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Integration of 2 D Secure Barcode in Identity Cards:A New Approach

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Abstract

*This paper introduces an ID card Management System that integrates 2-Dimensional Barcode which is responsible to produce more secure, reliable identification cards. This system will capture the personalized data including signature and photo of holder and dynamically generate an image of 2D Barcode containing the information provided and affix this barcode image on ID Card. This card can be used to validate and authenticate the holder. Main advantage of using 2D Barcode is its data encoding capacity, 2D Barcode is able to encode up to 500 bytes per square inch. Some data is used for error correction encoding provides the capability to tolerate the holes, cuts and dirt marks and makes 2D Barcode readable. There are varieties of 2D Barcodes available.This Paper uses one of the standard 2D Barcode PDF417 to demonstrate the ID card management. The paper discusses 2D barcodes and their encoding methodology, system workflow and architecture of proposed ID card management system***.**

***Keywords:*2D Barcode, ID Cards, ID card Management System, PDF417 Barcode.**

I. INTRODUCTION

An Identity card is a primary requirement for an individual by which he can prove himself that he has all rights he is claiming for. An identity card is properly designed to provide the trusted credentials(The term "credential" refers toinformation stored on the card that represents the individual'sidentity document and privileges.), that can be used to access or authenticate an individual for a particular service. To make ID cardmore secure itintegratewith 2D Barcode that encoded the credentials of the individual in it.When authentication is required a 2D Barcode scanner scans the 2D Barcode image and authenticates the holder.

2D Barcode [1] is a graphical image that is using to stores the information both horizontally and vertically. Unlike one-dimensional barcode that is use to stores the information only. 2D Barcode is using to tag the various objects in the real world and map them to digital references. 2D barcodes are often used because that are enabling to store more information and they enable fast data access and now 2D Barcode is commonly used in variety of applications such as transport, identification, mobile application and inventory management. 2D barcode firstly known in Japan and now it is spreading to western countries as well.

Since, 2D barcode reader application is available on smartphones, so anyone can read the 2D barcode. But somewhere it is not desired that everyone can read it, like if it contains Credit Card details, username and password for an account or any personal information that is vulnerable to theft. Thus, these kinds of information should not be encoded in the barcode directly. There must be some way to hide this information so that a normal reader/scanner cannot read or if read then user is not able to understand it. For this purpose we have to encrypt the information and then encode it and thus, encrypted barcode comes into existence.

II. RELATED RESEARCH STUDIES

*2D BARCODE:*In 1994, McCullouch and Lueprasert illustrated the use of 2d Barcode and how this could be applied in the construction industry, simultaneously barcode technologies integrated with other applications [2]. In 2003 Bell and Williams included the 2d Barcode with GIS technology to manage the road signals[3]. In 2005 Navon and Berkovich used barcode with Radio Frequency Identification for data collection to assist with materials management and control[4]. In 2005 Shehab and Moselhi illustratedhow the barcode technology could be used to develop an automated system for engineering deliverables such as drawings, reports and specification[5]. In 2010 Saeedet. al. illustrated the

integration of 2d Barcode, GPS and RFID to provide the solution for pedestrian users accessing information[6].

After the terrorist attacks on 11 September 2001[7],a proposal of ID cards becomes an Entitlement cards after the revived by the home secretary at the time David Blunkett. But it was opposed by Cabinetcolleagues. As the identity concern issue like identity theft and the misuse of public service in February 2002 increased, the proposed entitlement cards to be used to get the Social security services and consultant papers.

A.Identity cards

A document which is used to verify the person's personal identity called Identity document. ID document may be issued in form of small and standard-sized card; it is usually called an identity card(IC). A card identify data about a person, as name, age, hair color, etc. and often bearing a photograph.

Some countries do not have their formal identity card so they may require informal documents like driving license and passport. Earlier India also comes in the country that doesn't have their formal identity cards, to prove the personal identification driving license or passport requires but now in India also issues a formal Identity card named "AADHAR".

B. Types of Identity Card

In the absence of formal Identity card there are numerous methods to identify an individual. Today there are verities of identity documents and ID cards are available with the latest technologies such as biometrics, holographic image, special over lamination process and more. ID cards are becoming more effective for users and makers alike.

- **Birth certificates**-A document that give the information about the birth date and place, also it is used to identity parents name of an individual.
- **Social Security ID cards** - A Social Security cards is needed for verification and identification of an individual.
- **Passports** - Passport is an official government document that certifies one's identity and citizenship and permit to travel abroad. Without this traveling aboard is an illegal offence.
- **Driver's licenses** - Driver's licenses are issued by the government of countries to identify that individual have driving privileges or not. It also used for many other purposes.
- **Other ID cards** -Schools and universities also provide ID cards to students, but these are almost universally used for on-campus purposes and activities.

C.Identity Theft

Identity theft is a kind of crime in which an imposter get the personal information of someone such as Social security number, driving licence number in order to pretends someone else. This information can be used to access the resources or obtain the credit and services in the name of the victim or made a thief with false credentials.

Type of Identity Theft

- Identity cloning and concealment
- Criminal identity theft
- Synthetic identity theft
- Medical identity theft
- Child identity theft

III. BASIC OF BARCODES

A barcode represents data about the object to which it is attached such that only machine can read. Barcodes are of three types- one-dimensional (1D), two-dimensional (2D) and three-dimensional (3D). In 1D barcode, data is represented by varying the widths and spacing of parallel lines, whereas in 2D barcode information is stored both horizontally and vertically. 3D barcodes do not use any barcode labels. They are embossed or engraved directly on the product during manufacturing process.

(a) 1D Barcode (b) 2D Barcode

Figure 1: Barcodes

In general, there are two types of 2D barcodes: stacked 2D barcodes, such as Code 49 and PDF417, and Matrix 2D barcodes, such as Data Matrix and QR Code. 1D barcodes depend upon database for the object's description to which it is attached, where we can store the complete description of the object in the 2D barcodes.

Barcodes are scanned by special optical scanners called barcode readers and now-a-days software become available on devices including smartphones, so that anyone carrying mobile phone with barcode scanner software can read the barcodes. We can use Smartphone to capture, store and display the barcodes. We can store our card details in 2D barcode, which can be useful for payment through our smartphones. We can also store username and password with url in 2D barcode to access our mail account by just scanning it through smartphone.

A.TYPES OF 2D BARCODES AND ENCODING METHODOLOGY

*1)QR BARCODE:*QR Code [8] is a 2-dimenstional barcode invented by the Japanese corporation Denso-Wave in 1994. The prefix QR stands for Quick Response, as the code that can be decoded at high-speed [9]. QR Code support Kanji encoding that the reason for its popularity in mobile tagging applications. QR code is most popular in Japan.

The Size of QR barcode symbol depends on the information to be encoded. Symbol version defined in the range of 1 to 40. Each version has different module configuration (the module refers to the black and white dots of QR code). Version 1 size is 21 x 21 modules and as version increment by 1 module size increment by 4 x 4. e.g. version 1 module size is 21 x 21, version 2 module size is 25 x 25, version 3 module size is 29 x 29....version 40 module size is 177 x 177 modules.

Figure 2: QR Code

There are four modes:

- Numeric mode
- Alphanumeric mode
- 8-bit byte mode
- Kanji and kana characters mode.

The combinations of these modes are also possible.

QR code has in-built error correction based on Reed Solomon algorithms. Error correction level defined the readability percentage of damaged code. The QR code has four error correction levels 7%, 15%, 25% and 30% per symbol.

1.1)QR CODING METHOD: The QR encoding method works as follows:

1.1.1. QR code uses a smallest number of coding capability to store the QR code and error correction level, in consideration the total coding capability of data information.

1.1.2. Maximum number of coding characters in each mode is as follows.

- Numeric mode: 7089 characters
- Alphanumeric mode: 4296 characters
- 8-bit byte mode: 2953 characters
- Kanji and kana character mode: 1817 characters

1.1.3.To Create the QR Code and data encoding it uses the Reed Solomon code algorithm. RS Code parameters are shown in parentheses

2)DATA MATRIX: Data Matrix is a form of 2D barcode with high data density. That able to encodes text or row data in a pattern of black and white square modules. Data size of data matrix is maximum up to 2 kbs. The symbols can be readable even if they are partially damaged by including error correction codes according to ECC200 standard.

The length of encoded data depends up on the number of cells in the matrix.

Figure 3:Data Matrix

2.1) DATA MATRIX DATA CAPACITY: A Data Matrix barcode can hold upto 3116 digits, 2335 alphanumeric characters or 1556 bytes, barcode's capacity depends up on the structure of data to be encoded, Data capacity also affected by the available printing space and printer resolution.

2.2) DATA MATRIX ENCODING: The encoding process is described in documents published by ISO website [10]. Open source software for encoding and decoding the ECC-200 variant of Data Matrix has been published [11].

The diagrams below illustrate the how a message data placed within a Data Matrix symbol. Message data arranged in a complicated diagonal pattern, start from the upper-left corner. In diagonal pattern some characters are split in two pieces like as initial W, and "I" is in "corner pattern 2" instead of usual L-shaped arrangement. Also as shown below omit some other bytes like end of message code (marked End), P (padding), E (error correction) bytes and X (unused space).

Multiple encoding modes used to store kinds of messages. By default mode to stores one ASCII character per 8 bit codewords.

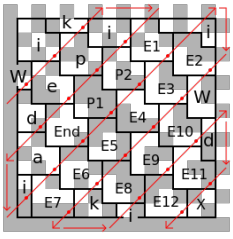


Figure 4: Encoding Data Matrix

TEXT MODES C40, Text and X12 modes codes are packed into two bytes. These codes are probably more compact for storing the text messages. These are use character codes in the range 0-39. V = C1*1600 + C2*40 + C3 + 1

B1 = floor (V/256)

B2 = V mod 256

Resulting value of B1 is in the range 0-249.

EDIFACT MODEEDIFACTmode uses three bytes of four characters and per character is six bits. It can store digits, upper-case letters and punctuation marks. It does not support lower-case letters.

BASE 256 Mode: Base 256 mode data starts from the length indicator, followed by a number of data bytes. 1 to 249 characters can be encoded in to a single byte and longer lengths are stored into two bytes.

L1 = floor(length / 250) + 249,

L2 = length mod 250

The length and data bytes are confused by adding a pseudorandom value R (n), where n is the position in the byte stream.

R (n) = (149 × n) mod 255 + 1

3*)PDF417:* PDF417 is high-capacity two-dimensional barcodes. it is capable to store up to 2710 data characters. It is a stacked liner barcode symbol is extensively used for example with in aviation, automobile industry, identification, transportation and inventory management. It was originally published by Symbol technologies, Inc. But later it become as ISO standard. Here PDF is for Portable Data File and 417 describes the structure that how a single data character is encoded 4 bars and 4 spaces in a 17 units wide.

3.1) PDF417 DATA CAPACITY: PDF417 is high data density barcode. PDF417 is a row based barcode. It consists with a maximum of 90 rows and 30 columns. The maximum number of data is depending on the compaction mode used, the number of columns and rows and the error correction level. The maximum data size is dependent on both the compaction mode as well as input data.

1. 2710 digits in numeric compaction mode
2. 1850 characters in text compaction mode
3. 1108 bytes in byte compaction mode

A barcode can hold up to maximum of 929 codewords.

*3.2) PDF417ENCODING*SYMBOL STRUCTURE:PDF417 symbology is also called a "stacked linear symbology" because a single PDF417 symbol can be imagined as multiple linear barcodes stacked above each other. And a row is consists of maximum 90 rows and 30 columns. The shape of a PDF417 is rectangular. Figure shows the detail structure of PDF417.

- Quiet zone
- Startpattern
- Left row indicator symbol characters
- 1 - 30 data symbol characters
- Right row indicator symbol characters
- Stop pattern
- Trailing quiet zone

Figure 5: PDF417[12]

Data region of each row is bounded by the left and right row indicators that provide the following information:

- row number
- number of rows (3 - 90)
- number of columns in the data region (1 - 30)
- error correction level (0 - 8)

SYMBOL DIMENSIONS

The size of a PDF417 barcode[13] can be calculated using the following formula:

Width = ((17 * # of columns) + 69) X + 2 (size of quiet zone)

Height = (# of rows) (row height) + 2 (size of quiet zone)

ERROR DETECTION AND CORRECTION

Error correction mode is used to detect and correct the errors in PDF417 barcode. Each PDF417 have a user defined correction level. Upto 510 additional error correction codewords can be added to the end of payload data for maximum data correction and each barcode has a minimum 2 error detection codewords. The Reed Solomon [14] error control code algorithm is used to compute the error correction codewords. Two types of errors that can address the error correction:

1. Rejection errors - In this type of error missing, unscanned and undecodable symbol character come whose position are known but value are not known.

2. Substitution errors - In this type of error missing, unscanned and undecodable symbol character come whose position or values both are unknown.

Here is the formula to determine the error correction capacity of PDF417

 # Of erasures + 2(# of errors) = # of error correction codewords - 2

Table shown below provides the error correction levels based up on the amount of data codewords in PDF417.

# of Data Codewords	Error Correction Level
1 – 40	2
41 - 160	3
161-320	4
321 – 863	5

Table 1: Error Correction Levels

TRANSMITTED DATA

Transmission of data in PDF417 is depends upon the compaction modes that are used. All other symbol start, stop, row indicators, symbol length descriptor, mode switch characters and error correction are not transmitted.

IV. SECURE IDENTIFICATION SYSTEM

Security is the main concern in the identification system, In our research we created a new innovative 2D Barcode based ID Card system. That can be used to authenticate holder's information when they required. System integrates 2D Barcode that encode the user personal information in encrypted format.

A. SYSTEM INFRASTRUCTURE AND FRAMEWORK ARCHI-TECTURE

- **CLIENT LAYER -** This layer includes a user interface to interact with users and perform user account and membership that uses for Input Holder's information and management.
- **APPLICATION LAYER -** This layer will include the 2D Barcode based security and business logics.
- **DATA STORE LAYER -**This is the main layer of system that includes a centralized database for storing, maintaining and processing the Holder's account such as Name, Photo ID, signature etc.

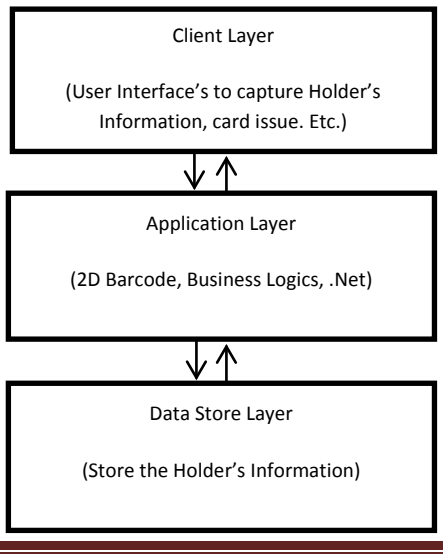


Figure 7: Architecture

B.SYSTEM WORKFLOW

1) BASIC CONCEPTS: For implementing the identity card management system, uses two processed first one is recording process and the second one is authentication process.

RECORDING PROCESS: In this process, the system consisting with a centralized database with Identity card management system that will take the inputs of the information given by the person and will issue an identity card with 2D barcode affixed on it.

AUTHENTICATION PROCESS: In this process, system authenticates the holder that he/she is a genuine one. A 2D Barcode scanner scans the image affixed on the ID Card and will send this image to centralized server for cross verification with the image already stored in database. If a relevant match found, then the person is genuine one.

2) BASIC STEPS FOLLOWED:

1. AnAuthenticated person will get holder's information and fill the key form manually and submit the form and forward the new application for verification to Admin department.
2. Next after the verification for the registered request received by the first step. Admin will check and validate that entered information and given documents are valid then he will forward it for card issue.
3. In this step a new interface that will issue a card with 2D Barcode affixed for respective request.
4. Whenever a person needs to be identified, the scanning machine extracts the holder's information from barcode and matches with information stored in the central database of the organization.
5. If scanned barcode information and stored information are same then the person is genuine and he allowaccessing the services where authentication is required otherwise not.
6. If verification fails, he/she has to report to authority, so that necessary action can be taken. The verification failure happens mainly when the barcode is tampered.
7. If 2D Barcode is tempered or lost then person has to report to Admin for the re-generation of card.
8. For regeneration request admin has to follow step-2 and 3 for the reissue cards.

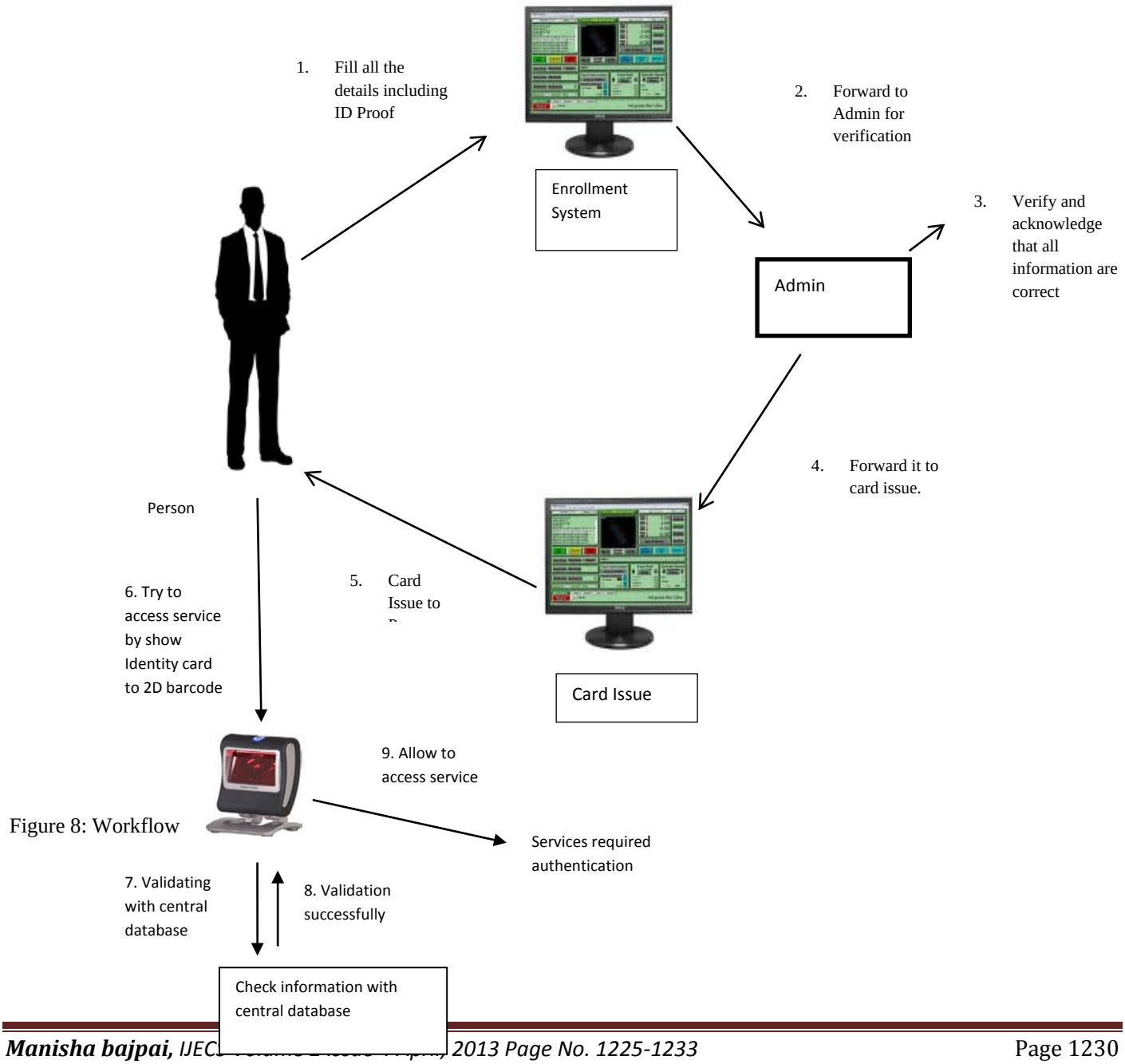


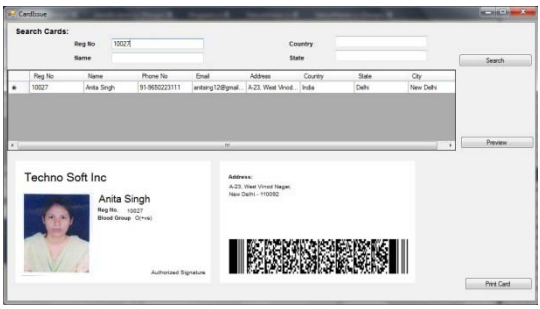
Figure 8: Workflow

B) PHOTO: This form is used to input the holder's photo and

C) signature.

2) IDENTIFICATION FORM: This form basically provides the identification facility of the holder. It requires barcode on the form as input. It extracts the Reg. No. from the barcode and match with the all holders in database and returns all subsequent matches and shows the full holder's information. This form is used by the Admin department for

3) identify the holder.



V. IMPLEMENTATION STEPS

We implemented this approach using "C# language"on Visual Studio 2010 with.Net Framework 4.0 installed on a PC running Windows 7 having Core i3 2.27 GHzprocessor and 320 GB of main memory.

The implementation consists of: Enrollment Form, Identification Form, Verification Form, Card Issue Form, Login Form, Change Password Form andMaster Forms. Master Forms are used serves the purpose of changing masterpassword.

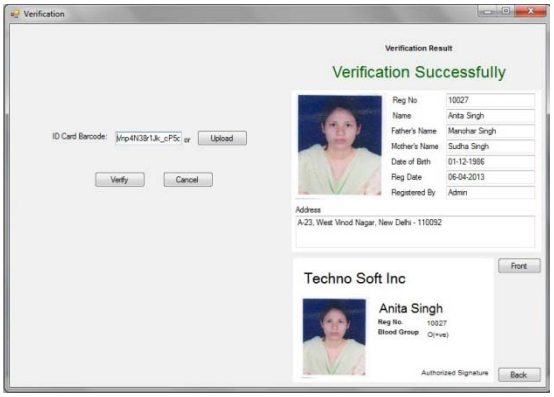
VI. DETAILS OF SCREEN SHOTS

1) ENROLLEMENT FORM: This form is used to enroll the holder in organization. In this form an authenticated person enter the holder's full information. This form has following three sub forms:

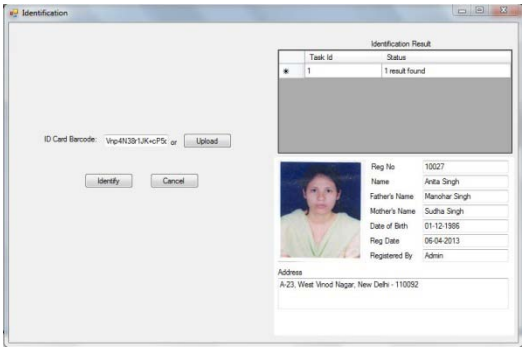
A) BIOMATRIC DATA: This form is used to input all the basic information about holder such as personal detail, birth detail, communication detail and identification detail.

4) VERIFICATION FORM: This form provides the verification facility of the holder. It takes barcode on the form as input and extract the Reg. No. and other information from the barcode and verify it with the information stored in the database and shows the holder's information.This form is used when holder needs to be verified.

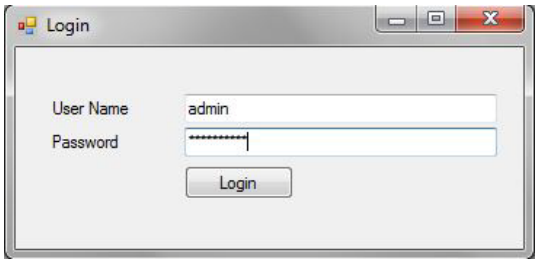
5) CARD ISSUE: This form is used to issue card to the holder. It has three panels search panel, list panel and preview



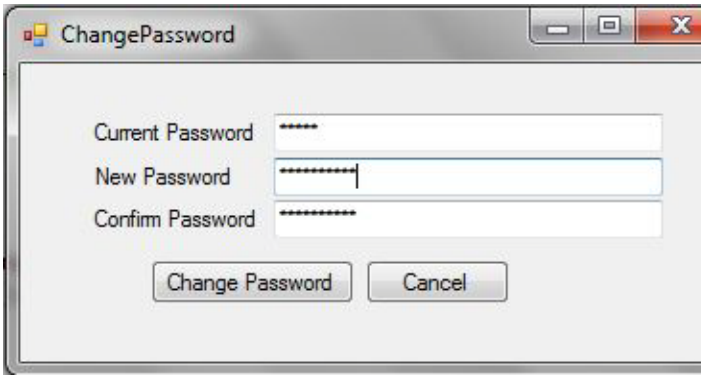
panel. Search panel have some field for finding the record from the database and resulted record will show in list panel and in the preview panel it show the identity card's preview of selected records from list panel. It shows the preview of card from both side front and back side of identity card, identity card has the holder's photo, name, reg. No. and authorized signature in front side, and contact address, signature and barcode in back side. This panel also has a print button to print the card in printer.



6) LOGIN FORM: This form provides the login facility of administrator person in the application.

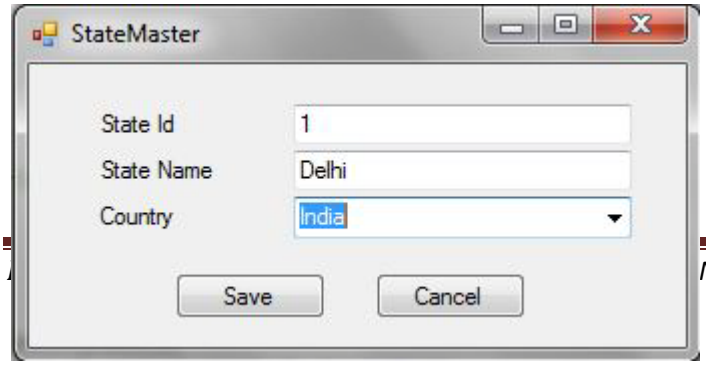


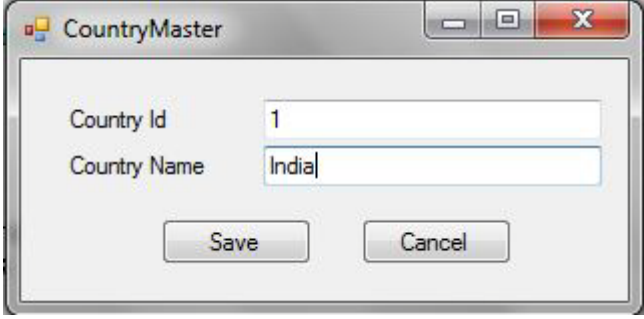
7) CHANGE PASSWORD: This form is used to change the password of admin user.



8) MASTER FORMS: These forms are used to store and update the master information such as Admin user's detail, county, state and status of holder's application for identity card. These formsare used by the admin person.

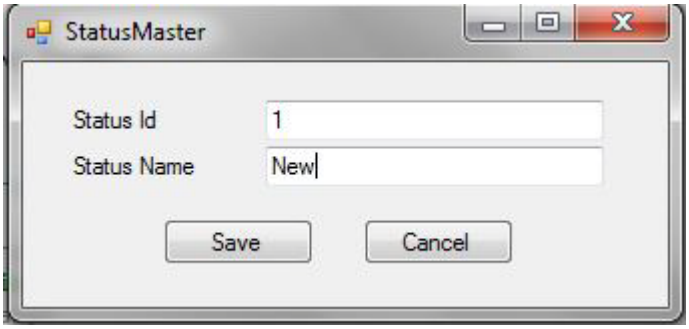
A) COUNTRY MASTER: This form is used to maintain countries master records.





*B) STATE MASTER:*This form is used to maintain state master records in database. It store states map with country.

C) STATUS MASTER: This form is used to maintain status master records in database. These statuses used to know the current status of identity card.



VII. CONCLUSIONAND FUTURE WORK

This approach provides the way to authenticate the person at the organization by affix the barcodes on them. The basic idea behind the authentication is encrypt the unique ID of the person in the barcodes. This approach is more secure than previous one. Our proposed approach also handles identification properly.

The encryption/decryption scheme and barcode we used here are PDF417, respectively. Since, all information is stored in 2D Barcode; this approach requires a minimum use of the database as well as minimum use of Internet. In the future, we will try to add signature and identity documents in the barcode for the authentication for make it more secure.

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