DEVELOPMENT OF A FACE RECOGNITION SYSTEM FOR E-GOVERNMENT IN IRAQ

MORAD SABAH HASSAN

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DEVELOPMENT OF A FACE RECOGNITION SYSTEM FOR E-GOVERNMENT IN IRAQ

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Submitted By **Morad Sabah HASSAN**

Approval of the Graduate School of Natural and Applied Science, Çankaya University.

Prof. Dr. Taner ALTUNOK

Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

Assist. Prof. Dr. Murat SARAN

Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

Assoc. Prof. Dr. Hakan MARAŞ

Supervisor

Examination date: 09/07/2014

Examination Committee Members:

Assoc.Prof.Dr.Hakan MARAŞ (Cankaya University)

Assist.Prof.Dr.Abdül Kadir GÖRÜR (Cankaya University)

Assoc.Prof.Dr.Fahd JARAD (Uni. Of Turkish Aeronautıcal Association)

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Name, Last Name : Morad Sabah HASSAN

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Date : 09/07/2014

ABSTRACT

DEVELOPMENT OF A FACE RECOGNITION SYSTEM FOR E-GOVERNMENT IN IRAQ

HASSAN, Morad Sabah

M.Sc. Department of Computer Engineering

Supervisor: Assoc.Prof.Dr.Hakan MARAŞ

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Innovations of technology build important effects on the world wide. Technological developments influence economy, social life, business and the way public services delivered. Public services are provided in associate degree electronic format to scale back time and value and to boost service quality. These innovations also cause a social transformation. Governments are required to adopt such changes and to be a related of "Information Society".

This thesis proposes e-government model based on the citizen's participation and improvements in the delivery of governmental services by using a qualitative case study strategy considering the Kirkuk region in Iraq. Regarding the proposal a Graphical User Interface (GUI) has been developed in order to compare the input face image with existing database images to display the citizen information such as (name, surname, birth date, etc.) This e-government model can also be used to detect the cases of forgery.

Keywords: Face Recognition System, E-Government, Local Binary Pattern.

ÖZ

IRAK E-DEVLET HÜKÜMETİNİN YÜZ TANIMA SİSTEMİNİN GELİŞTİRİLMESİ

HASSAN, Morad Sabah

Yüksek Lisans, Bilgisayar Mühendisliği Anabilim Dalı

Assoc.Prof.Dr.Hakan MARAŞ

Temmuz 2014, 53 Sayfa

Teknolojideki yeniliklerin dünya çapında etkileri olmaktadır. Teknolojik gelişmeler ekonomi, sosyal yaşam, iş ve sunulan kamu hizmetlerinin şeklini değiştirmektedir. Kamu hizmetleri zaman ve değerlere geri dönebilmek ve hizmet kalitesini artırmak için eşdeğer elektronik formatta sunulmaktadır. Bu yenilikler aynı zamanda bir sosyal dönüşüme de neden olmaktadır. Hükümetler bu tür değişiklikleri uygulamak ve "Bilgi Toplumu" ile ilişkili olmak zorundadırlar.

Bu tez, Irak'taki Kerkük bölgesini ele alan nitelikli bir durum çalışması stratejisi ile yurtdaş katılımına ve devlet servislerinin verilmesindeki gelişmelere dayalı bir e-devlet modeli önermektedir. Bu öneri kapsamında, yurtdaşın (ad, soyad, doğum tarihi gibi) bilgilerini sunmak amacıyla, girilen yüz görüntüsünü mevcut veri tabanındaki görüntüler ile karşılaştıran bir grafik kullanıcı arayüzü geliştirilmiştir. Bu e-devlet modeli sahtecilik vakalarını ortaya çıkarmak amacıyla da kullanılabilir.

Anahtar Kelimeler: Yüz Tanıma Sistemi, E-Devlet, Yerel İkili Desen.

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LIST OF ABBREVIATIONS

DPADM	Division for Public Administration and Development Management
ECDGISM	European Commission Directorate General Information Society and Media
EU+	European
G2B	Government to Business
G2C	Government to Citizen
G2E	Government to Employee
G2G	Government to Government
GIS	Geographical Information System
GUI	Graphical User Interface
ICT	Information Communication Technology
KLT	Karhunen-Loeve Transform
LBP	Local Binary Pattern
PCA	Principal Component Analysis
UNDESA	Department of Economic and Social Affairs
USAID	United States Agency for International Development

CHAPTER I

INTRODUCTION

1.1 Background

Recent developments in technology and communication systems, especially the information revolution that has taken place in the 21st century, have resulted in many changes to people's lives around the world. These developments must be controlled and managed via electronic government (e-government), which interacts with businesses, employees and the wider public on a daily basis [1]. Information communication technology (ICT) supports e-government by serving both people and national governments, providing more efficient services and easy access to information [1]. E-government has considerably increased in global significance, making life easier and more flexible. Such technology thus helps to both minimize resource sharing and increase the public contribution to, and evaluation of, government performance [1]. Many Middle Eastern nations have made great strides in this area. If Iraq wishes to reach to the level of these countries it must build a strong infrastructure, especially in terms of communication. Since 2003, the Iraqi government has introduced many new concepts and made many amendments to daily life, especially with regard to e-government. The Iraqi government is also currently interested in establishing new projects and holding meetings in order to develop and support the information revolution and its contributing technologies, with the aim of carrying out proper e-government. The present thesis thus represents an attempt to support e-government in Iraq by introducing a newly-developed program which has

The ability to recognize a person's faced and provides additional information such as their name. Furthermore, if the Iraqi government wishes to be a member of the global e-government family, it must also be a member of the “information society” and develop a strategy for electronic transactions [1].

When performing such a thesis the researcher should remember that information systems are designed to handle, analyze and execute information in order to collect data accurately, isolate required data from non-required data, and finally carry out data manipulation.

The fundamental purpose of e-government is defined as the use of knowledge technology information and data to supply governments and services through the web. E-government activities are used not only by state agencies, but also by businesses and individual citizens. In addition, e-government promotes a reform agenda (modernization of competent authorities) so that the government and its policies are more effective. In this case the main goals of government are to increase the use of networked digital information, including innovative design automation of common processes and other targets. Improved efficiency will enhance quality of service, as well as increase the ambition to achieve more effective results both in terms of new services and better functional abilities [2].

A further advantage of e-government is the ability to reduce the gap between citizens and the government, thereby strengthening democracy. Consequently, final service delivery via ICT additionally improves the association between government and citizens or businesses. Moreover, e-governance services make government considerably clearer, with the assistance of legislation such as the Information Acquisition Law. Public records will be accessible to the public, thus enabling them to participate in e-government.

The Iraqi government is currently in the initial stages of developing an e-government project in an atmosphere that depends on innovative ideas; these ideas will hopefully lead the country toward a positive and prosperous future [3]. Because of its poor security situation since 2003, Iraq is subject to special conditions which influence its path to development.

In June 2004, the United Nations asked member states to assist the new Iraqi government with the enhancement of its buildings and institutions. The Iraqi Minister of Science and Technology and the Italian Minister for Innovation and Technologies signed a memorandum offering financial and technological experience in order to build a suitable intranet architecture connecting the ministries of the new Iraqi Administration, and to construct an e-government project. This government intranet project represents the initial step in the construction of a smart e-government environment aimed at sustaining the rebuilding of Iraqi infrastructure [4].

The United States Agency for International Development (USAID) and the Iraq Ministry of Science and Technology put forward a strategy from 2007-2010 to develop Iraqi electronic government, as shown in Figure 1. This strategy of e-government will have the best chance of success if accompanied by a high level of funding and sponsorship [3].

Each government sector provides integral services and enhanced opportunities for community participation. However, there are several challenges which exist during process development and implementation [5].

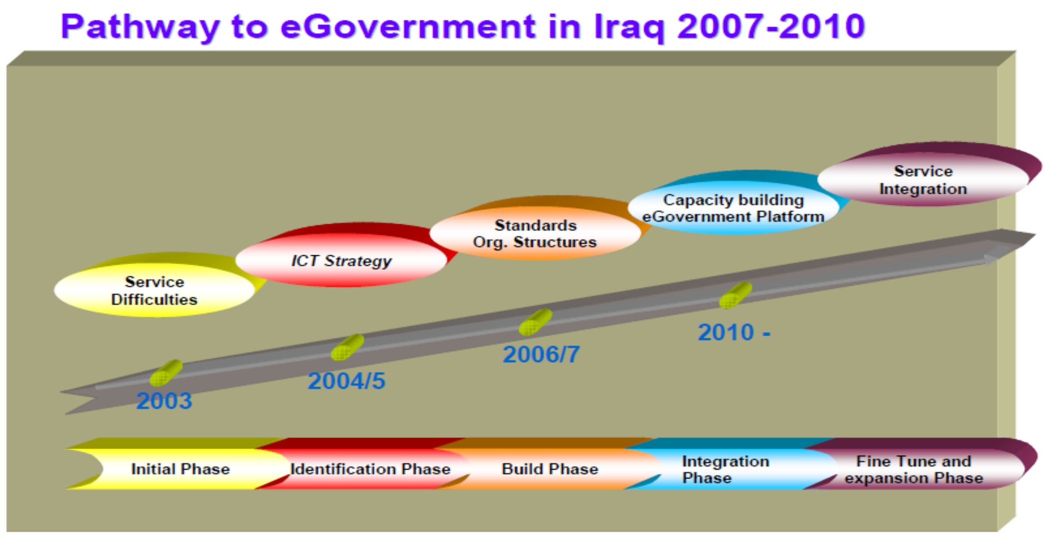

Figure 1 E-Government progress and pathway in Iraq 2007-2010

In 2013, a Geographical Information System (GIS) was utilized in establishing an E-health sector in the north of Iraq based on e-government. This project involved investigating the locations of hospitals in Erbil province, collecting information from time to time regarding both current hospital locations and suitable regions for the construction of new hospitals [6].

This year, a combination of GIS and e-government has been proposed aimed at providing services to students, teachers, citizens and decision-makers in the education sector. The starting point of this project should not be the acquisition of hardware and software, but rather the collection of clean data in the field, and to ensure that this data is updated in a timely fashion. In this way, Iraq can climb to a higher rank in international e-government measurement reports [7].

1.2 Aim of Thesis

This research proposes a novel e-government stage model based on citizen participation, aimed at improving the delivery of governmental services via the use of a qualitative case study strategy from the Kirkuk region of Iraq. A Graphical User Interface (GUI) is introduced with which to compare an input image with existing database images in order to display citizen information such as first name, surname, and birth date. The proposed e-government model also includes the detection of cases of forgery and other crimes using biometric systems.

1.3 Thesis Outline

This thesis is arranged in five chapters as follows:

Chapter one presents an introduction including a literature survey and thesis aims.

Chapter two provides an overview of e-governments, biometric systems, and their relation to face recognition.

Chapter three begins with a description of face recognition algorithms.

Chapter four presents and discusses the simulation results.

Chapter five includes the thesis conclusion and suggestions for future work.

CHAPTER II

ELECTRONIC GOVERNMENT: BASICS AND OVERVIEW

2.1 E-Government

E-government refers to the application of ICTs both to improve the delivery of government services in terms of enhanced service quality, and to integrate government and services for citizens, businesses, and other government agencies. E-government thus enables users to access government information and services wherever and whenever required (i.e., 24 hours a day, seven days a week), through multiple channels including the Internet.

E-government is not limited to simply putting official forms on government websites; it is also about using ICT to its fullest in order to provide public-focused services and information. As ICT has proven to be an efficient method of directing transactions between the government, the public, and business communities, as well as within the administration itself, Nag has argued that it increases the accessibility of many kinds of government service and enables their delivery to the public and businesses on their terms and at their convenience, rather than following the logic of internal government structures [8].

E-government also helps to build/regain confidence between government and citizens. For instance, ICT can enable citizen engagement in the policy process by increasing transparency, and hence prevent corruption in a promoted, open and accountable government. A few examples of popular services include the payment of income tax and corporate tax, the registration of new companies, employment search services and application systems for personal documents such as passports and driver's licenses. Indeed, Gartner has provided an alternative definition of e-government based on the delivery of electronic services [9]: "E-government is the continuous enhancement of service delivery, constituency participation and governance by transforming internal and external relationships through technology, the Internet and new media." This includes government to government (G2G), government to business (G2B), government to citizen (G2C), and government to employee (G2E) types of service delivery [10].

2.1.1 Types of E-Government Delivery Model

The main aims of e-government can be classified based on four groups: businesses, citizens, employees, and other governments and public bodies, as shown in Figure 2. The electronic transactions and interactions between the government and each group mentioned in Section 2.1 together constitute the e-government web of relationships and the respective four main types of e-government service delivery.

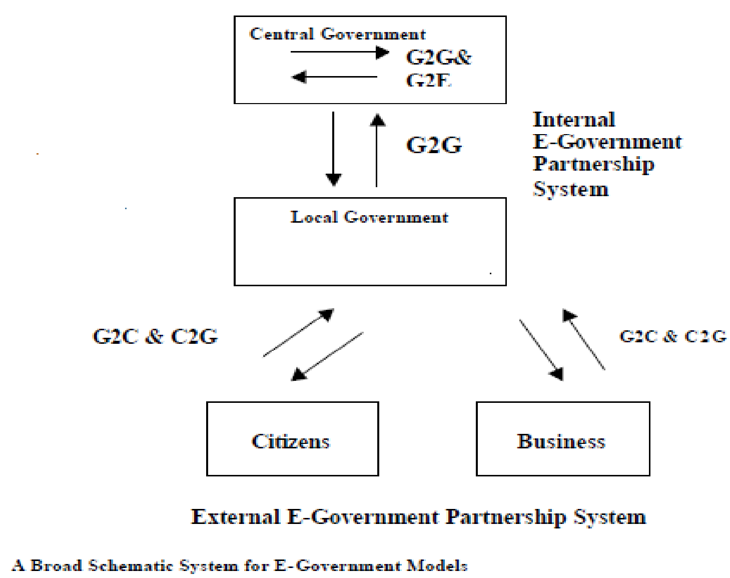

Figure 2 Types of e-government delivery model [10]

2.1.1.1 Government-to-Citizen (G2C)

In providing online public services and building testable relationships between government and citizens, e-government applications encourage governmental bodies to talk and listen, and hence continuously communicate with citizens in order to participate in and improve public services [11].

Additionally, G2C allows citizens to access information and services conveniently, at any time and from any location, via the use of multiple channels (Personal Computer, Web TV, mobile phone or other wireless device), as shown in Figure 3. The primary goal of e-government is thus to serve the public and promote citizen-government interaction by making public information more accessible through the use of websites, reducing both the cost and time spent on completing transactions in government departments. It also enables and enhances governmental participation in local community life, through methods such as sending emails or contributing to online discussion forums; further examples are shown in Figures 3 and 4.

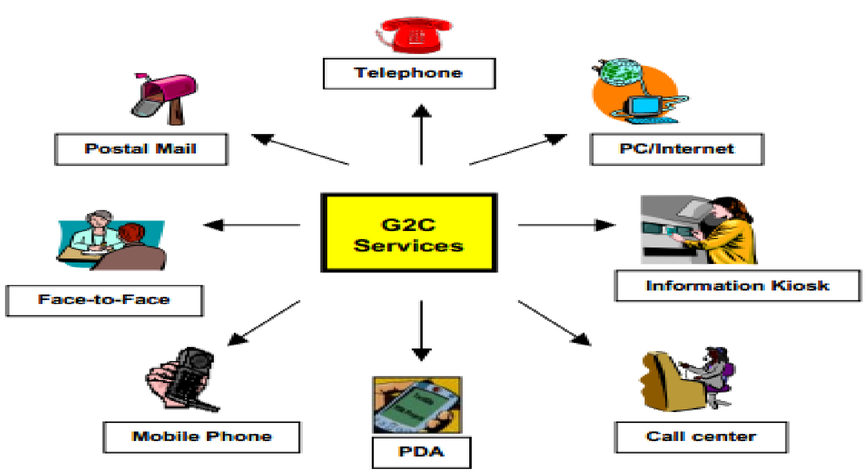

Figure 3 Multiple channels of access to G2C services

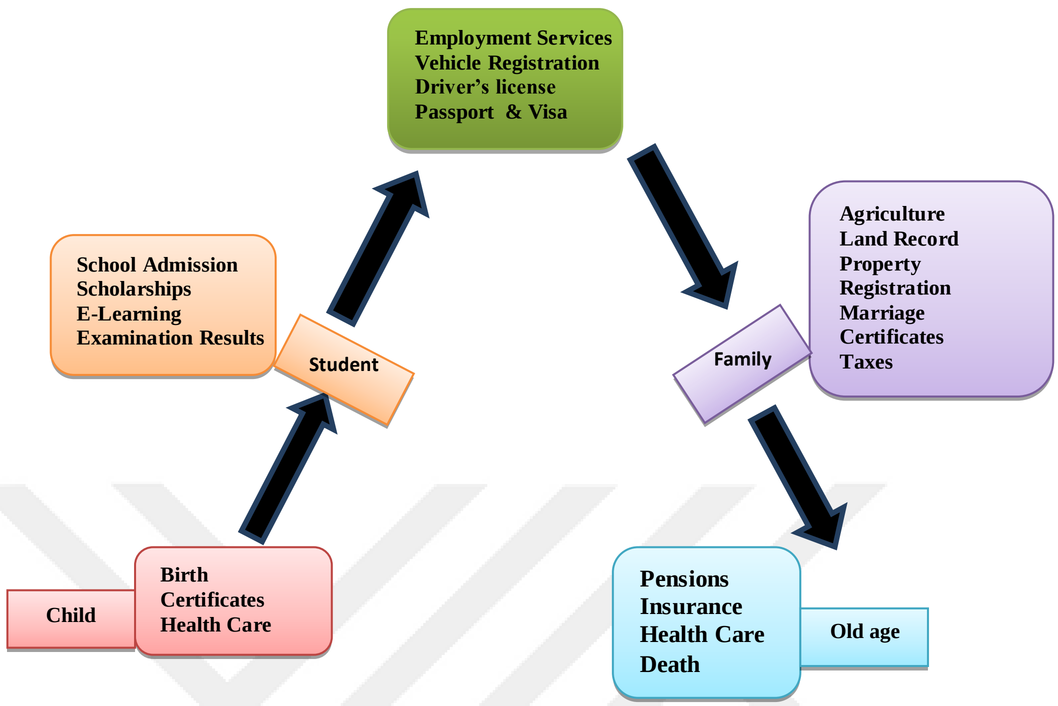

Figure 4 G2C services

In summary, G2C models cover all governmental services provided to citizens, most of which can be offered on the WWW. A popular example of such a service is the recording of address changes. When an individual moves to another address, they should inform the local authority. Additionally, they may also be asked to inform other bodies such as the police department, social security agency, and local health center. On the governmental side, a working G2C should provide citizens with a service through which they can inform the government online, i.e., through a website. This updated information can later be easily shared amongst different government parties. In this way, data needs to be collected only once, thus avoiding any inconsistencies in official databases. Another benefit is that citizens are not required to physically visit local authority offices in person; communication does not therefore have to be made within a specific time period, e.g., 8:30-17:00. Additional examples can be found in Section 2.5.1.

2.1.1.2 Government-to-Business (G2B)

Government-to-Business models of e-government refer to the online interaction between government and business; the government provides services through the Internet, with companies applying for these services via digital platforms. Such models also include transactional activities that allow users to do business online, such as the registration of a new company, filing tax documents, renewing licenses, and public procurement [8]. For example, as part of a public procurement service, if a government department wishes to sell or buy something, an event is advertised and held on a specifically-built website during which businesses bid for procurement. For additional examples the reader is referred to Section 2.5.2. G2B models include intelligent activities which enable users to create online accounts and to personalize site content and services. An example of such services can be seen in Figure 5.

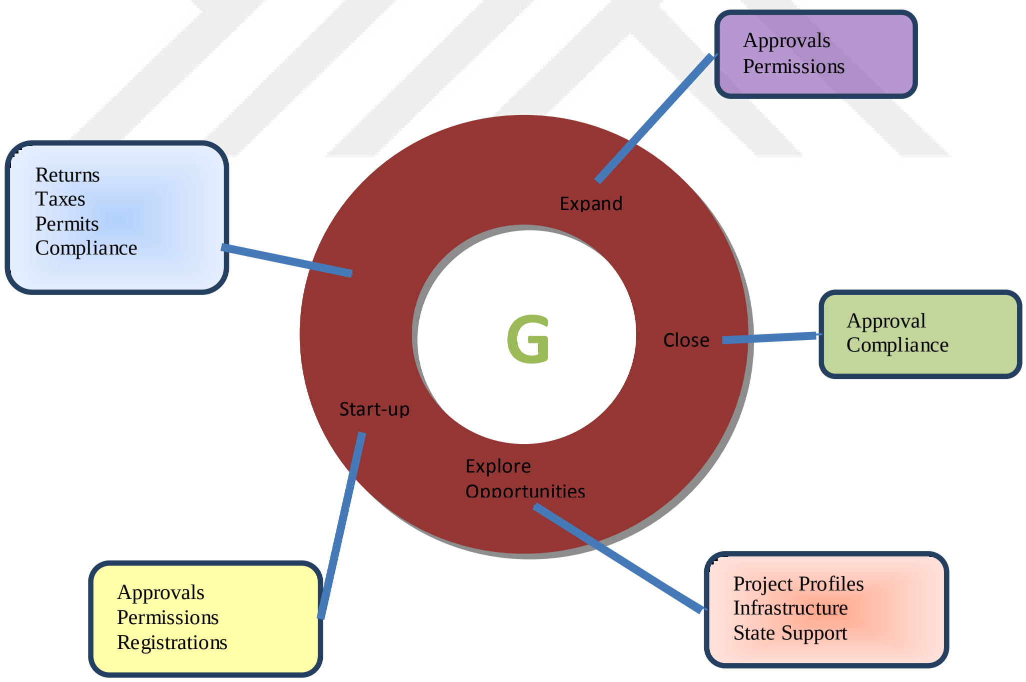

Figure 5 G2B services

2.1.1.3 Government-to-Government (G2G)

G2G refers to the online relationship between different governmental organizations in a single country (regional, national, and local) or between different foreign government organizations, as takes place in the EU. This online communication allows the sharing of data and information between governmental organizations, departments and agencies [11]. For example, public hospitals can automatically send the birth certificates of new-born babies to tax agencies and/or police departments for registration. This can be done electronically using shared data.

2.1.1.4 Government-to-Employee (G2E)

G2E defines the relationship between government and employees working under the authority of that government. It is easy to confuse this group with G2C; G2E specifically concerns employees that are not also citizens. Examples of G2E processes include tracking tax records, as well as health insurance and address registration. G2E is an effective way to support e-learning and to encourage employees to work together to enhance knowledge-sharing; it also gives employees the possibility of accessing relevant information regarding training and learning opportunities, benefits policies, and civil rights laws [11].

2.1.2 E-Government Benefits

As evidenced by the early success story of the EU, there are many benefits of e-government applications that other countries are now hoping to exploit. Indeed, the provision of such applications in a manner that serves all parties is climbing in many government agendas. These benefits include but are not limited to the following, gathered [12]:

- Efficiency gains and cost-reductions are made by using outcome and income services online. Activity processing costs are reduced whilst simultaneously increasing government efficiencies, including that of both processes and tasks.
- Increases the quality of services delivered to citizens and businesses, as the time needed to provide such services can be considerably reduced. This can be achieved by providing self-service facilities over the WWW and thus services are not limited to physical interaction with counter clerks. Many citizens can use the same service at the same time online; however, online services offer fast and convenient transactions only as long as they possess user-friendly interfaces.
- Network and society creation: E-government aims to create an environment of interaction amongst all partners involving the exchange of information via both networks and the formation of an integrated society. This process increases and motivates citizen participation in the digital transformation, and also reduces the digital gap.

2.1.3 E-Government Measurement

The main goal of such measurement is to enable countries to analyze their own progress within the field of e-government, and to compare their performance and development with that of other countries.
In the following sections, two methods of measuring e-government initiatives are described which are well recognized in countries of the EU and/or UN.

2.1.3.1 UNeGovDD Measurement

To compile the information necessary for measurement, the UN appointed the Division for Public Administration and Development Management (DPADM) in the Department of Economic and Social Affairs (UNDESA) to prepare a database. This database has essentially been employed to compile information which can then be used to create tools with which to compare, explore and analyze e-government data at global, regional, sub-regional and national levels. The reports are publicly accessible; visitors can find and sort the e-government profiles of member countries online at http://unpan3.un.org/egovkb. The measurement index is based on a four stage model [10], a brief description of which follows.

Stage 1 Emerging information services

In this stage, government websites must have links to ministries; citizens should be able to easily obtain information online regarding the national government and ministries [5]. At this stage, only information is provided and any user interaction is absent.

Stage 2 Enhanced information services

Government websites deliver enhanced one-way electronic communication between themselves and service consumers, such as the ability to download application forms for subsequent service acquisition. In addition, websites are expected to provide audio and video guidance/multimedia and multi-language options. Some limited e-services can be expected to submit requests for personal information or non-electronic forms, which will be mailed to the registered addresses of the service consumers [5].

Stage 3 Transactional services

Government websites engage in two-way communication with citizens, including electronic authentication of user identity, which is required to successfully complete the exchange. Additionally, the government websites process non-financial transactions, the downloading and uploading of forms, e-voting, license and permit applications, as well as tax filing and certificate applications. Such websites also handle financial transactions in which money is transferred via a secure network to the government [5]. In this stage, communication is carried out entirely in digital format.

Stage 4 Connected services

Governments at this stage of development have drastically changed the way they communicate with their citizens. Services provided are now people- rather than provider-oriented, i.e., citizens log on to their accounts to acquire services; they do not go the service provider's site as the services are now connected at the government side. Governments are proactive in requesting information and opinions from citizens using Web 2.0 and other reactive tools. This connectivity creates an environment that empowers citizens to be more involved with government activities, and to have a voice in decision-making [5] through citizen networks. More clearly, citizens can log on, for example, to a government portal through which they can see and use all the services that are provided by the government; this is in contrast to a citizen searching the appropriate government website to find out which service he is looking for. To reach this stage, governments must both connect services in real-time and use a central database, as the services offered should not be government office oriented but rather citizen-oriented. Figure 6 displays an example from the Turkish government website found at www.turkiye.gov.tr; as can be seen in this figure, the user can log on in several ways, including via citizenship id, mobile-phone password, electronic signature, and citizenship electronic card.

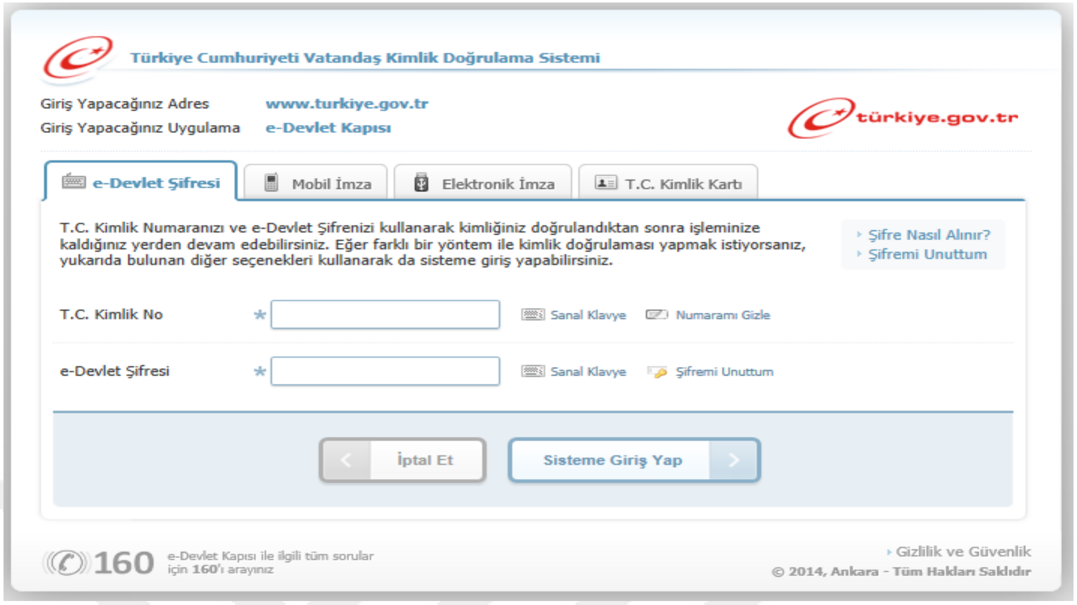

Figure 6 Turkey's e-government portal authentication screen

2.1.3.2 EU Measurement

EU countries measure their level of success in e-government initiatives through collaborative work carried out by Cap Gemini (a French IT company), the IDC (International Data Corporation), Rand Europe, Sogeti, and the Danish Technological Institute (DTi). The European Commission considers this research as representing e-government benchmarks in terms of measuring public sector performance, with the measurement bodies informed by the European Commission and country representatives as to which variables to measure.

The benchmark uses a comprehensive ranking system to specify European countries executing the most mature government services [13].

Measurement involves assessing the availability of 20 basic services (Section 2.1.4) and their sophistication via a 5-stage model, similar but not identical to UNeGovDD (Section 2.1.3.1). Assessment is carried out of more than 10,000 websites at global, regional and local levels across the 32 participating European countries, and is executed by a multi-language team of researchers.

Analysis of the online sophistication of these services comprises the following essential elements:

Online developments: By application, this is the extent to which government services allow for interaction and/or transaction between the administration and citizens or businesses. This measure covers 20 basic public services such as permit acquisition, online tax filing, and enrolling in schools.

The online developments ranking system assesses service delivery against a 5-stage maturity model: (1) information, (2) one-way interaction, (3) two-way interaction, (4) transaction, and (5) personalization. As shown in Figure 7, this measure represents the level of online availability of (20) basic public services. In 2010 the EU27+ score for this indicator stood at 90% [13].

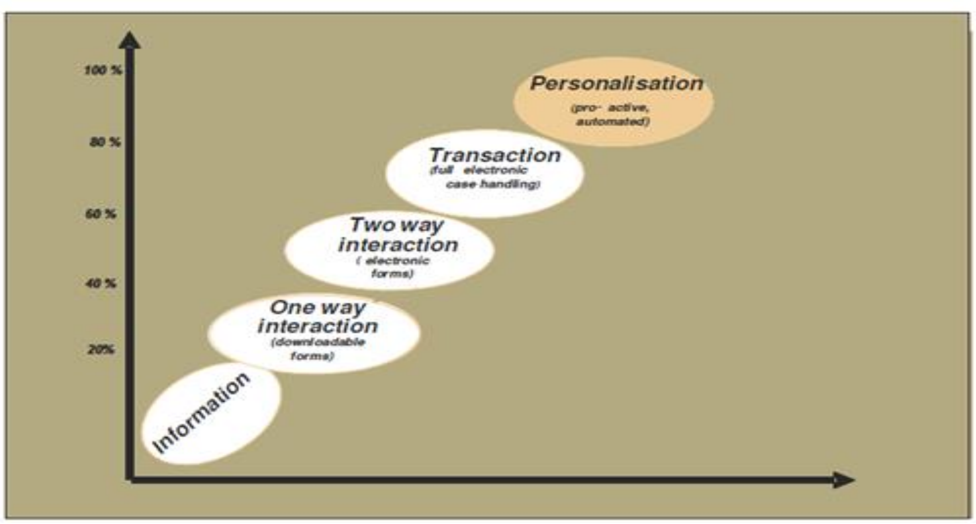

Figure 7 Five-stage maturity model

- **Information:** service information is available on the website; for example, basic information about the organization.
- **One-way interaction:** downloadable forms are available on the website.
- **Two-way interaction:** online information exchange, for example electronic official form uploading, and online submission of examination results.
- **Transaction:** no paperwork, electronic case handling, decision, delivery, real-time response. For example, online bill payment.
- **Personalization:** no need for user to request services. For example, child allowance in Sweden is an automated social security service: when a child is born, the hospital sends his/her birth certificate to the tax agency for registration, and an insurance agency pays the child allowance to the parents automatically.

Full online availability: the total number of basic public services that are fully available online. Figure 8 represents the 5-stage maturity model for EU+ countries; as can be seen, most are at the fourth or fifth development level, depending on the service in question. In 2010 this rate stood at 82% [13].

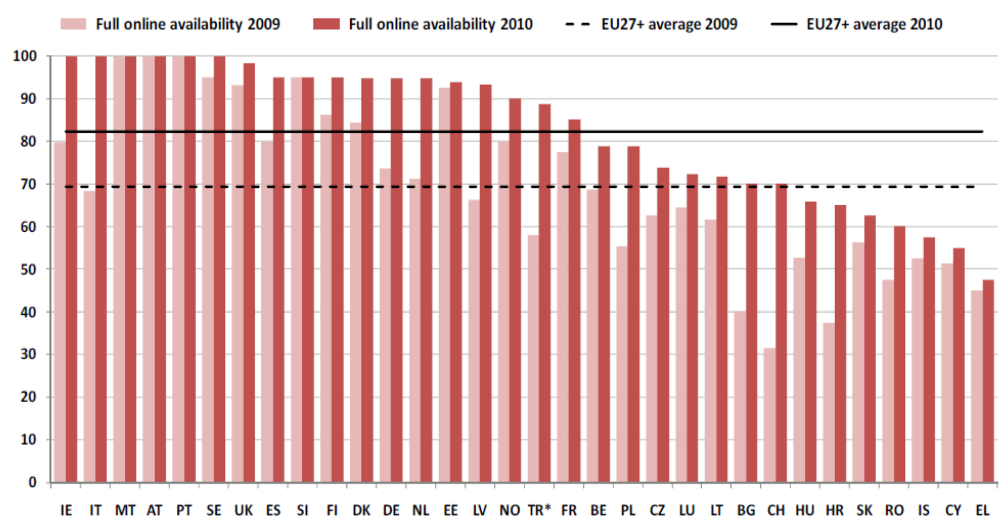

Figure 8 Full online availability for EU27+ services in 2010

- **User service experience**: the user-centricity and usability of e-government services. This pointer assesses the usability of 20 service websites, as well as the extent to which they allow for the monitoring of user satisfaction. Figure 9 displays the five key criteria employed in the measurement of user experience, based on the 2010 benchmarking study [13].

- **Transparency of service delivery**: tracing and tracking of service provision, including the ability to use the service in steps and an indication of the time required for service completion.

- **Multichannel service provision:** whether the service is available using channels other than online, for example call center.

- **Privacy protection**: the existence of any privacy regulations concerning user data placed on the website.

- **Ease of use:** whether the website provides user guidance, such as FAQs, demonstrations and live support, and whether the user can add further documents to applications/requests.

- **User satisfaction monitoring:** whether the website includes forms for user satisfaction monitoring, feedback options and/or complaints management.

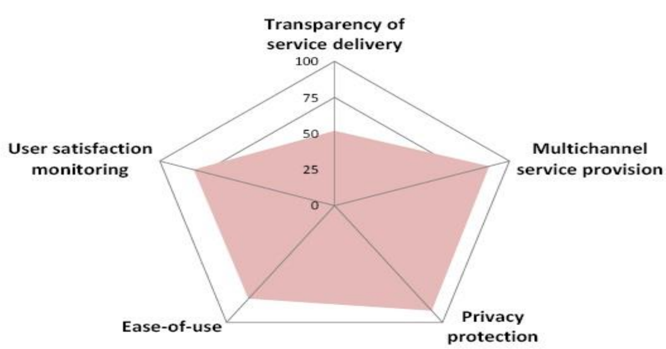

Figure 9 Five key criteria for the measurement of user experience

Portal sophistication: characteristic identifying the most mature user-centric and personalized portals that offer direct access to a wide range of e-government services. This indicator comprises the following sub-indicators/measures of the availability of the 20 services provided through the portal: one-stop-shop approach, user-focused portal design, and usability (Figure 10) [13].

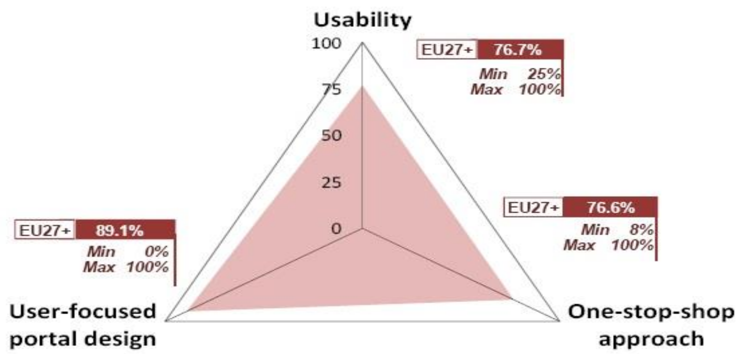

Figure 10 User experience of portals, EU27+

Sub-national analysis: the 20 analyzed service metrics have been applied at NUTS (Nomenclature of Territorial Units for Statistics) level in order to provide granularity of e-government performance across regional and local administrations.

2.1.4 Twenty Basic E-Government Public Services as Defined by the EU

As previously mentioned, e-government services aim to create positive changes regarding the way in which governments deal with both businesses and citizens, and as a consequence, save money and time, increase convenience for citizens and businesses by providing on-line transactions and on-line data acquisition, as well as promote honest treatment of citizens and businesses. There are 20 basic public services identified by the ECDGISM that governments can make available on digital platforms (and hence pass to the e-government sector). Twelve of these services aim to help citizens and eight aim to serve businesses, as shown in Table 1.

Table 1 E-government services as defined by the EU

Citizens	Businesses
Income Taxes	Social Contribution for Employees
Job Search	Corporate Tax
Car Registration	Registration of a New Company
Social Security Benefits	Submission of Data to the Statistical Office
Personal Documents	Customs Declaration
Application for Building Permission	Environment-related Permits
Declaration to the Police	Value added tax (VAT)
Public Libraries	Public Procurement
Birth and Marriage Certificates	
Enrolment in Higher Education	
Change of Address	
Health-related Services	

2.1.4.1 The Twelve E-Government Services Provided for Citizens by the EU

- **Income tax**: citizens should be able to pay tax electronically ubiquitously; a government website should provide related information concerning all types of taxes, as well as the appropriate forms**.**

- **Job search services**: citizens can look for a job online by searching related government websites. The searcher does not need to go to the government office in person to provide their documentation as they can send all documents via the Internet.

- **Social security benefits**:
  - **Unemployment benefits:** the government provides money to people without a reasonable income [14].
  - **Child allowances:** the money given by the government to the parents of a newborn child. The conditions required to receive this money vary from one EU country to the next [14].
  - **Medical costs:** citizens pay the government every month or every year depending on the rules of that country. Citizens can obtain this benefit as part of a health insurance scheme [14].
  - **Student grants:** The government provides grants to cover living costs and tuition fees to support student education.
  - **Personal documents:** Citizens can electronically send requests for passport or driver's license documents, instead of going to the specific department in person and standing in a queue.

- **Car registration:** if a citizen buys a new car, they do not need to go to the vehicle registration office in person, but can instead register it online through the appropriate government website. They should also be able to send documents and other information regarding the new vehicle over the Internet.

- **Application for building permission:** citizens should be able to obtain permission for a new building via online submission. All documents and information should be sent to the government website; the applicant then receives a response via e-mail if the website includes transactional services.

- **Declaration to the police:** citizens should be able to contact the police over the Internet [5]. Related services include online theft declarations, a database of terrorist and organized crime groups, the detection of car theft offenders through the vehicle database and of other criminals through the criminal records database, and the ability to access global information via the police network.

- **Public libraries:** the government should provide a website through which citizens can easily search and place orders for books.

- **Certificates:** a citizen can submit documents online through a government website, and also request birth, marriage or death certificates.

- **Enrolment in higher education/university:** the government website should provide information regarding the country's universities; course registration is provided by universities through their own student information systems, without the need for paper-based correspondence.

- **Change of address:** if a citizen moves and changes their address, they do not need to go to the related office in person but instead can inform the government electronically, as discussed in Section 2.2.1.

- **Health-related services:** the government provides a portal website through which information regarding doctors and hospitals can be obtained. Patients can easily make appointments online, as well as discover the location of their nearest hospital or pharmacy.

2.1.4.2 The Eight Services for Businesses

As already mentioned in Section 2.2.1, these are services which have been identified by EU countries [13] [15].

- **Social contributions for employees:** a system of payment for social, medical and pension insurance for employed people. Payment is made to those employees working in either public or private sectors as a benefit toward social and medical costs; after the employee retires they will also receive pension insurance money every month. This service requires information regarding both the employee and the amount of money to be paid. Such information can be provided through digital platforms.

- **Corporate tax:** in a working e-government medium, the submission of tax forms and payment can be performed electronically. Related functionalities include the ability to follow one's tax status, check account balances, and obtain information regarding regulations and updates via the network.

- **Registration of a new company:** an organization should be able to both register a new company and lodge related documents online.

- **VAT (value added tax):** VAT is a tax paid on the purchase price of products, goods and services. Organizations and businesses should be able to submit information and pay online.

- **Submission of data to statistical offices:** any data/information that the government is to collect should be provided electronically.

- **Customs declarations:** customs declarations can be submitted fully in an electronic environment.

- **Environment-related permits:** if a business has an impact on the environment, the person responsible may need to obtain an environmental permit or apply for an exemption.

- **Public procurement:** the procurement of goods and services on behalf of a public sector. A government website should provide information about public procurement requirements, as well as forms for prospective candidates.

CHAPTER III

FACE RECOGNITION ALGORITHM

3.1 Face Recognition

In the early 1970's, Goldstein, Harmon and Lesk used 21 subjective markers such as hair color and lip thickness to create a face recognition system [16]. However, this system proved difficult to automate due to the subjective nature of many of the measurements, which were then made completely by hand. The first completely automated system employed universal pattern recognition, relating each face to a general face comprised of predictable features and producing a sequence of patterns to construct an image in relation to this model. This method is principally statistical and is based on histograms and gray-scale values. Kirby and Sirovich developed the aging face approach at Brown University in 1988. This was considered a milestone in face recognition research because it demonstrated that less than one hundred values are required to accurately code a suitably aligned and normalized face image [17].

3.2 Feature Extraction

Feature extraction involves the computation of LBP values from an input image, and the construction of regional histograms. These two operations can be carried out in a single kernel, without the need to temporarily store the LBP values in a GPU's global memory, which typically exhibits very high access latency.

In the proposed arrangement, each thread block computes the histogram of a single region R_j. This is achieved by making each warp in a thread block compute a per-warp histogram in shared memory, which are then combined by the threads in the block to obtain the regional, pre-block histogram.

By constructing the histograms in shared memory, this method eliminates the need for expensive atomic operations in global memory.

The arrangement of the thread blocks for a 130 × 150 input image generated by the CSU Face Identification and Evaluation System (FIES) [18] divided into 7 × 7 regions is shown in Figure 11.

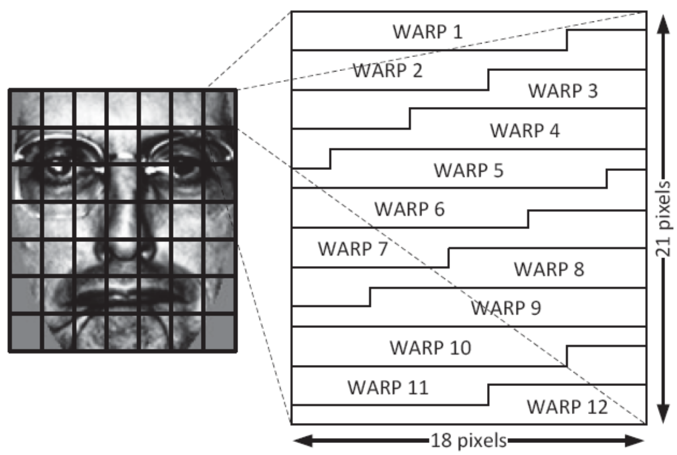

Figure 11 Arrangement of thread blocks for a sample image divided into 7 × 7 regions

If the number of warps in a block is N_w, and the number of bins in the histogram is N_b, the size of the shared memory required for a single block is $N_w * N_b * 2$ bytes, provided that the histogram values are 16 bit integers. Figure 12 illustrates this memory layout for a single block.

The construction of a per-warp histogram is performed as follows: Each thread in the block applies the LBP operator to the neighborhood centered at its location in the input image. In order to take advantage of the hardware linear interpolation capability of the GPU during the computation of LBP values, the input image is stored in the texture memory. The computed LBP value is converted to a uniform LBP value with the help of a lookup table stored in constant memory.

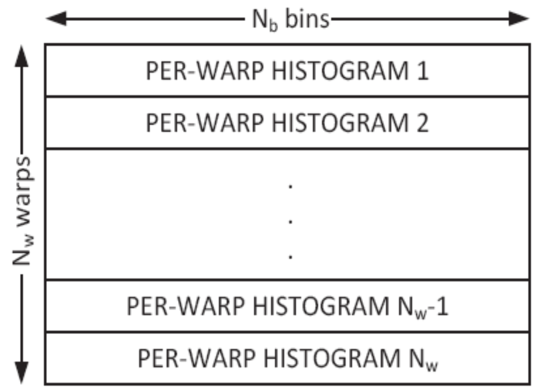

Figure 12 Shared memory layout for histogram computation

This uniform LBP value is immediately used to update the corresponding per-warp histogram residing in shared memory. Since more than one thread in the same warp may try to increment the same bin, the increment operation must be atomic. In the case of a GPU that does not have the capability to carry out atomic operations in shared memory, one can fall back to an alternative method known as "tagging", as explained by Shams and Kennedy [19].

Before starting to construct the per-block histogram, in order to make sure that the construction of all per-warp histograms is complete, the threads in the block are synchronized with each other using the *__syncthreads ()* primitive of CUDA. Each block then combines all of its per-warp histograms to obtain the regional histogram, and writes the result to global memory.

3.3 LBP Operator and Extensions

The original LBP operator [20] generates an 8 bit binary number by thresholding the pixels in 3 × 3 neighborhoods with the center pixel as shown in Figure 16. The operator was later extended to handle different neighborhood sizes by using circular neighborhoods and bilinear interpolation [20]. The recommended notation to describe such a neighborhood is (P, R), where P is the number of sampling points on the circle and R is the radius of the circle.

Figure 13 shows the location of the sampling points in an (8, 2) neighborhood. The values of non-integer coordinates are computed using bilinear interpolation.

Another extension of the LBP operator is the usage of uniform patterns [20].

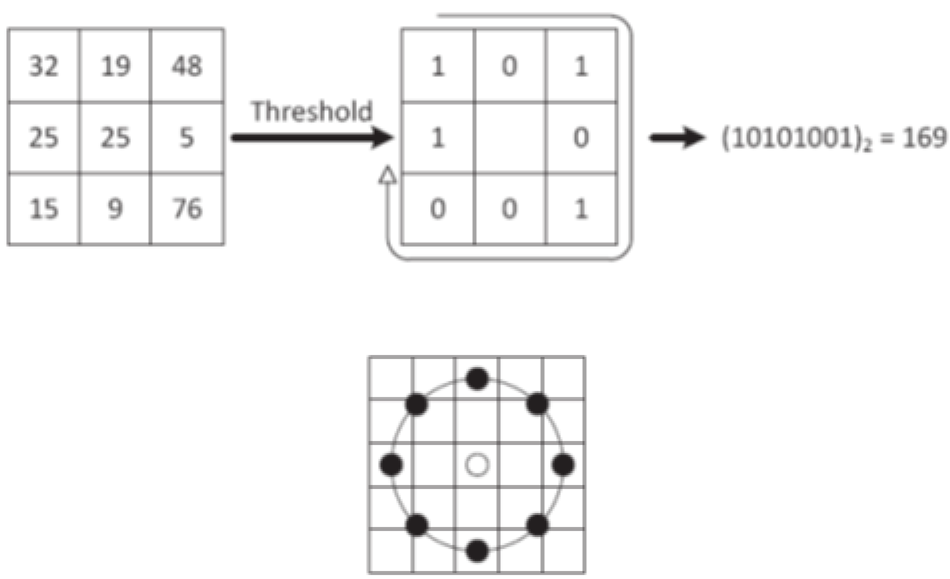

Figure 13 Local binary pattern architecture

A double pattern is considered identical if it covers at most two bitwise evolutions when the bit series is measured as circular. For example, the patterns 00000000 (0 transitions).

01110000 (2 evolutions) and 11001111 (2 evolutions) are identical, while the patterns 11001001 (4 evolutions) and 01010011 (6 evaluations) are not.

With 8 sampling points, the number of different uniform patterns is 58.

This leads to the production of a 59 bin histogram when all the non-uniform patterns are considered to be in the same bin. When 16 sampling points are used, the number of bins increases to 243. The employment of identical patterns is encouraged by the fact that most patterns in facemask images are identical. According to Ahonen et al [21], 90.6% of patterns in the (8, 1) area and 85.2% of patterns in the (8, 2) area are identical in the situation of preprocessed FERET [22] facemask images. The practice of identical patterns is designated with the notation $(P,R)^{2u}$.

Later the operator was extended to neighborhoods of different sizes [20], using the neighborhood notation (P, R), or P sampling points on a circle of radius R. Pixel values are bilinearly interpolated whenever the sampling point is not in the center of a pixel. Figure 14 displays an example of the circular (8, 2) neighborhood.

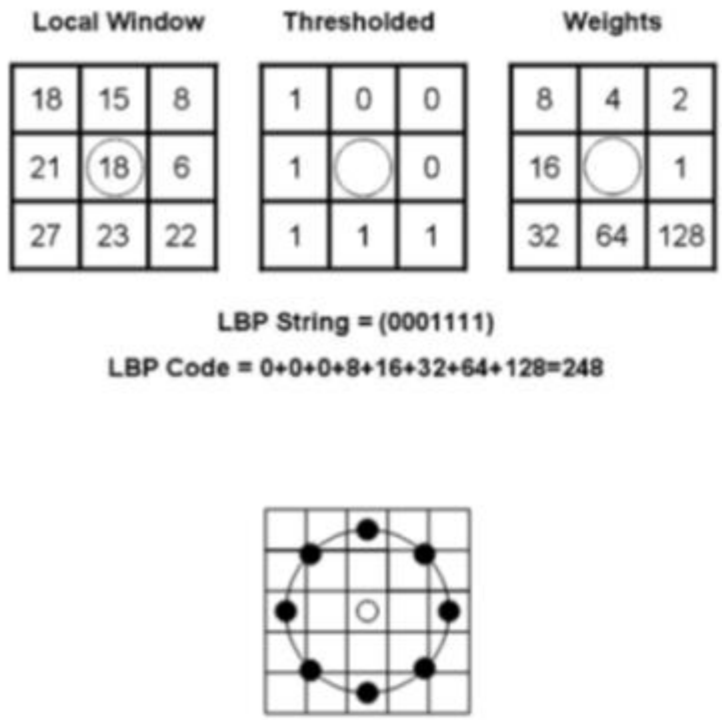

Figure 14 Example of a local binary pattern

The following notation is employed for the LBP operator: $LBP_{P,R}^{u^2}$, where the subscript denotes the use of the operator in a (P, R) neighborhood, and the superscript u^2 the use of uniform patterns only, categorizing all remaining patterns with a single label.

This histogram provides information regarding the distribution of localized micro-patterns, such as edges, spots and flattened areas, over the total image. Effective face representation also requires the preservation of spatial information. For this purpose the image is divided into areas $R_0, R_1, ..., R_{m-1}$ [23]. The length of the feature vector is thus $B = mB_r$ in which m is the number of areas and B_r is the LBP histogram size.

A large number of small areas yield long feature vectors, resulting in high memory usage and slow classification, whereas large areas cause the loss of more spatial information. Figure 15 (a) displays an example of a preprocessed face mask image divided into 49 windows [23], a similar number to that used in the present study.

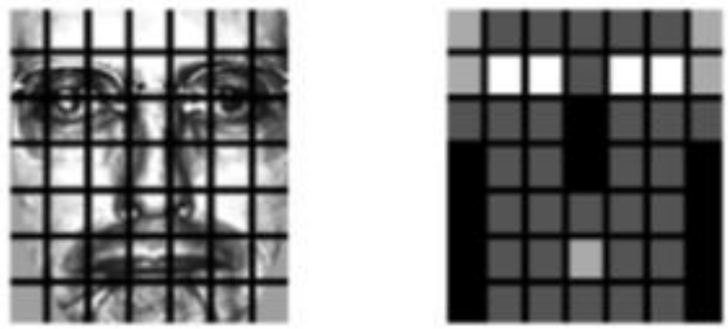

Figure 15 Example of a preprocessing face mask image divided into 49 windows

3.4 Local Binary Patterns (LBP)

One of the best methods with which to represent texture is the LBP technique, which has been widely used in various recent applications. The method is considered one of the most useful for appearance analysis due to good separation/discrimination and other important features, such as invariance in monotonic changes in gray level, and computational efficiency. In this technique each face is composed of a combination of several small models and thus can be described more precisely.

3.5 Description of the Local Binary Pattern Method

The local binary pattern method is considered the strongest approach to texture analysis and was initially proposed as a 3×3 square operator by Ojala [20]. The operation of this method is similar to that in which 8-neighborhood pixels are compared with the central pixel. If the eight neighboring pixels are greater or equal to the amount of the central pixel, they are replaced by 1; otherwise, their amount is set to zero. Finally, the central pixel is replaced by summing the weighted binary neighboring pixels, and the 3×3 window passes to the next pixel. By constructing a histogram of these amounts, a descriptor for the appearance texture is obtained. Figure 16 demonstrates the working of a local binary pattern operator.

7	3	5
6	5	1
2	3	8

(a)

1	0	1
1		0
0	0	1

(b)

1	0	4
128	149	0
0	0	16

(c)

Figure 16 Demonstration of a local binary pattern operator

Equation (3-1) describes the composing relationship of the local binary pattern in each pixel:

$$LBP_{P,R(x,y)} = \sum_{P=0}^{P-1} s(g_p - g_c)2^P \tag{3-1}$$

Where s denotes the sign 1, and g_p and g_c denote the gray level amount of neighboring and central pixels, respectively. 2^P is a required factor for each neighbor due to the fact that the LBP method involves the use of tissues with different ratios.

3.6 The Uniform Local Binary Pattern

The first improvement made to the LBP method was introduced in the form of uniform pattern by Ojala et al. [24].

If a local binary pattern consists of a maximum of a 2-bit transition from 0 to 1 or vice versa, it is considered uniform. For example, 0000000000 (0 transitions) and 11001001 (4 transitions) are respectively uniform and non-uniform. It has been shown that using the neighborhoods (1, 8) and (16, 2) respectively about 90% and 70% of all patterns produced are uniform.

The overall pattern of a binary with P bits is expressed as P+2(P-1) in the monotone model. In the LBP $\binom{u2}{P,R}$ notation used for uniform LBP, the lower script indicates the use of neighborhood (P, R) and the superscript indicates the use of only uniform patterns. The uniform binary model is then calculated according to equation (3-2) as follows:

$$LBP_{P,R}^{U2}(x,y)=\begin{cases} I(LBP_{P,R}(x.y)) & if \begin{cases} U(LBP_{P,R})\leq 2 \\ I(z)\in[0,(P-1)P+2] \end{cases} \\ (p-1)p+2 & otherwise \end{cases} \quad (3\text{-}2)$$

Where U(x) is the detonator of the number of transitions between bits, and is defined as in equation (3-3):

$$U(LBP_{P,R})=\left|s(g_{P-1}-g_c)-s(g_0-g_c)\right|+ \sum_{P=1}^{P}\left|s(g_{P-1}-g_c)-s(g_{P-1}-g_c)\right| \quad (3\text{-}3)$$

If U(x) is smaller than 2 pixels, the pixels are labeled with an indicator function I (z), otherwise, (P-1) P+2 is assigned. Indicator function index I (z) includes the (P-1) P+2 which is applied to a specific index for each of the uniform patterns.

3.6.1 Appearance Histogram

In a scalar appearance, image pixels have specific amounts. The first gray level histogram represents the brightness distribution in the image. The horizontal axis of this histogram contains the pixel brightness values, and the vertical axis the number of corresponding pixels with each appearance brightness value. Suppose that the input image is a gray image with 256 levels of brightness, so each image pixel can range in value from 0 to 255. To obtain the appearance histogram, it is sufficient that in traversing all the pixels in the image we calculate the number of pixels at each brightness level.

It is clear that in a simple histogram, all pixel location information is missing and just the gray values are calculated.

3.6.2 Evaluating and Choosing a Distance Function in System Performance

There are two solutions required to calculate the similarity between feature vectors. The first involves calculating the distance between two feature vectors, and the second calculating the similarity. These two measurements oppose each other. Different criteria are employed to evaluate distance and similarity. In the present paper, the similarity between a test image S and a training image T was determined via the chi-square distance [25], expressed as follows:

$$D(S,T) = \sum_{n=1}^{N} \frac{(S_n - T_n)^2}{(S_n + T_n)} \qquad (3\text{-}4)$$

A minimum of 1 and maximum of 4 face images of each of the selected test subjects were used in the training.

As is clear, the PCA method produces the worst results, whereas the standard LBP method is the most accurate. However, the currently proposed method has a higher accuracy than standard LBP.

Performance-based approaches appear to be strongly influenced by the number of training images employed. In a further experiment we therefore investigated the influence of this parameter on the proposed method, using a minimum and maximum of 3 images of each test subject for training. Experiments were performed on the database, and the results presented using different algorithms.

3.6.3 Principal Component Analysis (PCA)

PCA is a standard linear algebra technique pioneered by Kirby and Sirovich [17]. Commonly referred to as the use of Eigen faces in face recognition, PCA is employed in image analysis to reduce data dimensions by means of data compression basics. This reduction in dimensions removes non-useful information and decomposes the face into orthogonal (or uncorrelated) components, which are also known as Eigen faces.

DCT is preferred in image processing due to its approximation of the Karhunen-Loeve Transform (KLT) for natural images. However, if there is sufficient training data, one can obtain the data-dependent version of the KLT, which is the PCA transform. PCA is an orthogonal linear revolution that plans data into a minor dimension by preserving most data alteration.

The first principal component represents the path of maximum data alteration, the second the path of second most data alteration, and so on. In length reduction carried out via PCA, those data features that account for most of its alteration are reserved by keeping lower-order principal components. So, by using a smaller amount of information, most data alteration is taken. We chose the rows of the revolution matrix, *W*, as the eigenvectors corresponding to the *p* highest eigenvalues of the scatter matrix *S*.

$$S = \sum_{k=1}^{n} (x_k - m)(x_k - m)^T \quad (3\text{-}5)$$

Where x_k denotes the *kth* sample and *m* is the sample mean.

The main weakness of PCA is that it is light and background modified, so that variations in lighting conditions and backgrounds reduces the success of reliable plotting and classification. However, the benefits it brings are that it is fast, computationally easy and needs only a minimum amount of memory. However, PCA does not take class information into account, and so there is no assurance that the direction of maximum alteration will contain good features for image discernment.

An example of a set of Eigen faces is shown Figure 17 [26]. Feature vectors are derived using such Eigen faces.

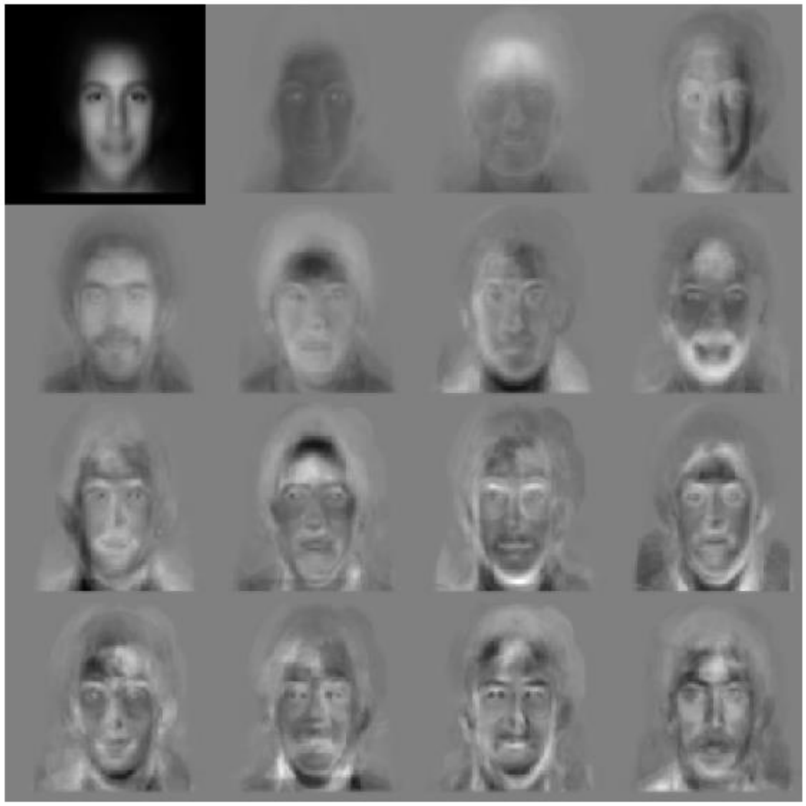

Figure 17 An example of eigen faces (MIT media laboratory, 2002)

Let the training set of M face images be $I_1, I_2, ...I_M$. The average of the training set is μ, where

$$\mu = \frac{1}{M}\sum_{n=1}^{M} I_n \qquad (3\text{-}6)$$

The difference between each image and the average is defined as

$$\theta_i = I_i - \mu$$

This set of very large vectors is then subject to PCA, which seeks a set of M orthonormal vectors describing the distribution of the whole data set. The k^{th} vector of this vector is selected so that

$$\lambda_k = \frac{1}{M}\sum_{n=1}^{M}\left(u_k^T\theta_n\right)^2 \tag{3-7}$$

Is a maximum, subject to

$$u_1^T u_k = \zeta_{Ik} = \begin{cases} 1, & if\ l = k \\ 0, & otherwise \end{cases} \tag{3-8}$$

The vectors u_k are eigenvectors and the scalars λ_k are eigenvalues of the covariance matrix, which is written as follows:

$$\begin{aligned} C &= \frac{1}{M}\sum_{n=1}^{M}\theta_n\theta_n^T \\ &= AA^T \end{aligned} \tag{3-9}$$

Where C is the covariance matrix and $A = [\theta_1, \theta_2, ...\theta_M]$.

As C is an N^2 matrix, finding the N^2 eigenvectors and eigenvalues is an obstinate task for usual image sizes, so a computationally reasonable technique with which to find these eigenvectors must be realized. If the amount of data points in the image space is fewer than the dimension of the space ($M < N^2$), there are only $M - 1$ rather than N^2 evocative eigenvectors [27]. By using this method the eigenvectors v_i of $A^T A$ are such that

$$A^T A v_i = \beta_i v_i$$

Multiplying both sides by A,

$$AA^T A v_i = \beta_i A v_i$$

Eq. (3-6) shows that Av_i are the eigenvectors of $C = AA^T$. Employing this analysis, the $M_x M$ matrix

$L = A^T A$ is constructed, where

$L_{mn} = \theta_m^T \theta_n$

Thus revealing the M eigenvectors, v_l, of L. These vectors are then used to define the linear mixtures of the M exercise set face images, thus forming the Eigen faces u_l.

$$u_l = \sum_{k=1}^{M} v_{lk} \theta_k \qquad l = 1,2,\ldots,M \tag{3-10}$$

Using this exploration the calculations are significantly abridged, from the order of the number of picture pixels (N^2) to the order of the number of pictures in the exercise set (M). In practice this means that the exercise set of face images will be comparatively small and the computations fairly unwieldy [27].

CHAPTER IV

APPLIED SYSTEM

4.1 Introduction

In this chapter, a biometric face recognition system for e-government is suggested and presented, based on the Local Binary Pattern (LBP) method. We used a real database produced from multiple individuals, with each subject contributing three images taken from different positions. In the proposed system a Graphical User Interface (GUI) is employed to compare input images with existing database images, in order to then display citizen information such as first name, surname, birth date, etc. The system can also be used to detect cases of forgery and counterfeiting at passport directorates, airports and national borders.

4.2 The Proposed Face Recognition Model for E-Government

Sample diagrams for image capturing, LBP operation and matching process subsystems are shown in Figures 18, 20 respectively.

Figure 18 represents the graphical user interface (GUI) available for users to access software functions for the image capturing process. We used the LBP face recognition method as displayed in Figure 19 to identify the characteristic vectors for any face image. These characteristics are taken from the original image to signify the subject's distinctive identity, and are then used as inputs to calculate facial similarity during subsequent classification and recognition. The subsystem in Figure 20 provides any

Matching result after a search is completed, including citizen information such as given name, surname, and birth date. In the case of a non-match the subsystem inserts the newly-captured image into a database folder with a request to record the citizen information of the new subject.

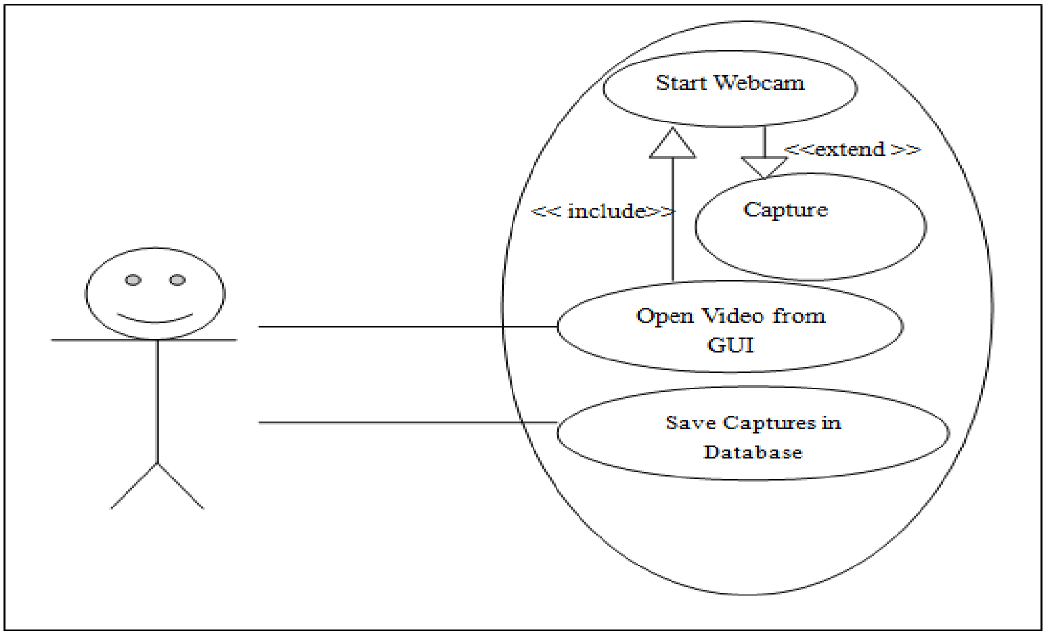

Figure 18 Subsystem for face capture and saving

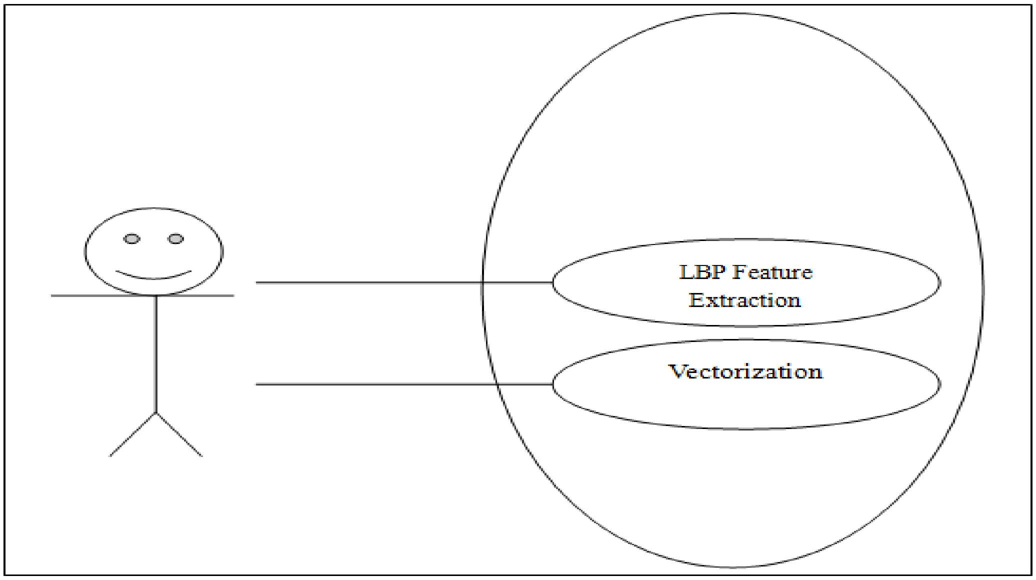

Figure 19 Subsystem for condition setting using the LBP algorithm

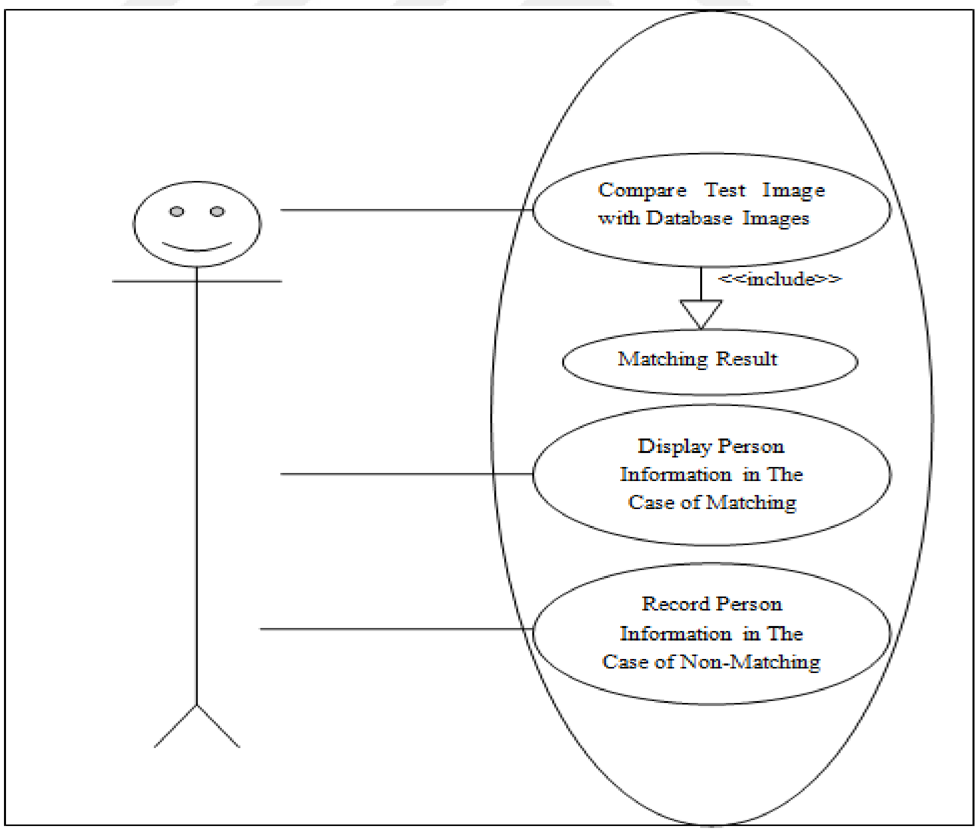

Figure 20 Subsystem for displaying and recording results

An additional demanding state is recognition at a distance, when the subject is captured in a random situation. In this scenario, citizens may be rather distant from the camera and uninformed of the sensors. Under these conditions, the greatest challenge stems from the awkwardness of users. In the case of a subject template obtained with an impartial expression, it is easy for an individual who attempts to keep from being sensed to adjust parts of his or her facial surface by smiling or adopting an open-mouthed expression. Likewise, the growth of a moustache or beard, or the wearing of glasses may complicate the identification process. One possible solution to this problem is to make use of only the rigid parts of the face, particularly the nose region, for identification. Although limiting input data to such a small area tends to result in the loss of a large amount of practical information, and a subsequent reduction in identification accuracy, the LBP method reduces these effects. The analyzed sample face images are illustrated in Figure 21.

Figure 21 The sample faces

The LBP method is able to recognize similarities between different images of the same individual with a high level of accuracy. Accordingly, we selected input images and compared them with images from the database using the developed algorithm, thus revealing similar and non-similar images. The method is also able identify images taken under different situations, even when subjects have grown a beard, are wearing glasses, or have moved their eyes or mouth, as shown in Figures 22, 23.

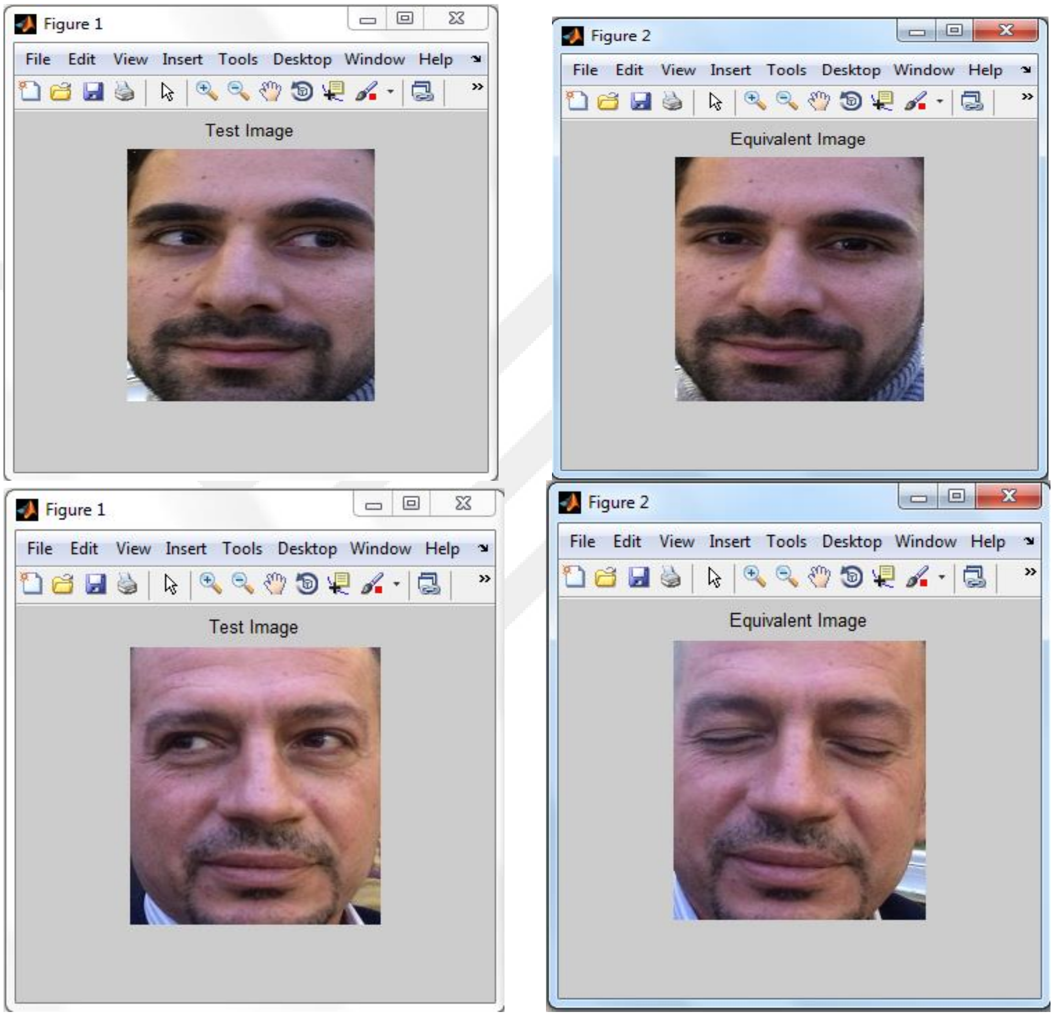

Figure 22 Face recognition in the case of moved and closed eyes

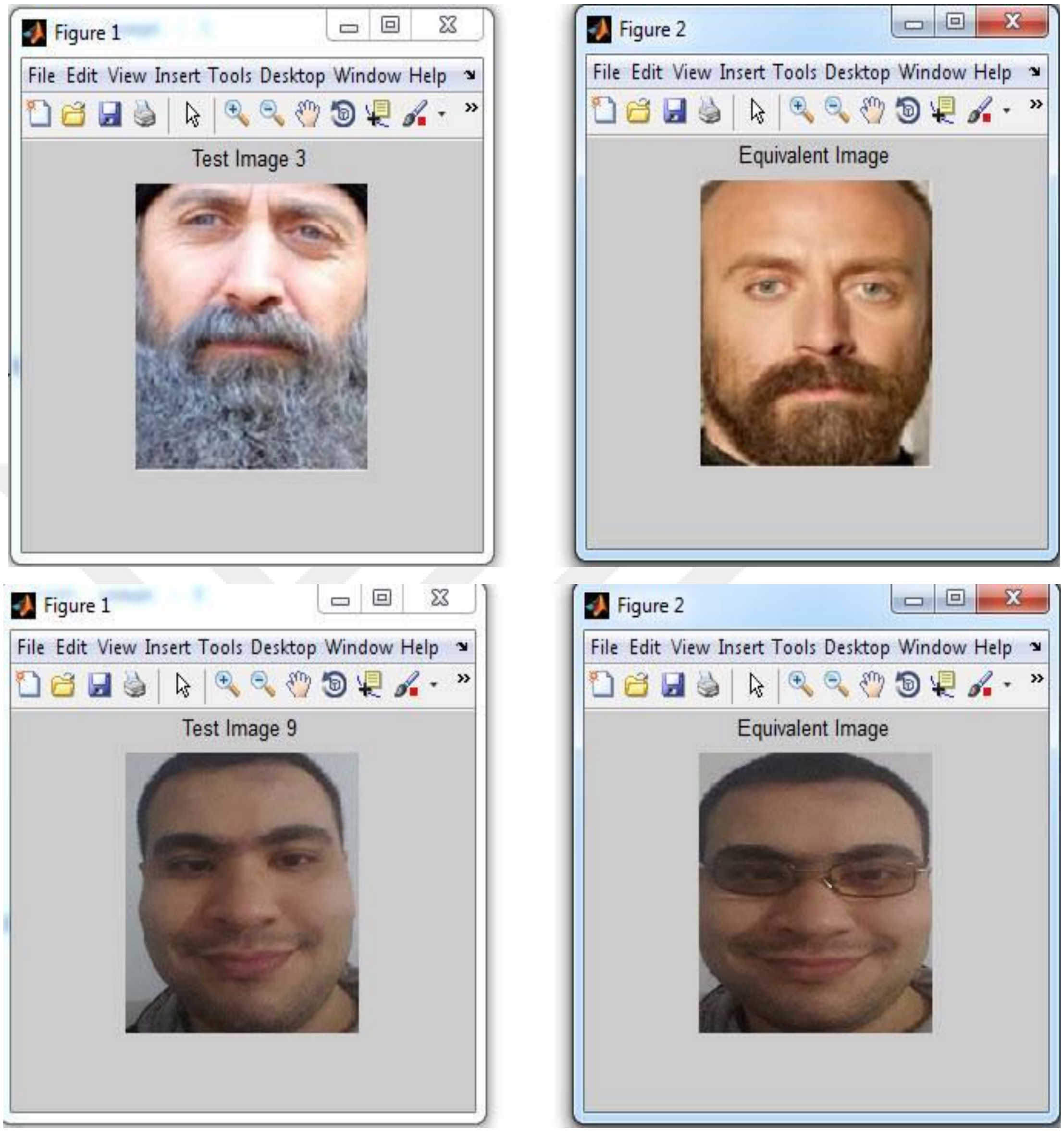

Figure 23 Face recognition in the case of a beard and glasses

Figure 24 illustrates an example of erroneous face identification, in this case because the individual is wearing black sunglasses. This object creates some errors for our system, with the algorithms providing a faulty output.

Figure 24 Face identification error due to the wearing of sunglasses

4.3 The Proposed E-Government Model

The human face is a complicated multidimensional image; expanding a computational model for face recognition is therefore difficult. This section presents a methodology for e-government related to face recognition and information theory criteria employed in coding and decoding facial images. This methodology is based on Local Binary Protocol and personal information. The aim is to apply the system (model) to any specified face and recognize the individual from amongst a large number of database faces, with a number of real-time deviations in addition to personal information such as given name, surname, and identity number. The flow chart for the proposed e-government model is shown in Figure 25.

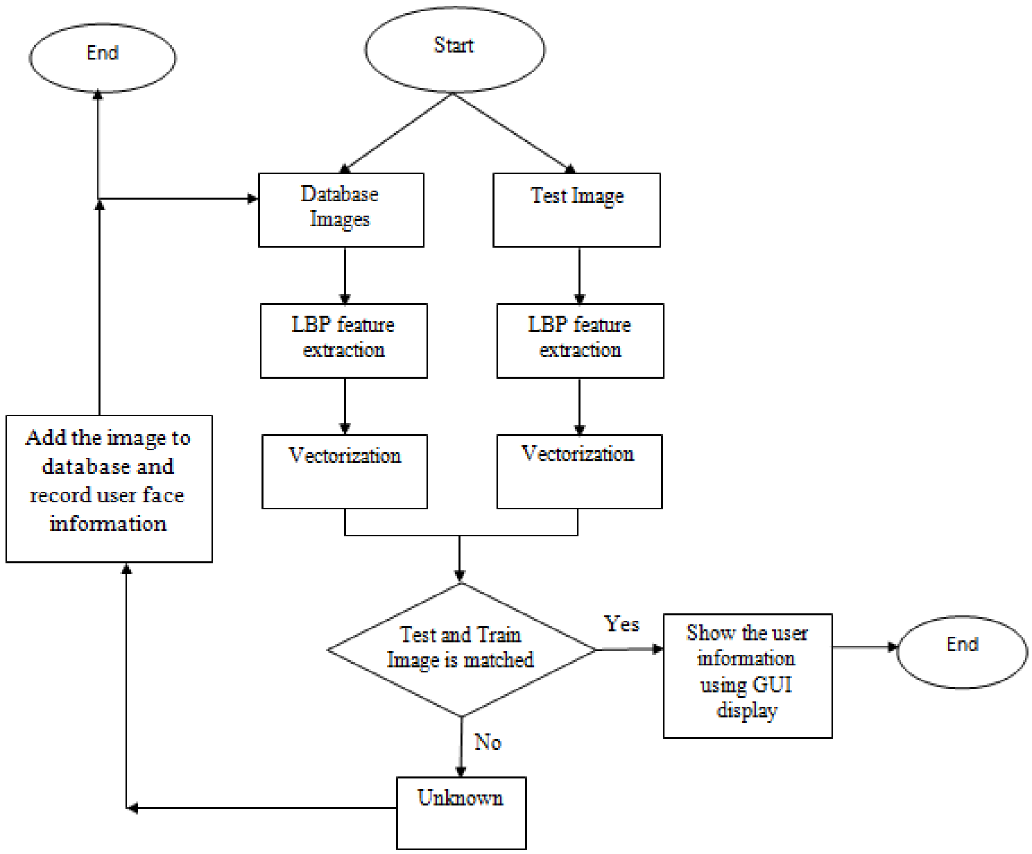

Figure 25 Flowchart of the proposed e-government model application

A test image of any individual can be captured via a webcam, as shown in Figure 26. The image can then be adjusted using the GUI display, as illustrated in Figure 27.In this case the employed webcam captured images at around 2 mega pixel resolution. An improved performance can be achieved via the use of a direct USB connection and a higher resolution webcam. The citizen whose image is to be collected must look into the adopted camera carefully in order to obtain a good snapshot. Using the GUI, around ten seconds are required to capture each face, as shown in Figure 28.

Figure 26 The webcam used in the development of the proposed GUI model

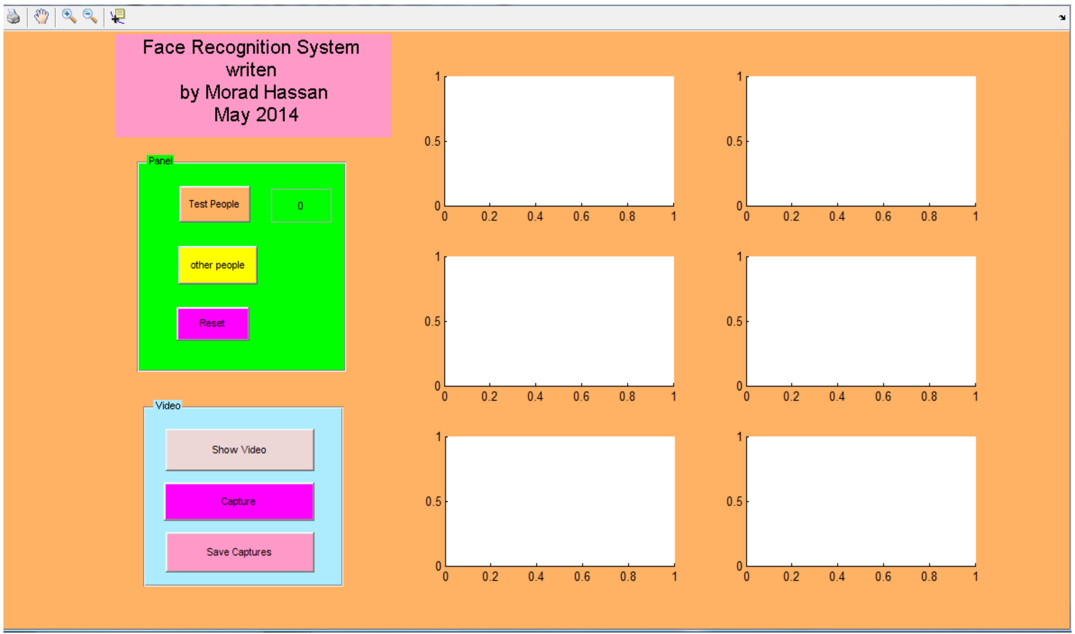

Figure 27 General GUI display

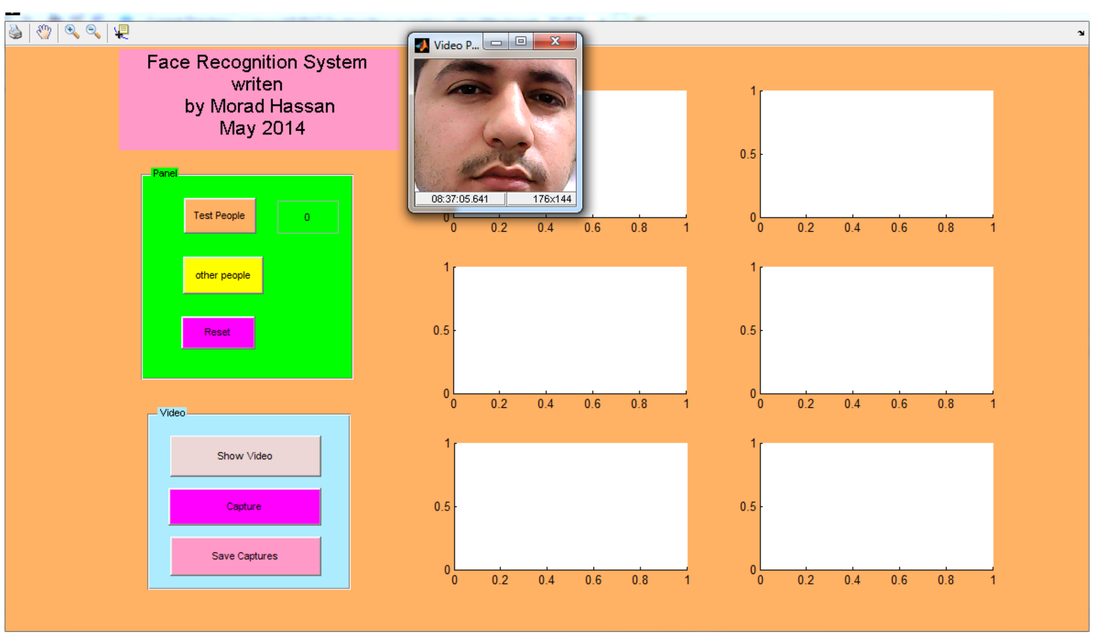

Figure 28 Face detected and captured via webcam, and adjusted by the proposed GUI model

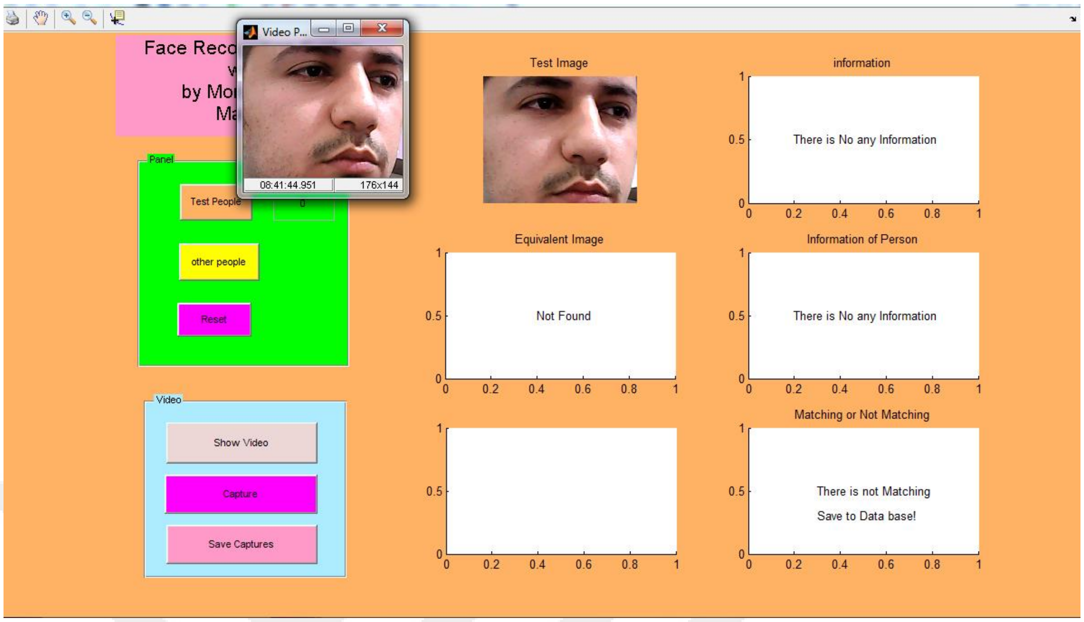

Figure 29 E-government model: non-identification

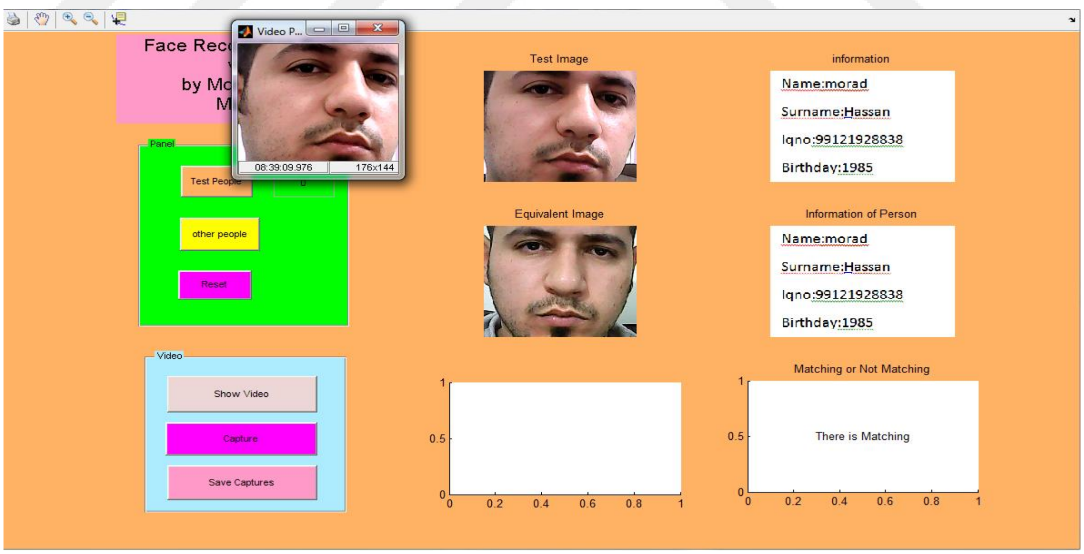

Figure 30 E-government model: successful identification, with citizen information GUI display

As can be seen in Figures 29 and 30, the model displays subject information in the case of successful face identification. If the input face is new to the database system, this individual’s information must be entered into the database for future use and identification. The hard-drive location and name of the destination folder is dependent on operator choice, e.g. '/C: /nufus database/’. It should be noted that the success rate of the proposed model is better than 95%. Nevertheless, it is recommended that subjects remove colored sunglasses before face capture in order to avoid erroneous identification, as concluded from Figures 24 and 25. The ‘other people’ button can be used to compare images stored on a hard drive (internal or external) or in any external memory with the images stored in the database folder.

CHAPTER V

CONCLUSION AND FUTURE RECOMMENDATIONS

There currently exists an increasing need for independent information and knowledge management strategies aimed at obtaining a competitive advantage in social and economic areas. Governments in developed countries have invested in Information Communication Technology (ICT) to ensure that their strategies succeed (e-governance). The Iraqi government is only in the initial phases of adopting ICT to enhance information management and reporting, to streamline the delivery of government services, enhance communication with the citizenry, and to serve as a catalyst for empowering citizen-government interaction.

In this thesis, a modern and rapid face recognition system has been proposed for use in important Iraqi institutions such passport directorates and airports. The developed identification procedures and features include highly accurate classifiers for rapid face recognition. These, together with engineering inspirations, have made a successful system. According to evaluation carried out via real-world user scenario tests, the system demonstrates excellent accuracy, speed, and usability. We believe that this is a very useful system for cooperative face recognition, whose success can be attributed to two factors: Firstly, the identification tasks are made very simple, with faces captured via a hardware device and LBP, although a high-quality camera must be used in order to obtain accurate results. Secondly, the employed algorithms and associated local features represent powerful classification engines.

Future work will include adapting the image-matching procedure to display citizen information such as first name, surname, and birth date; the system can also be used to detect cases of forgery and counterfeiting at passport directorates, airports, and national borders. The webcam employed in system testing acquired images at around 2 mega pixel resolution; direct USB connection and a higher resolution webcam is recommended for better performance. Further work will be carried out aimed at improving the imaging hardware and processing software to deal with eye identification.

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APPENDIXS A

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, name: HASSAN, Morad
Nationality:
Date and place of birth: 29 January 1985, IRAQ
Marital state: Single
Phone: 0090 536 940 95 85
Email: shali2005@yahoo.com

EDUCATION

Degree	Institution	Year of Graduation
Bachelor	Dijlah University Collage	2011
High School		

FOREIGN LANGUAGES

Arabic, English and Turkish

HOBBIES

Reading, Sport, Movies