

Smartphone Color-Code based Gate Security Control

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Abstract

Smart building gate security control system using smartphone integrated with near field communication (NFC) has become part of daily life usage these days. The technology change in replacing RF NFC device using visible light communication technology based approach growing faster in recent days. This paper propose a design and development of gate security control system using color code based user authentication ID generation as part of an intelligent access control system to control automatic door open and close. In this approach gate security access control use the recent visible light communication technology trends to transfer the user specific authentication code to door access control system using color code on smartphone screen. Using a camera in the door access control system (ACS), color codes on smartphone screens are detected and matched to the database of authenticated user to open the door automatically in gate security system. We measure the visual light communication technology efficiency as a part of the research and the experiments have revealed that more than 95% users authenticated correctly at the suggested experiment environment on gate security control system.

Keywords: Visible Light Communication, Color-Code, NFC, ACS, Mobile Device, User Authentication, Gate Lock, Smartphone APPS.

1. Introduction

The global security industry trend is changing rapidly from communication information protection to individual's social safety on living and working areas. There are lot of research on information security for computer network security and now the security trends is extending to individuals social security to protect individuals personal information on personalized devices and day to day individuals activities .

The development on physical security enables the convergence on security information from information level security to knowledge based on the information security. The convergence in security area develops new active service called security control service in the physical security.

The technical enhancement and trends on security control service area is moving towards to integration of

CCTV, gate security or door control system with private security services like PC based authorization information, IP network based authorization information, Smartphone based authorization information, and printed documents based authorization information and so on.

Now a days, network based central control system developed to give automatic security gate or door access control in most of the door or gate access control systems and works with the user verification interface such as RFID, face recognizer, and fingerprint recognizer, etc. The gate or door authentication system receives authentication information from a centralized system using network and gives the automatic user gate/door open or close to the user using RFID/NFC tag or face features or fingerprint features.

Most of the automatic gate or door access control systems designed to give user access control to fixed residents with wired communication access in the network. However, the cost of building network for access control is high and has network weakness with maintenance efficiency issue.

In these days, the advent of smart devices functional characteristics and revolutionize the personalized data security and access control with more secured user access control on smartphone based applications. So this paper propose a novel user authentication model with color coded user customized user specific access ID for smart gate or door access control system using smart phone authentication key for efficient access management.

This paper describes the design of Smartphone based color coded user authentication ID design and development along with the receiver system detects these color-coded images by using a camera, extracts the color values, and decodes them into get the original user access ID to control the gate or door automatic access control.

2. Color Code for Gate Security User ID's

There were many research activities have been performed on image based user authentication methods to replace existing RF based methods. Initially iris or fingerprint based method is most predominantly used in user specific authentication model and later QR codes and Colored QR codes [3] are used for user specific image based authentication model. However, the available approaches has limitation with illumination on system robustness and recognition.

In 2012, H.Endo [4] developed the $m \times n$ cells two-dimensional code using CYM color model and the data are encoded using different colors to each cell. This method arranges eight different colors in code cells according to defined rules for paper printing processes. This is a printed code on the paper has surrounding illumination affects data transfer efficiency and needs special application to show the guideline to extract the coded images.

In order to resolve the problems in color coded user authentication, this paper propose a novel user authentication method for gate /door access control that uses a red, green and blue (RGB) based color code pattern on smartphone screen area. This ensures that the 'reference colors', which color coded are robust to illumination and uses the sequentially changing color codes to enable it to send user specific color coded user authentication ID.

In this paper, color coded user authentication ID TAG design uses the channel model using a color pattern symbol which are represented by $N \times M$ matrix of color pattern. Each color pattern is a vector with three component of [R, G, and B] and each component of RGB color space model is given value from 0 to 255. The color pattern is created by blending three component of RGB color space. The number of color pattern need for n-Color Pattern can calculate by equation (1). Here n is number of bit in one sub-symbol.

$$N_{\text{ColorCODEpattern}} = 2^n \quad (1)$$

This color coded pattern is the 2-D array of color coded pattern and an $N \times M$ Color Pattern constellation is defined as the collection of triplet [1].

$$N \times M_{\text{ColorCode}} = \begin{bmatrix} S_{11} & \cdots & S_{1M} \\ \vdots & \ddots & \vdots \\ S_{N1} & \cdots & S_{NM} \end{bmatrix}$$

Where $S_{ij}=[R_{ij},G_{ij},B_{ij}]$.

The Table 1 shows the 8 color code data symbol bitmapping as per the designed color code triplet and the designed color coded user authentication ID Tag is shown in figure 1.








Code	Dec Value	R	G	B	Color Code
Bit 000	0	255	11	120	
Bit 001	1	251	101	10	
Bit 010	2	135	255	0	
Bit 011	3	0	183	251	
Bit 100	4	67	0	255	
Bit 101	5	144	19	254	
Bit 110	6	243	137	218	
Bit 111	7	255	255	255	white

Table 1. Color Code Bit Mapping [6]

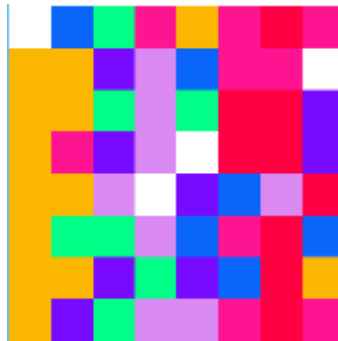


Figure 1. Color Coded User Authentication ID Tag

Let us assume that noise effect in each symbol of color pattern is same to light variation in the space. The received color pattern symbol which represented by smartphone camera can express by equation (2)

$$r_{ij} = S_{ij} + N \quad (2)$$

The received color pattern symbol r_{ij} can be classified by comparing Euclidean distance from r_{ij} to other color pattern point. i.e. is r_{ij} belong to nearest neighbor.

3. Color-Code based Gate Security System Architecture

The proposed color code based gate security authentication uses the visual light communication NFC

technology to perform contactless standard data exchange between smartphone and door/gate access control system built-in with camera interface to recognize the color coded pattern for user specific authentication ID as used similar to the RFID technology was very commonly used in contactless access control cards, electronic tags and ETC systems. In this proposed approach, the color coded ID Tag stored in smartphone and the camera built-in access control system receives the color coded ID Tag from user smartphone color coded image when user show the pattern on smartphone display and does user authentication process to access the gate/door for the particular user. The proposed gate/door access control system is shown in Figure 2.



Figure 2. Color Code based Gate Access Control System

4. Color-Code based Gate Security System Implementation

4.1 System Implementation

This paper proposes a design uses a gate/door security lock system with VLC based NFC technology using color coded user ID Tags. Figure 3 shows the diagrammatic sketch of the proposed system which includes a magnetic lock, access control systems (ACS) using remote control unit designed for gate/door lock control and smartphone based color code NFC ID Tag. The RCU interface with central CCTV monitoring and control system to control the user authentication. Only one step is necessary for a user to be able to open a door, "by just sensing smartphone based color coded ID Tag by CCTV Camera". In this proposed system, the authentication implemented on central security management server to give user specific secured authentication in the building.

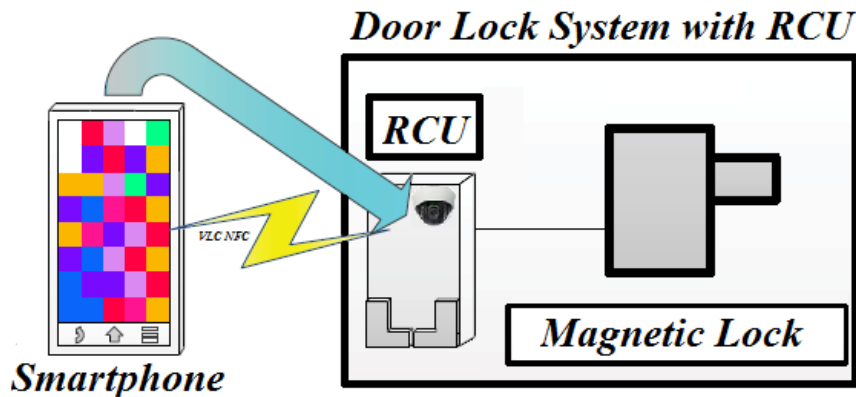


Figure 3. CCTV based Door Authorization using Smartphone Color-Code

4.2 Experimental Result and Analysis

In order to investigate the color coded user specific authentication ID for gate security control authentication system, the security gate control designed with CCTV based infrastructure to design a central control system. The color code for user specific authentication ID implemented using designed color code pattern as described in section 2 on android smartphone development environment and smartphone act as NFC transmitter using visible light frequency spectrum. In this experiment used Samsung galaxy tab, and LG G4 as a Color coded NFC Tag module.

The central security control system designed using OpenCV framework on host computer connected with all security CCTV system through DVR on IP based network with gate or door control system interface. The gate or door control system interface with host PC using RS232 interface via embedded remote control unit (RCU) to support door open and close control using magnetic lock.



Figure 4. Smartphone Color-Code Gate Security Experimental Model

This motivated that, a new secured authentication control system design using color code on smartphone without any external card or device to provide user specific information to door access control system. This implementation does not required any additional infrastructure to provide automatic door access control system other than the door interface with a central control system. This develop new business development activity in next generation IoT based smart home or smart building authentication.

5. Conclusion

The proposed gate security door control system using smartphone screen based color code present a comprehensive design framework for secured user access control system to access the door in building or office. The color code based user authentication ID design uses the color pattern constellations based on nearest neighbor classifier approach for visible light communication channel design with n-Color pattern and this research analyzed using different color pattern and found this work at high efficiency at 8-Color Pattern. The proposed user authentication system uses 8-Color pattern color code on smartphone display screen area for user specific authentication code and the security door access control system uses the camera based interface to verify the user access color code to automatic approve to open the security door.

In this implementation, propose an efficient user ID encoding and decoding algorithm to give secured user access. This approach can be enhanced by adding user specific features based user ID generation using color code and this compensate the defects of existing automatic security system control. This authentication system is more secure by adding the user ID encrypted by a specialized encryption algorithm passes through a mobile device, and transmitted through visible light communication method. The error performance can be repudiate by color selection by color correlation to avoid color blending on color channel model.

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