tag approaches the RFID antenna, the induction between RFID tag and antenna happens [9]. The RFID antenna reads or obtains the information and content recorded in the tag. Then the information is translated into the computational data by the RFID reader. Due to the portable RFID tag and untouched data transmission, many local or small area wireless applications for track and trace based on RFID systems were proposed [2, 7, 8].

RFID reader can access data of RFID tag and transmit the content from RFID tag to middleware which is a necessary component in RFID application system. The middleware is also the interface software that connects new RFID hardware with legacy enterprise IT systems [36]. Middleware is used to route data between the RFID networks and the IT systems within an organization. It merges new RFID systems with legacy IT systems.

RFID Reader is also called Interrogator. The RFID reader can read and write data of RFID tag via radio frequency. RFID readers can classify serial reader and network reader according to connection interface.

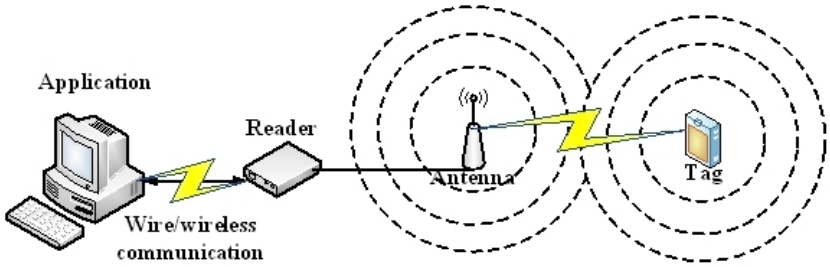

Figure 7. Operation concept of RFID system

In Radio Frequency Identification, there are four standard frequency ranges used: Low Frequency (LF), High Frequency (HF), Ultra-HF (UHF), and Microwave respectively. Frequency decides the reading distance of RFID devices and the interfered with environment. Figure 7 shows the shows the conditions and factors related to the frequency. Higher frequency RFID tag has longer induction distance, higher data rate, and smaller Tag size. On the con-

trary, lower frequency RFID tag has shorter induction distance, lower data rate, and bigger tag size. In addition, higher frequency RFID tag has bad performance when tag near metal or liquids. In this thesis, the proposed system selects low frequency RFID tag because that the cultivation environment is wet and dirty. Low frequency RFID tag has better performance than high frequency RFID Tag at cultivation environment.

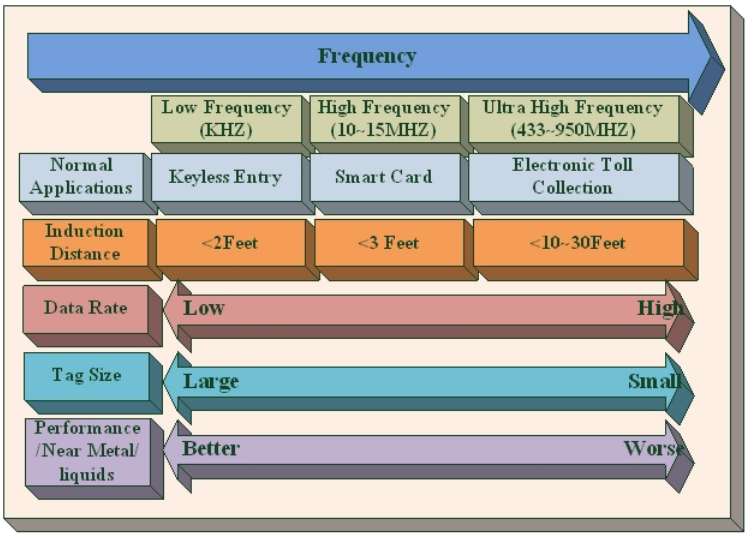

Figure 8. RFID frequency specification chart

There are two main types of RFID tag, active and passive. Active tag is a powered tag which equips battery and actively sends signal itself. In opposition to active tag, passive tag without battery can only send signal when the tag is inducted. Table 1 presents an introduction for RFID Tag.

Freq. Effect	Low Frequency(LF)	High Frequency(HF)	Ultra-HF (UHF)	Microwave
Usable Frequency	100~500 KHz	10~15 MHz	433~955 MHz	1GHz~
Common Frequency	125 KHz 135 KHz	13.56 MHz	433 MHz 868~950 MHz	2.45 GHz 5.8 GHz
Power Type	Passive	Active / Passive	Active / Passive	Active / Passive
Reading Distance	Short range	Short range	Longer range	Longer range

Source: EPCglobal.(http://www.gs1tw.org/twct/web/EPC/index.jsp)

Table 1. The relational table of RFID frequency and instruction.

The RFID technology is affected by several factors such as frequency, energy, and environment. When users decide to use RFID in a particular place, users have to select the fittest specification of RFID at first. Because the fittest specification of RFID can make higher performance in the efficient of RFID application system, to select the fittest specification of RFID is important. Furthermore, the cost of RFID is an important factor for users to select.

4. Challenges

4.1. Cost

Today, based on the behavior of customers, the history or record of the production including the delivering is not the most important thing. Most consumers care about the price, expiration date, or packing of the goods. In other words, although the RFID can enhance the management of logistic, to embed the RFID technology into current system also cost a lot. For example, one RFID tag for paste once (non-reusable) may cost $0.8. However, a bottle of water may also cost about $1. Most consumers would not to pay almost twice payment to obtain the information which they do not care about. Comparing with barcode or 417-barcode, the RFID tag costs more than barcode or 417-barcode which can be printed by a printer. In other words, to identify an object via RFID tag costs more than using barcode.

In opposition to once-using RFID tag, to reuse the RFID tag may be a solution. A plastic card where RFID embedded can be used for identification or payment. For example, in Taiwan, most mass transit systems can be paid according to the RFID card that pre-registered and sold to the consumers. Each consumer can use the RFID card to pay the consumption in convenient store, fee of the parking lot, and use the card as a ticket for railway or MRT system. Due to the convenience, most consumers have at least one RFID card for payment. However, the security for financial application is very important. Although there are some security method proposed, no algorithm or system can provide the 100% promise that the security method is always safe.

(a) (b) (c)

Figure 9. The sample of RFID Tag; a.3D Toy, b. plastic card, c. button tag.

In addition to the RFID card, various styles of RFID tag may be required by different consumer. According to the environment, the RFID tag may be designed to anti-water or anti-wet. Some RFID tags need to be applied to the metal environment such as containers. Due to the characteristics of RFID, suitable frequency of RFID corresponding to the environment should be selected carefully. In other words, the cost of different RFID may be also different according to the applications and environment. Furthermore, different shapes of RFID tag also costs. For example, the cost of an RFID tag embedded into a 3D toy is much more expensive than that embedded in a plastic card.

4.2. Hardware and integration

The RFID Antenna is the main component for RFID tag induction. The antenna continuously spreads the electromagnetic wave. The energy is transmitted to the RFID tag. After induction, the RFID Antenna also receives the signal from the RFID tag.

After receiving the signal, the RFID Reader translates the signal into the digital data such as the UID of this RFID tag. Then, the RFID Reader sends the digital data to the corresponding systems or applications. To implement the RFID system, not only the RFID tag but also RFID reader and antenna hardware should be considered. Due to the design and product limitation, the RFID antenna cannot dynamically change. Therefore, similar to the RFID tag, the environment of the RFID system affects the size and cost of the antenna. The size of the antenna increases, the costs also increases. In addition, considering the implementation environment, to place the antenna at the suitable location for signal receiving also affects the performance and costs. Therefore, to integrate the RFID system with the existed system, some additional problems may need to be overcome.

The existed applications or systems should include or integrate the RFID system. In other words, to integrate the RFID system, the original working practices of the existed system may be changed which needs extra costs. For example, to identify goods in warehouse, original applications or systems may only need the manual operation. However, to integrate the RFID system, some infrastructure such as the placement of RFID antenna, wire line for connection between antenna and reader, and the establishment of RFID reader and system server are required. In other words, the extra costs of RFID infrastructure are needed. In addition, some existed systems are based on mechanical operation without too much intelligent analysis. For example, a car parking lot only needs to open the gate when a car approaching or according to the teleswitch. When integrated with the RFID system, the RFID antenna should be placed in front of the gate for induction. All the cars to the parking lot should present the RFID tag given on demand. In addition, the RFID reader should be used to analyze the signal information from the RFID tag. The server which includes the database should be used to judge whether the gate should open or not. Although the RFID system enhances the automation with less manual operation, some extra costs and delay may also happen. Therefore, the benefits of RFID system integration such as automation, information exchanging with third party applications, etc., are very important. Only when the benefits or additional new functions overcome the extra costs of RFID system integration then the integration of system will be used.

4.3. Plug and play middleware

In the RFID systems or applications, there are two partitions: RFID devices (includes RFID tag, antenna, and reader) and other devices or systems. Therefore, the application or middleware for communicating these two parts is needed. When using the RFID device, the third party systems or applications should obtain the information from RFID devices.

Due to that there are many types of RFID hardware, the application program interface (API) for the communication between RFID Hardware and different third party applications is needed. In addition, the end user's devices are also various. Hence, the plug and play middleware for different hardware and applications is important.

To manage the RFID information from different RFID Hardware, and the communication with different applications, the Plug and Play Middleware is proposed. To realize the concept of Plug and Play, the proposed middleware has to manage the information from the all possible third party RFID Hardware, deal with and parse the information, and then provide the required information to the corresponding applications. Therefore, the main purposes of the proposed Plug and Play Middleware are:

1. to parse the information from the RFID Hardware. Due to that there are different RFID product, the RFID parser is needed for analyzing and parsing the information from RFID Hardware. The information about UID, password, etc. will be parsed as the string for the further execution of applications. In this paper, two possible parsers are established. First, the Plug and Play Middleware provides the remote procedure call (RPC) function for the third party RFID Hardware. The UID of the RFID tag inducted by the RFID Hardware will be formulated as the string. In addition, the password or requirements for further information such as decryption code recorded in the End User RFID Device can be provided by the remote procedure call function. Second, for general communication, the Plug and Play Middleware also provides the sever-client socket link between the RFID Hardware and the middleware. In other words, even the RFID Hardware cannot implement the remote procedure call, depends on sever-client socket link, the information can be transmitted between Plug and Play Middleware and RFID Hardware.
2. to provide the application program interface (API). Since the RFID Hardware may not directly communicate with the applications, the Plug and Play Middleware has to implement the corresponding API for other third party applications or software.

Furthermore, the Plug and Play Middleware also should implement two possible APIs: the external procedure call and network communication. If the application is embedded in the Plug and Play Middleware, the external procedure call sends the required information to the specific application. In addition, some communications of the related applications such as database query are also established by the external procedure call. Then, the Plug and Play Middleware deals with the results from the external procedure call. In opposition to external procedure call, for the concept of Plug and Play, normal network communication should also be implemented. Most third party software or applications can communicate with the Plug and Play Middleware via sending the information in string format. For example, if the third party application

requires the further checking, the Plug and Play Middleware sends the required information such as UID to the server via Internet. To reduce the cost for communicating with different third party applications, the unify data storage format is necessary. Therefore, the eXtensible Markup Language (XML) can used as a data exchange standard. After obtaining the response from the server, the Plug and Play Middleware can acknowledge the third party application. At last, the corresponding services can be presented.

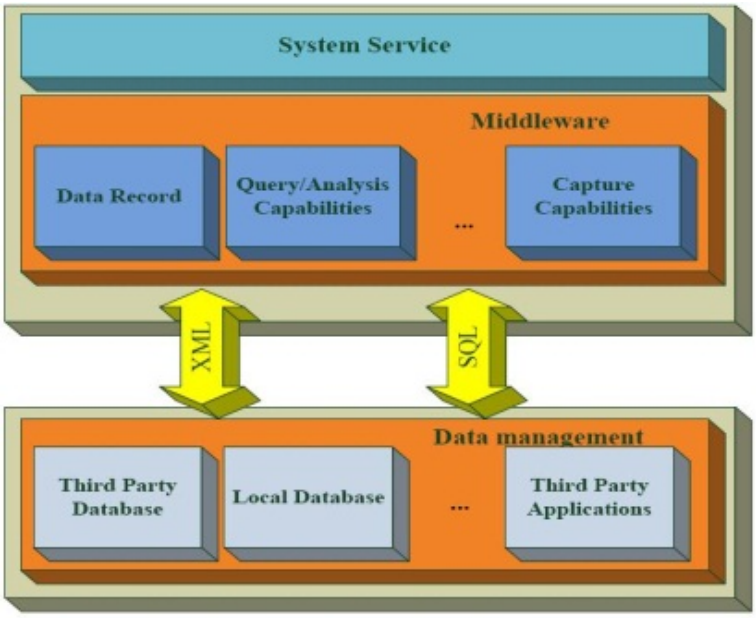

Figure 10. The structure chart of data exchange in Database management

5. Conclusion

In this chapter, we show applications and systems based on RFID technology which integrated into the existed service systems. The RFID technology can enhance the automatic management procedure. Identification and tiny information exchanging can be achieved. Individual or personal services can be provided to different consumers. However, to establish the RFID embedded systems and applications, the cost, convenience, feasibility should be considered. To adopt RFID system, some extra costs such as RFID tag and hardware should be overcome by the enhanced performance of management. In other words, to implement the RFID systems for the consumers, to enhance the convenience for consumers will be an important issue than the cost.

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References

[1] "Hoboken RFID-enables Its Parking Permits," RFID Journal, Jun 2006, http://www.rfidjournal.com/article/articleview/2421/1/1/

[2] "RFID Takes a Swing at Ticket Fraud", RFID Journal, Dec 2005, http://www.rfidjournal.com/article/articleview/2060/1/1/

[3] "Moscow Metro Tries RFID-Enabled Ticketing," RFID Journal, Feb 2007, http://www.rfidjournal.com/article/view/3049/

[4] A.S. Martinez-Sala, E. Egea-Lopez, F. Garcia-Sanchez, J. Garcia-Haro, "Tracking of Returnable Packaging and Transport Units with active RFID in the grocery supply chain," Computers in Industry, Vol. 60, Issue 3, pp.161-171, Apr 2009.

[5] T.C. Poon, K.L. Choy, Harry K.H. Chow, Henry C.W. Lau, Felix T.S. Chan, K.C. Ho, "A RFID case-based logistics resource management system for managing order-picking operations in warehouses," Expert Systems with Application, Vol. 36, Issue 4, pp. 8277-8301, 2009.

[6] C. Loyce, J.M. Meynard, C. Bouchard, B. Rolland, P. Lonnet, P. Bataillon, M.H. Bernicot, M. Bonnefoy, X. Charrier, B. Debote, T. Demarquet, B. Duperrier, I. Felix, D. Heddadj, O. Leblanc, M. Leleu, P. Mangin, M. Meausoone, G. Doussinault, "Interaction between cultivar and crop management effects on winter wheat diseases," lodging, and yield, Crop Protection, Vol. 27, Issue 7, pp. 1131-1142, 2008.

[7] Colin H. Burton, "Reconciling the new demands for food protection with environmental needs in the management of livestock wastes," OECD Workshop, Vol. 100, Issue 22, pp. 5399-5405, 2009.

[8] Beijing Olympic Games Prompts RFID Development in China, http://www.rfidglobal.org/news/2007_9/200709031653253861.html

[9] M.S. Jian, K. S. Yang, and C.L. Lee, "Context and Location Aware Public/Personal Information Service based on RFID System Integration," WSEAS Trans. on Systems, Vol. 7, pp. 774-784, Jun. 2008.

[10] Z. Pala and N. Inanc, "Smart Parking Applications Using RFID Technology," Proc. of 1st Annual RFID Eurasia, pp. 1-3, Sep 2007.

[11] M.F. Lu, S.Y. Chang, C.M. Ni, J.S. Deng, and C.Y. Chung, "Low Frequency Passive RFID Transponder with Non-revivable Privacy Protection Circuit," Proc. of WSEAS Inter. Conf. on Instrumentation, Measurement, Circuits, and Sys., pp. 166-169, April 2006.

[12] "Hospital Uses RFID for Surgical Patients," RFID Journal, Jul 2005, http://www.rfid-journal.com/article/articleview/1714/1/1/

[13] "RFID Hospital: Columbus Children's Hospital To Install RFID System From Mobile Aspects", RFID Solution Online, Mar 2007.

[14] "RFID trial tracks hospital equipment," http://www.computing.co.uk/computing/news/2168717/rfid-trial-tracks-hospital

[15] C.L. Lai, S.W. Chien, S.C. Chen, and K. Fang "Enhancing Medication Safety and Reduce Adverse Drug Events on Inpatient Medication Administration using RFID," WSEAS Trans. on Communications, Vol. 7, pp. 1045-1054, Oct 2008.

[16] M.S. Jian and S.H. Hsu, "Location Aware Public/Personal Diversity of Information Services based on embedded RFID Platform," Proc. of ICACT'09, pp. 1145-1150, Feb 2009.

[17] Ming-Shen Jian, Kuen Shiuh Yang, and Chung-Lun Lee, "Modular RFID Parking Management System based on Existed Gate System Integration," WSEAS Trans. on Systems, Vol. 7, pp. 706-716, Jun 2008.

[18] http://www.ist.com.tw/

[19] C.S. Baptista, C.P. Nunes, A.G. de Sousa, E.R. da Silva, F.L. Leite, and A.C. de Paiva., "On Performance Evaluation of Web GIS Applications," Proc. of the IEEE 16th Inter. Workshop on Database and Expert Sys. App., pp. 497-501, 2005.

[20] M. Marmasse and C. Schmandt, "Locationaware information delivery with commotion," Proc. of 2nd Inter. Symposium in Handheld and Ubiq. Comp., 2000.

[21] D. Ashbrook and T. Starner, "Learning significant locations and predicting user movement with GPS," Proc. of Inter. Symposium on Wearable Comp., 2002.

[22] D.J. Patterson, L. Liao, D. Fox, and H. Kautz, "Inferring High-Level Behavior from Low-Level Sensors," Proc. of 5th Inter. Conf. on Ubiqutious Comp., 2003

[23] P. Bahl and V.N. Padmanabhan, "RADAR: An inbuilding RF-based user location and tracking system," Proc. of Infocom, pp.775-784, 2000.

[24] [24]K. Romer, T. Schoch, F. Mattern, and T. Dubendorfer, "Smart Identification Frameworks for Ubiquitous Computing Applications," Wireless Networks, pp. 689-700, 2004.

[25] S. Willis and S. Helal, "A Passive RFID Information Grid for Location and Proximity Sensing for the Blind User," TR04-009, 2004.

[26] G. Chen and D. Kotz, "A Survey of Context-Aware Mobile Computing Research," Dartmouth College Technical Report TR2000-381, 2000.

[27] J. E. Bardram, R. E. Kjar, and M. O. Pedersen, "Context-Aware User Authentication - Supporting Proximity-based Login in Pervasive Computing," Proc. of Ubicomp, pp. 107-123, 2003.

[28] C. Floerkemeier and M. Lampe, "Issues with RFID usage in ubiquitous computing applications," Proc. of Pervasive Comp., pp. 188-193, 2004.

[29] M. Crawford, et. al., "RFID Enabled Awareness of Participant's Context in eMeetings," Proc. of Pervasive Tech. Applied Real-World Experiences with RFID and Sensor Net., 2006.

[30] J. Bravo, R. Hervas, G. Chavira, and S. Nava, "Modeling Contexts by RFID-Sensor Fusion," Proc. of Pervasive Comp. and Comm. Workshops, pp. 30-34, 2006.

[31] J. Choi and E. Kim, "Using of the Context in RFID Systems" Comm. of the Korea Information Science Society, pp. 64-70, 2006.

[32] L. Han, S. Jyri, J. Ma, K. Yu, "Research on Context-Aware Mobile Computing," Proc. of 22nd Inter.Conf. on Adv. Infor. Net.g and App. –Workshops, pp. 24-31, 2008.

[33] L. Buriano, "Exploiting Social Context Information in Context-Aware Mobile Tourism Guides," Proc. of Mobile Guide 2006, 2006.

[34] M. A. Munoz, M. Rodriguez, J. F. Center, A. I. Martinez-Garcia and V. M. Gonzalez. "Context-Aware Mobile Communication in Hospitals," IEEE Computer, pp. 38-46, 2003.

[35] C. Ciavarella and F. Paterno, F., "The design of a handheld, location-aware guide for in-door environments," Springer Verlag Personal and Ubiquitous Computing, pp. 82-91, 2004.

[36] Z. Pala and N. Inanc, "Smart Parking Applications Using RFID Technology," Proc. of 1st Annual RFID Eurasia, pp. 1-3, Sep 2007.

[37] R. Tesoriero, J. A. Gallud, M. Lozano, and V. M. R. Penichet, "A Location-aware System using RFID and Mobile Devices for Art Museums," Proc. of 4th Inter. Conf. on Autonomic and Autonomous Sys., pp. 76-82, 2008.

[38] Y.C. Hsu, A.P. Chen, C.H. Wang, "A RFID-Enabled Traceability System for the Supply Chain of Live Fish," Automation and Logistics, pp. 81-86, 2008

[39] P. Jones, "Networked RFID for use in the Food Chain," Proc of the 2006 Emerging Technologies and Factory Automation Conference, pp. 1119-1124, 2006.

[40] F. Gandino, B. Montrucchio, M. Rebaudengo, and E.R. Sanchez, "On Improving Automation by Integrating RFID in the Traceability Management of the Agri-Food Sector," IEEE Transactions on Industrial Electronics, Vol. 56, Issue 7, pp. 2357-2365, 2009.

[41] L.C. Wang, Y.C. Lin, and P.H. Lin, "Dynamic mobile RFID-based supply chain control and management system in construction," Advanced Engineering Informatics, Vol. 21, Issue 4, pp. 377-390, 2007.

[42] A.S. Martinez-Salaa, E. Egea-Lopez, F. Garcia-Sancheza and J. Garcia-Haroa, "Tracking of Returnable Packaging and Transport Units with active RFID in the grocery supply chain," Computers in Industry, Vol. 60, Issue 3, pp. 161-171, 2009.

[43] M. Tu, J.H. Lin, R.S. Chen, K.Y. Chen, and J.S. Jwo, "Agent-Based Control Framework for Mass Customization Manufacturing With UHF RFID Technology," IEEE System Journal, Vol. 3, Issue 3, pp.343-359, 2009.

[44] K. Ohashi , S. Ota, L. Ohno-Machado, and H. Tanaka, "Comparison of RFID Systems for Tracking Clinical Interventions at the Bedside," Proc of AMIA Annu Symp 2008, pp. 525–529, 2008.

[45] Chung-Chih Lin , Ping-Yeh Lin, Po-Kuan Lu, Kuan-Yu Hsieh, Wei-Lun Lee, and Ren-Guey Lee, "A Healthcare Integration System for Disease Assessment and Safety Monitoring of Dementia Patient," IEEE Transactions on Information Technology in Biomedicine, Vol. 12, No. 5, pp. 579-586, 2008.