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Machine Readable Travel Documents Using Visible Light Communication

Trupti Lotlikar[1], Divya Mahajan[2], Pratik Ashwekar[3], Ritvik Ranadive[4]
Computer Engineering Department, Fr. CRIT, Vashi (Navi Mumbai)

Abstract: *Use of visible light for communication is an old concept. E.g.: Smoke signals or lighthouses for guiding ships have been used for centuries. However, there has been very little work related to use of visible light to transfer streams of data. A major step towards this was completed by Professor Harald Haas and was demonstrated by him making use of LED lamp for data transfer. However, this experiment was very costly. In this paper, we propose to make use of hardware that are already integrated on various mobile platforms like LCD/LED screens and cameras as the senders and receivers for visible light communication, in applications where small amount of data needs to be transferred. We propose the use of an electronic passport, the key to which would be saved on you mobile phone in an encoded format. The key would be transmitted from the mobile phone to the passport checking authority's desktop/laptop using visible light communications, upon which the passport can be retrieved from a database and verified by the authority. This would eliminate the need of an actual physical passport to be carried while travelling from one country to another.*

Keywords: *Mobile application, Visible light communication, LED, CMOS, e-Passport*

I. INTRODUCTION

Visible light communication or the direct use of visible light for transmission of messages is not a new concept. The first ever attempt to use visible light for transfer of data was made by Scottish scientist and inventor Alexander Graham Bell, who invented the photophone. The photophone allowed data transmission on rays of sunlight and turned out to be a precursor to fiber optic communication.

However, the use of light waves along with air as a medium of data transfer was not revived until the year 2003 when the Nakagawa Laboratory in Keio University started with the use of LEDs for data transfer. After this move, multiple researches were carried out in universities across the world. The true power of this technology was demonstrated by Professor Harald Haas of the School of Electronics and Engineering of the University of Edinburg at TED Global, where he showed the real-time transfer of a High Definition video using an LED lamp.The demonstration was using a circuit based which was very costly. We propose a system which would avoid the necessity of carrying a passport with you. The issued passport would be stored on a database. Your passport can be accessed using a key that would be stored on your mobile phone in a light encoded format. When this key is flashed in front of a camera and certain back-end video processing is performed, the actual key that is to be used to query the passport issuing authority's database would be obtained and this passport can then be viewed and verified. Thus, this demonstrates the use of visible light communication for the data transfer that has to be performed in this application. We aim to use visible light communication for this proposal without the use of a complex costly circuitry, as the application requires a small amount of data to be transferred and hence such circuitry can be avoided. The hardware which is already integrated in our mobile devices is enough for the purpose of data transfer. We would be using the LED/LCD screen or a flashlight of the mobile phone as a transmitter and a simple camera or the webcam of a laptop as the receiver. The success of the application would also prove to be helpful in evaluating the data rate that can be achieved using this technique and make a comparison of data rate and cost-complexity, which would help in decision making whenever a compromise between one of the two needs to be achieved for visible light communication.

II. RELATED WORK

A machine readable travel document is one where the data on the identity page is encoded in an optical character recognition format. The data in the machine readable zone of a passport consists of two rows of 44 characters each.

The only characters used are A-Z, 0-9 and the filler character <. These two rows thus compose 88 characters. These 88 characters contain information about the passport holder like his name, nationality, date of birth, expiration date of passport and certain check fields. All the passport information that is contained in the machine readable zone can be auto filled into the database and this makes machine readable travel documents quite fast and efficient. This importance of each of these 88 characters can be read in the following tables:

Table 1: Format of the first row:

Position	Meaning
1	P, indicating a passport
2	Type (for countries that distinguish between types of passport)
3-5	Issuing country or organization (ISO-3166 1 alpha-3 code with modifications
6-44	Last name, followed by two filler characters followed by given names

Table 2: Format of the second row:

Positions	Meaning
1-9	Passport number
10	Check digits over digits 1-9
11-13	Nationality
14-19	Date of Birth(YYMMDD)
20	Check digit over digits 14-19
21	Sex(M,F)
22-27	Expiration date of passport(YYMMDD)
28	Check digits over digits 22-27
29-42	Personal number (may be used by issuing country as it desires)
43	Check digit over digits 29-42
44	Check digit over digits 1-10, 14-20 and 22-43

Fig 1. Sample of Machine Readable Passport

III. PROPOSED SYSTEM

The basic concept is that there would be no such thing as a physical passport which a person needs to carry anywhere with him when he leaves the country. Instead your passport would be in an electronic form, stored in a database which is linked your country's government/passport issuing agency. A copy of this passport can be accessed from any location necessary by querying this database using a key which is stored on your mobile in a encoded format. This light encoded key, when opened, would look similar to flashing disco lights on your mobile screen.

When your mobile phone is flashed in front of an active camera, with the application running in the background, a real time detection of the flashing colors on your mobile screen can be done, which would reveal the key to the application which is reading it. Querying the passport issuing agency's database using this key, an electronic, read- only copy of your passport can be made available which can be used for verification purposes. At the same time, since this key is the same as the 88 character machine-readable text on the identity page of the currently existing machine readable passport, it can also be used to automatically fill the passport holder's information.

At the sender's end:

At the sender side, each of the characters of this 88 character key would be read in groups of three characters each. Hence there would be 30 such reads in order to transfer the 88 characters. Each of these three characters would first be converted to their ASCII code. These individual ASCII codes would then be converted to their corresponding hexcode.

Once the hexcode has been obtained for three characters in a sequence, these hexcodes would be attached one after the other at the end of 0x00, thus forming a total hexcode of 0x00GHIJKL, where GH would signify the hexcode for the first character in the series, IJ would signify the hexcode for the second character in the series and KL would signify the hexcode for the third character in the series.

This hexcode of 0x00GHIJKL would correspond to a color, which would be displayed on the screen at the sender side i.e. the traveler's mobile phone. The color would be displayed in this format as in order to achieve platform independency; there is great chance that we would be using Java as the programming language. Each flash of a color would thus be used to transmit 3 characters and hence 30 such flashes can be used to transmit the 88 character key.

In short, the hexcodes for the first three characters would correspond to the R, G and B values of the first color displayed on the screen, the next three characters would correspond to R, G and B values of second color displayed on the screen and so on.

The passport issuing official would perform these actions and the result would be published together in the form of a multimedia file which would contain only the flashing colors. This file would be made available to the passport applicant on his mobile phone.

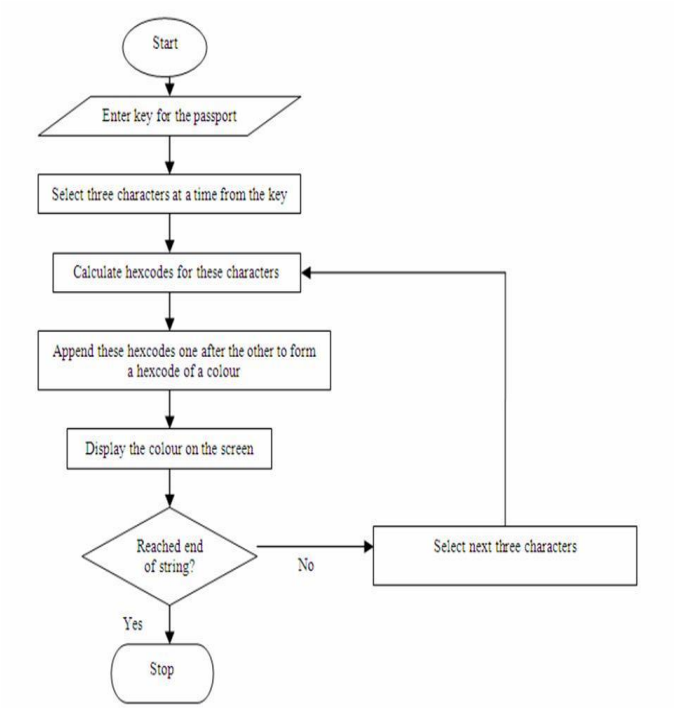

Fig. 2 Flow diagram for sender(performed by passport issuing officer)

At the receiver's end:

At the receiver's end, a real-time video processing would be performed. The receiver would be continuously recording a video of the flashing patterns and side by side, processing this video. The receiver would detect the color of the pixel which is located at approximately the center of the screen. Once the receiver recognizes this color i.e.the hexcode for this color, this hexcode pattern of the color can be ANDed with 0x00ff0000, 0x0000ff00 and 0x000000ff to get the R, G and B components of this color respectively.

Once these R, G and B values are detected, they can be converted to ASCII values and then from ASCII values to character, and thus the data transfer for the corresponding three characters is achieved. The time required for this processing can be measured and then the sender can be made to keep the same color active on the screen for that amount of time. Thus, with each flashed color, three characters would be detected at the receiver side; the first of these would be obtained in the R component of flashed color, second would be obtained in the G component of flashed and third would be obtained in the B component of flashed color. These flashing colors can thus be used to transfer the key.

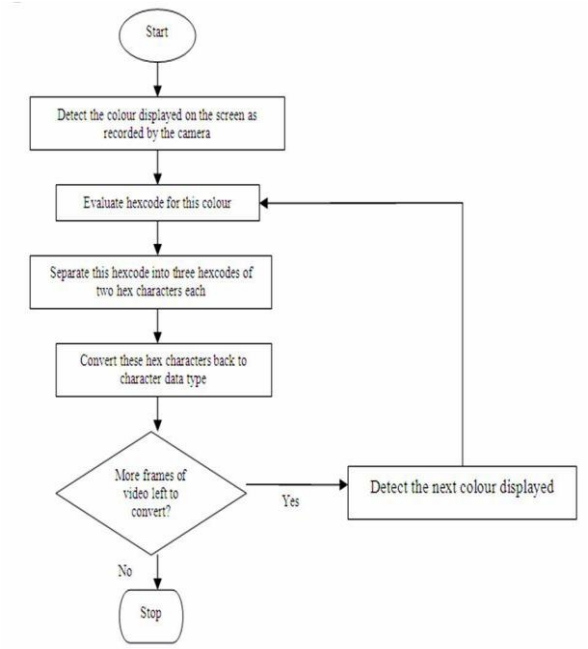

Fig. 3 Flow diagram for receiver

IV. SYSTEM DESIGN

As mentioned before, we are trying to achieve data transfer using light between two mobile phones. The screen acts a transmitter and the camera acts as a receiver.

CMOS Sensor

We have done away with a CCD sensor because a CCD sensor is only good for still pictures. CMOS sensors are better at capturing video and have pushed CCD sensor based cameras out of the market due to their cheaper price. This is why all cameras and mobile phones today contain CMOS sensors. Current generation of cameras on smartphones surpass our need.

LED Screen

The major problem with using light to transfer data is ambient light. This could be ambient sunlight or tubelights and such. This poses a problem as they contribute towards noise in the system. Also the intensity of the LED screen must be enough so that the receiver can pick up the signal. A 10 cm2 light source is recognizable at distances up to 10 meters and is equivalent to approximately 2.1% of the area of a 42-inch monitor. The average screen size for a smartphone nowadays is greater than 35 sqcm. So theoretical range can be assumed to be 10 meters. All current smartphone screens satisfy our requirements.

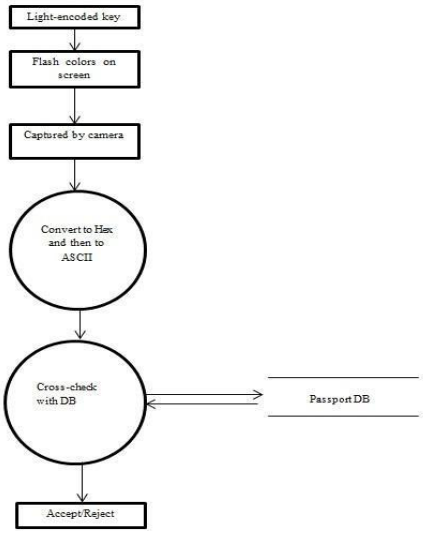

Fig 4. System Design

V. PROS OF THE PROPOSED SYSTEM

The various advantages of this technology are:

- The current cost of issuing a 36 page passport for an adult is Rs. 1000. This passport issue cost need not be so high if this technique is used. In fact, it can be possible to issue passports for free. The cost of reissue of passport can also be minimized or eliminated.
- Since there would be no such thing as a physical passport, the problems of passport forging can be solved completely. Any person who needs to forge a passport would have to hack into the government database. This database can be provided huge amounts of security and such hackers can also be traced.
- Storing the key in the mobile phone in the light encoded form gives an added advantage as any layman will not be able to detect any information or understand any information through it. Only a computing device would be able to detect this key.
- Since a programming process is involved in between actually reading the key and making any sense out of it, this provides an added layer of security to the passport.
- Even if the key gets detected, a person would need access to the passport issuing agency's database in order to get any personal information about the passport holder, apart from the holder's name and nationality.
- When your mobile phone gets lost, there is no danger as nowhere does the e-copy of the passport display your address. Since there is a photograph present on the passport, no other person who finds your phone can do anything with the passport.

VI. FUTURE SCOPE:

Visible Light Communication is a very promising technology. The main reasons behind this are the huge bandwidth available and the feature of illumination and data transfer at the same time. Visible Light Communication is also secure since data gets blocked as soon as the receiver is out of the line of sight.

Intel has actually come up with a prototype chip which transfers data at the rate of 50Gbps using visible light communication. Research is being carried to replace all the internal communication of a computer by this technology and thus try and remove PCBs from the internal parts of a computer as far as possible.

In the future, Visible Light Communication has the capability to replace all kinds of Radio, Infrared and wired short range communications. We will soon be able to transfer large amounts of data from one mobile device to another using simple LED lamps and LED screens.

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