



Research Journal of  
**Information  
Technology**

ISSN 1815-7432



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## **A Smarter E-currency Management System**

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### **ABSTRACT**

This study concentrates on a novel efficient solution to counterfeit problems like recovering of currency which has been lost during interbank transferring process, to get rid of cloning and so on with the inclusion of latest Radio Frequency Identification (RFID) technology. In this proposed method each and every currency note is equipped with a RFID-tag i.e., A smart tag analogous to Bar code which can be accessed at a distance. Each tag is given with a unique serial number which will be useful for easy management like for the purpose of simultaneous verification for Genuineness of note, counting and tracking etc., The proposed management system consists of a Central Server which coordinates its activities with Mobile Networks, RFID currency reader's in order to track and management of currency. ORACLE database serves as the master. Thus, a high level of security can be incorporated in currency notes in an economical incisive manner.

**Key words:** RFID Currency reader, tracking lost notes, central server, RFID technology

### **INTRODUCTION**

World moves on currency although it may differ from country to country as well as period to period. In every aspect of life currency plays a major role. Cloning of currency notes has to be prevented because it will decrease the control of government over the currency which leads to decrease in value of money as so many people are generating currency. Another problem concerned to currency is looting of currency of banks while transferring from one place to another or from banks directly. This results in major loss to bank as well as to government as no one knows exactly where the lost money is moving in the society (Juels and Pappu, 2003). Recently, ICICI bank lost RS.40 lakhs of rupees during interbank transferring. So preservation from cloning, recovery of lost currency in the case of theft and tracking them are things to be done for efficient management system of currency. Considering the aforementioned facts and after analysis an efficient solution is mandatory in the field of currency management in order counterfeit effectively ailments. After reviewing the available literature, this study proposes a novel efficient solution using RFID to counteract currency recovering during interbank transferring process and to get aware of cloning process.

### **RADIO FREQUENCY IDENTIFICATION (RFID)**

Radio Frequency Identification (RFID) is a wireless identification system. It transmits the identity of an object or person through radio waves (Juels, 2006; Ahson and Ilyas, 2008). For the basic understating of RFID (Want, 2006), there are varieties of applications found in the literature like toll collection, automatic vehicle location (Wei and Chetty, 2012), digital id, dispensing

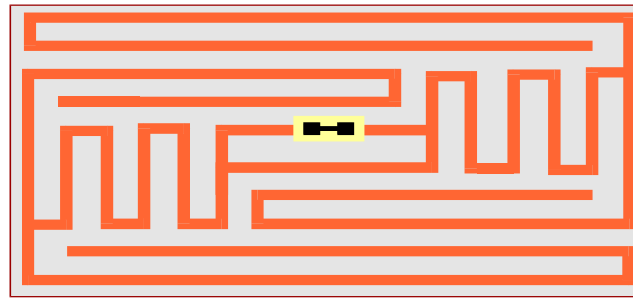


Fig. 1: A basic RFID system

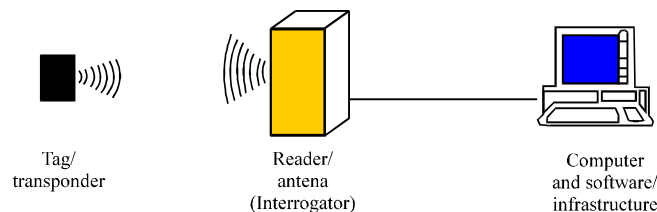


Fig. 2: RFID system description

Control, obstacle detection with wireless monitoring (Sasikumar *et al.*, 2013), smart card, military logistics, gaming chips, electronic passports, digital signature, luggage handling, patient medical history, asset tracking, smart parking (Idris *et al.*, 2009), waste haulage and bank note identification. The other application include supply chain management a data driven approach (Zhang *et al.*, 2011), consumer privacy (Juels *et al.*, 2003), clinical decision support system (Al-Safadi and Al-Sulaiman, 2011), genetic programming to optimize RFID network described by Weijie *et al.* (2011). In addition RFID working and its application (Ahson and Ilyas, 2008) and for enterprises is described in Weinstein (2005). Furthermore, A way to use RFID for billing services in communication system is available in Lo *et al.* (2009).

A detailed research survey has been carried by Juels, 2006 for RFID security and privacy. Kanno *et al.* (2009) explained tamper resistance of contactless ic card for side-channel attacks. In addition Garfinkel *et al.* (2005) described the privacy issue problems and solution for RFID. Similar study on privacy and security in RFID issues is also explain by Molnar and Wagner (2004). There are attacks and its remedy through anticollision algorithms or protocols to mitigate the problems (Jutao *et al.*, 2013; Sampe and Masuri, 2008; Kanno *et al.*, 2009; Sandhya and Rangaswamy, 2011).

A basic RFID system consists of three components (antenna, transceiver and a transponder-holds unique information) and its description is given in Fig. 1 and 2:

- An antenna radiates the radio signals for activating the tag for read/writes data operation
- Range of operation is up to of 30 meter or more (depends on signal strength)
- The reader decodes it for further processing by host computer. In addition, RFID-tag is of three types-active, passive and Bi passive. Passive tags are used in currency notes. After carefully reviewing the vast applications and knowing the power RFID, This study suggests e-currency through RFID

## MATERIALS AND METHODS

The basic idea of this suggestion is based on Juels and Pappu (2003) work on Squealing euros: Privacy protection in RFID-enabled banknotes. The description to install RFID Tag in currency notes is as follows.

## INSTALLATION OF RFID-TAG IN CURRENCY NOTES

For each and every currency note, an RFID-TAG with a unique serial number is installed as shown in Fig. 3. Currency notes made of polymer are preferred over the paper currency notes as paper currency notes:

- Cannot provide the required mechanical strength
- The friction between the tag and paper will be more and
- The probability of currency note to be torn is more

Central Server is the heart of the RFID-tag based currency management and tracking system is shown in Fig. 4. The data regarding the all currency notes in the country is maintained and managed by this server. Any modification or addition of the data related to currency note is carried in central server as per the guidelines of RBI. RBI holds the whole responsibility regarding maintenance of Central Server.

## DATA BASE AND SECURITY

Regarding the generation of UCSN and management cryptographic algorithms like TRIPLE DES (or RSA) is used. The encrypted form of UCSN is stored in RFID-tag instead of the original UCSN. A general format of a currency note in database (IN CENTRAL SERVER) as follows:

DATE	UCSN (EF*)	UCSN (O*)	DENOMINATION
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\* EF-ENCRYPTED, FORM O-ORIGINAL



Fig. 3: Currency note equipped with RFID-Tag (currency note made of polymer)

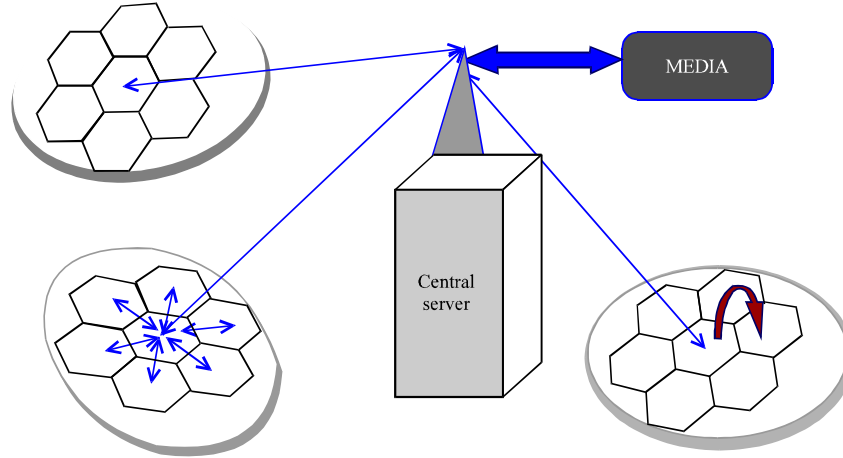


Fig. 4: Architecture of RFID based currency management systems

### UNIQUE CURRENCY SERIAL NUMBER (UCSN)

For each and every currency note a unique currency serial number is given which is useful during processing, tracking, management...etc, of currency. Each currency note is equipped with RFID-tag which contains information of UCSN, security algorithms etc.

A currency note equipped with RFID-TAG consists of following data:

- Genuiness data
- Encrypted UCSN
- Frequency switching data (FSD)
- Algorithm switching data (ASD)
- Pseudo noise sequence (PNS)

**Genuiness data:** RBI (Reserve Bank of India) has to introduce some bits for the purpose of genuiness of currency notes. This is generated with some function taking in to account the date of introduction of currency, governor name etc. This data is also stored in an encrypted and scrambled form which can be accessed only if the proper and appropriate key is provided. This is verified during the processing and necessary changes can be made to a certain extent during the process of tackling currency notes. This is verified during processing.

**Encrypted UCSN:** After the generation of UCSN it is encrypted using algorithms like TRIPLE DES and the obtained encrypted result is stored in RFID-tag. During the processing of currency the currency note replies to the interrogating signal with this encrypted form of UCSN.

**Frequency switching data (FSD):** Frequency switching data consists of information regarding in which frequency the currency notes has to respond or modulate its data for the interrogating signal. This frequency is depends on the information sent by interrogating signal. This feature is a tradeoff between performance and cost.

**Algorithm switching data (ASD):** Algorithm Switching Data are the bits sent by interrogating signal which indicates the RFID-tag in which algorithm it has to encrypt the UCSN. This is an optional feature for enhanced security.



**Pseudo noise sequence (PNS):** Pseudo noise sequence is the random bits stored in RFID-tag which are used to modulate the unused frequencies with this data. Scrambling can be used to increase the level of security.

An RFID-tag carries the following information:

- Geniuness data
- UCSN

The whole information carried by RFID-tag is in encrypted form. This data can be accessed only if proper key is provided:

- Flash memory chip
- Antenna

Microcontroller:

- Encryption and decryption circuits
- Signal generation circuits (generation of interrogating signal)
- Flash memory chip is used to store the data related to currency notes in an encrypted form. It has to be made with several security features in order to prevent unauthorized accessing

Microcontroller is used for the purpose of processing calculations during verification authentication, counting etc.

RFID reader emits interrogating signal, receives the signal sent in response by RFID-tag processes and provides verification, certification and authentication is shown in Fig. 5.

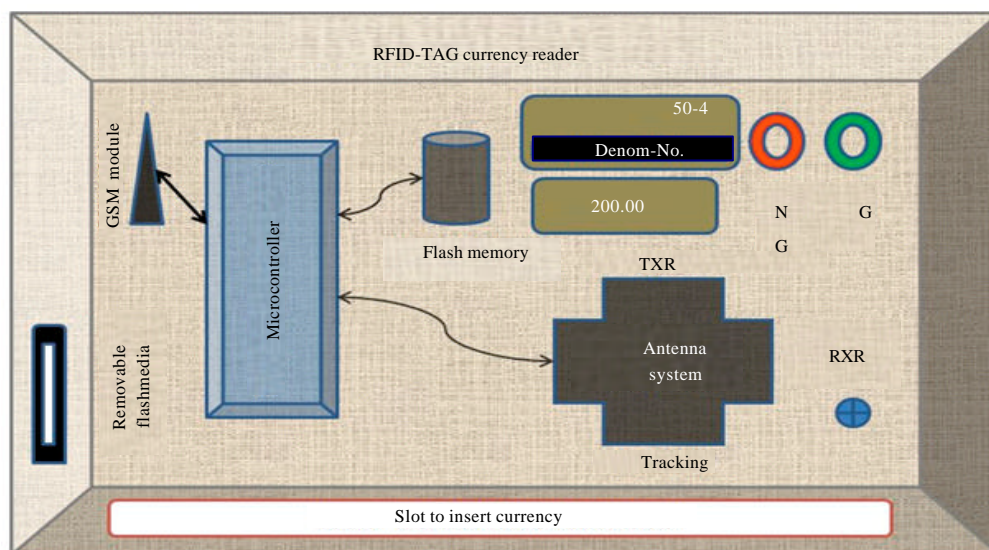


Fig. 5: RFID-TAG Currency reader

## **RFID-TAG-COUNTING**

The processing speed while counting manually is very less and is a very tedious job. Though the counter machines reduce manual power, usage of RFID reduces it much further and is more efficient. On an average, 400-500 notes are processed per minute which is very less compared to No. of RFID tags processed per minute which is 3000.

The process of counting RFID-tag starts with the generation of interrogating signal and it is emitted from the transmitting antenna of reader. The currency notes present in the vicinity of the radio (Reader equipment) waves equipped with RFID-tag responds to the interrogating signal with encrypted form of UCSN (only in the case if proper key is provided by the interrogating signal). The data (in encrypted form) is received by the reader antenna and it is further processed by the processing block. In the processing block verification and counting is done simultaneously which a major advantage in contrast with the conventional is counting machine. In this way the overall performance, efficiency and processing speed are increased to greater extent.

## **MANAGEMENT**

The management of currency on a large scale is a laborious process which involves counting, manual updating etc. The probability of making error by a human is more in the above cases. In order to avoid errors, processing speed usage of RFID-tag based currency gives a good improvement in these tasks which saves a lot of time which is more valuable than money in this present technical world.

RFID-currency readers can be used for the above discussed laborious manual works which reduces human effort to a great extent. The process of counting, verification and entering records regarding denominations, number of notes can be done by reader efficiently. With this the various works of the bank can be handled very easily, accurately and at high speed. A bank can have an entire record of details (UCSN, number of denominations) regarding the currency notes present in the bank.

## **TRACKING**

Generally banks involve large transactions from one place to another place i.e., it may be from bank to bank or an ATM and there are many cases in which money is lost during transferring. And obviously this currency will be used as usual in the society. It is very difficult to track the movement of lost currency. As of now there is no efficient tracking solution. The process of tracking can be done effectively for the RFID tagged currency notes.

The preliminary step that has to be taken for the tracking to be possible is "The bank has to have a record of UCSN's of all the currency (that has to be transferred)".

CENTRAL SERVER and MOBILE networks play prominent role in tracking. As preliminary step has been taken by banks, they will be having a record of all the UCSN's (encrypted form) of the currency that has been transferred.

Whenever, the currency has been lost at any point on its way to its destination, the following steps are to be done as soon as the information about the theft is known:

- Informing police and RBI
- Updating the UCSN's by Police or RBI in the CENTRAL SERVER
- Updating of lost currency UCSN's in RFID CURRENCY READER's in and around the lost region using Mobile networks

- Execution of tracking command in order to increase the range of scanning of RFID currency reader's
- Broadcasting the lost currency UCSN's serial numbers via media like television, radio etc,
- Updating the police and central server as soon as a match is found corresponding to the lost currency UCSN
- Updating the UCSN's over the entire country

As soon as a match is found the location of the lost currency will be Sent as Messages (SMS) to the Police officials in that area, toll gates around that area and it will be updated even in airports, railway station etc, Based on the above data further steps has be taken by the Police for tracking of lost currency. Thus the process of tracking is done effectively.

### **IMPLEMENTATION (EMBEDDED TECHNOLOGY)**

The processes of verification, interfacing of RFID with microcontroller are practically implemented using embedded C.

### **CONCLUSION**

RFID-tag based currency provides a number of advantages when compared with that of conventional paper currency notes (Juels and Pappu, 2003). Some of the advantages provided by RFID based currency are as follows:

- Reliability is more compared to that of paper currency (Juels, 2006)
- Prevents inflation
- Tracking of theft notes (Juels *et al.*, 2003)
- Improves the processing speed of counting
- Easy verification of genuineness of notes
- Cloning of notes can be eradicated at the greater extent
- Easy management (Sampe and Masuri, 2008)
- Water resistant

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