

Building E-Voting System for Educational Institutions

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Abstract

In the past, educational institutions were interested in providing only good education. But with the democratic transition this interest has changed to include other aspects, particularly for students. A fertile environment for students to practice the democratic activities in education sector is the students' union. Although the students' union is the core nucleus to form the electoral awareness of students, but until now the process of electing student representatives in the students' union is performed by manual paper based methods. These methods are no longer acceptable in the era of technological advances. Therefore, employing modern technologies for managing elections of the students' union has become mandatory to reduce time consuming, effort, cost and mistakes which reflected positively on accuracy results of the electoral process. This paper presents an electronic system based on Web technology for managing the students' union elections in institutions of higher education. The system evaluation process has been performed by a group of experts and end users. The overall findings confirm that, the proposed system is fully accepted with minor revisions.

Keywords— Democracy, Elections, Educational Institutions, Students' Union, E-Voting, Online Voting.

I. INTRODUCTION

In recent years, democracy is a major matter in most modern societies since its distinctive features led many societies to adopt the democratic environments in various fields [1]. The most common feature in the theory of democracy is the election of representatives [2], which allows people to choose their leaders and express their opinions on various issues freely according to the Universal Declaration of Human Rights issued in 1948 [3]. In fact, the principles of democracy were applied in educational field since several years by "John Dewey's" works who eventually earned the title "American Philosopher of Democracy". In his famous work "Democracy and Education", he asserted that the relation between democracy and

education is mutual where there is no education without democracy and also no democracy without education [4]. Undoubtedly, this relationship has several effects on both sides. The most important influence for applying democratic ideas in education sector is to provide a large area for students to participate in making various kinds of decisions concerning the institution[5]. Students' participation is a formal provision for students' representation on the governing bodies of higher education institutions. Legally, there is no clear binding provision for the representation of students either at the level of higher education or at the national level. Therefore, the students' participation is limited to side issues – such as evaluating the teaching and learning process in the classroom – not critical ones like planning, financial support, staff appointments and granting PhD degrees ... etc [6], [7]. In practice, students' participation depends on several factors such as institutional conditions, policies and culture. Moreover, it greatly affected by ideological model which includes two common models: market and developmental. In market model, the students take the rights of the consumer but in developmental model the students takes both the rights and the responsibilities of citizens [8]. Over the years, students' union has become a fertile environment for the students' democracy where it provides many opportunities for students to actively participate in various activities. Generally, it aims to achieve the following goals [9]:

- It gives the students the experience of democratic participation in a real safe environment where a large number of students vote in students' union elections every year;
- It gives the students the experience of participating in debate and discussion around issues inside and outside the institution;
- It gives the students a wider sense of community through activities, camps and voluntary works;
- It gives the executive officers and committee members of the students' union the chance to develop their skills by attending meetings and organizing various activities.

Until this moment, the process of managing various electoral systems including students' union elections are performed by traditional manual methods in which, the allowed voter heads to the suitable polling station and shows the unique Identification Card (ID) to the polling official for Verification. Based on the ID, the official looks up the name of the voter. After ensuring that no vote has been performed by that voter, he takes a ballot paper and his left thumb is marked with indelible ink as an indicator for casting the vote. In a private space, he chooses a candidate of choice on the given ballot paper and sign in the space customized for that candidate. Then, the voter folds the ballot paper and puts it into the provided ballot box. Finally, the voter leaves the polling center to allow the others to do the same steps [3]. Since voting based manual methods has several drawbacks, the researchers continually are trying to find improved alternatives using information technology. One of the most important information technology outcomes is Electronic Voting (E-Voting).

E-Voting is an aspect of Electronic Democracy (E-Democracy), which aims to manage referendums

and elections remotely via various electronic means such as telephones, mobiles, computer networks, internet ... etc [10].

The aim of this study is to design an electronic system based on Web services for managing students' union elections in Mansoura University in Egypt to make the election process more accurate and easier by reducing its requirements (time, effort and cost). The general structure of the paper is shown in Figure 1 and is simplified as follows: Section (I) is dedicated to present the introduction of the study. Section (II) is dedicated to introduce an overview about the Web technology including history and major features. Section (III) is dedicated to display the most important rules contained in the regulation of students' union in Egypt. Section (IV) is dedicated to define the research problem. Section (V) is dedicated to explain the details of the proposed system simply including main components and development scenario. Section (VI) is dedicated to discuss the testing results. Finally, the concluding remarks and directions for future works are presented in the final section.

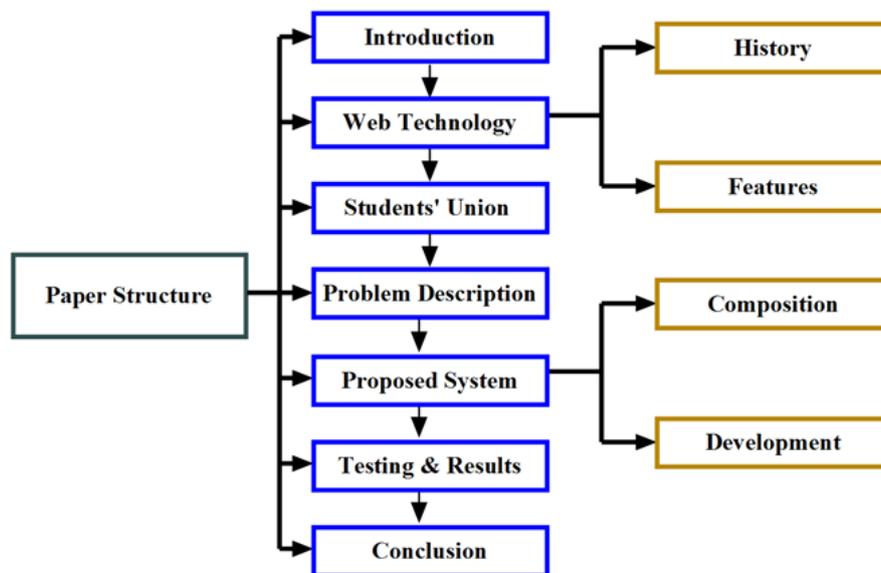


Fig 1: Structure of the paper

II. WEB TECHNOLOGY

A. History

An overview about history of the Web technology will be provided in simplified and abbreviated form as follows [11] – [15]:

The concept of the Web goes back to the British software engineer “Sir Tim Berners-Lee”. During his work at the European Organization for Nuclear Research (CERN) in Switzerland, Sir Tim noticed a difficulty in sharing information since it is distributed on a number of computers, which requires various operations to get at it. To solve this problem, Tim connected a huge number of

computers together through the fast-developing internet and the process of sharing information is performed by a new technology called “Hypertext”. This was the nucleus of the invention of the World Wide Web (WWW) where Tim introduced his vision for what would become the Web in a document called “Information Management: A Proposal” in March 1989. In October 1990, Tim determined the Hypertext Markup Language (HTML), Uniform Resource Identifier (URI) and Hypertext Transfer Protocol (HTTP) as the three fundamental technologies required for the success of the Web. In addition at the same year, he introduced the first Web browser and the first Web server. In 1991, everyone outside CERN were allowed to join

the new Web world. In 1993, the software of World Wide Web has become available in the public domain where the next version was released under an open source license. In 1994, Time moved to Massachusetts institute of technology to establish an international community for developing open Web standards, which known as World Wide Web Consortium (WWWC-W3C). In 2003, many companies sought to develop the Web standards committed to a royalty free policy. In 2009, Tim founded an organization called World Wide Web Foundation which aims at building a just and thriving society based on social cooperation and participation. In 2013, CERN reinstated the world's first Website to its original address. In 2014, the rate of Web users up to two in five (2/5) people around the world.

B. Features

Modern generations of Web technology are characterized by four promising features as follows[16]:

- **Intelligence**

It means, the Web technology is linked with tools and techniques of artificial intelligence such as Neural Networks, Fuzzy Sets and Machine Learning to enable Web users to work and communicate with the others around the world through their natural language.

- **Personalization**

It means, the all needs, desires, preferences and interests of the Web visitors are met. So, all Web services like browsing Web pages and search are based on what the user wants.

- **Interoperability**

It means, the all Web services and products work efficiently on different types of electronic devices, operating systems and Web browsers without loading extra efforts on the Web clients.

- **Virtualization**

It means, the Virtual Reality applications can be fully created over the Web environment by utilizing high speed internet and high quality 3D graphics.

III. STUDENTS' UNION

An overview about the students' union based on the regulation of Egyptian students' unions will be provided in an accurate and simplified form as follows [17], [18]:

Students' union is a legal organization which represents students of colleges and institutes in Egypt and aims to achieve the following goals:

- To develop the spiritual and moral values.
- To strengthen the national awareness and raise the values of belonging and loyalty.
- To deepen the principles of democracy, human rights and citizenship among students

and to work in a team spirit, while ensuring the expression of their views under university traditions.

- To refine the talents of students, develop their abilities, skills and employ them to the benefit of the student, his educational institution and the motherland as a whole.
- To form the students families, clubs and scientific societies.
- To support the creative abilities of various students.
- To organize various student activities whether cultural, sporting, artistic, social, scientific ... etc., and encourage students to active participation.

Students' union consists of a number of committees:

- **Families Committee:** This committee is specialized in forming various families, coordinating among them and supporting all their activities.
- **Sports Activity Committee:** This committee is specialized in forming various sports teams and supporting all sports activities.
- **Cultural and Media Activity Committee:** This committee is specialized in organizing cultural and media activities, raising awareness of national issues, spreading the culture of human rights and community participation ... etc.
- **Artistic Activity Committee:** This committee is specialized in organizing artistic activities for students to highlight their talents and raise the level of artistic productions.
- **Scouting and Public Committee:** This committee is specialized in organizing and supporting scouting activities and to participate in public service projects, and programs related the surrounding environment and society.
- **Social Activities and Excursions Committee:** This committee is specialized in organizing social, cultural, and recreational trips, as well as the development of social relations between students and university faculty members and to help in solving various students problems.
- **Scientific and Technological Activity Committee:** This committee is specialized in holding seminars and lectures for developing the scientific and technological abilities and to spread awareness related to the production and applications of knowledge through clubs and scientific societies.

In fact, the Egyptian students' union elections take place in three stages. In the first stage, the members of the seven committees are chosen by direct election. Each committee is represented by two members of each study grade. Therefore, the total number of committee members is 8. In the second stage, the secretaries and assistant secretaries of the committees are only elected from among the

committees members. In the third stage, the secretary-general of the council and his deputy are only elected from among the secretaries and vice-chairmen of the committees.

Any student wants to apply for candidacy at any level of the students' union must provide an electoral program with new ideas and meets the following conditions:

- To be Egyptian.
- To be a lasting moral character and good reputation.
- To be a passed student in his study grade.
- To be a regular student in his study grade.
- To have paid the study fee in full.
- To be with significant and continuous activity in the work of the committee which desired to nominate himself for a position interior it.
- To have not been given a custodial sentence for liberty, or decide to drop or suspend the membership of students' union, or one of its committee.

The first stage of the students' union elections begins each year within a maximum period of 8 weeks of the study start date. Then a decision is issued by the university president or the dean of the educational institution to determine the dates of the rest of the election stages.

Legally speaking, the validity of the election process requires at least a presence of 50 % of students who have the right to vote for each study grade separately.

If the quorum is not completed, the elections are postponed for the next day and in this case, attending at least 20 % of the voters are required for the soundness of the elections.

If the former quorum is not completed as well, the president of the university or the dean of the institution shall be appointed a council to manage the affairs of the union includes members of the top students in the study who are qualified for candidacy.

If the quorum is achieved, the committee supervising the elections counts the correct votes on the day of the elections to prepare the results.

Finally, the final outcomes of the election process are signed by the committee supervising and are adopted by the dean of the institution.

IV. PROBLEM DESCRIPTION

Throughout history, students have been seen as the weakest part in the educational systems in many countries of the world. But with the development of educational systems, the viewpoints toward students have been changed and they gained more rights in the education sector. One of the most important of these gains is the right of participation in the selection of their representatives within students' associations.

Until now, the methods used to manage the students' union elections in different universities around the world including Mansoura university in Egypt are paper based ways which have many cons such as, require a long time and effort, require the voter attendance to voting centers and lack of accuracy, objectivity and neutrality in most cases. Therefore, alternatives to manage students' union elections in educational institutions have become a necessity.

The current study employs modern technology to overcome these shortcomings by building a Web based system for managing the elections of students' union in Mansoura University remotely.

V. PROPOSED SYSTEM

To reduce mistakes of manual systems used for managing students' union elections at Mansoura University, an online system has been proposed. The proposed system will be described in detail in the following subsections:

A. System Composition

In software engineering, any software product consists of a number of sub-parts known as modules or units. All embedded components of our software system are shown below in Figure 2

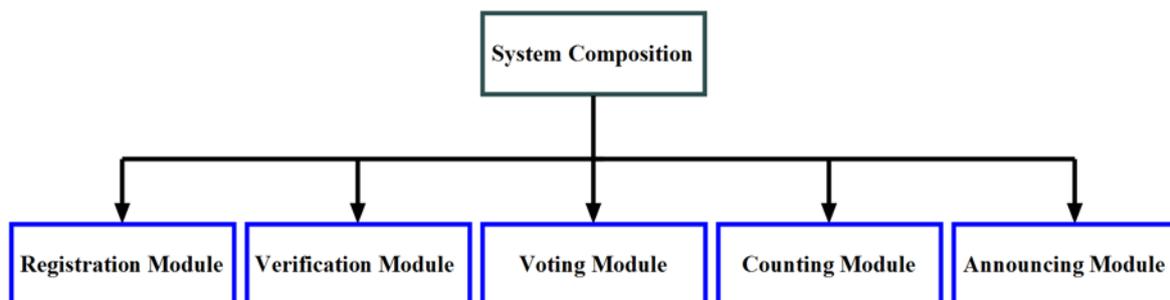


Fig 2: The proposed system components

A detailed description of these modules is presented in the following:

1) Registration Module

The main goal of this module is to prepare all prerequisites needed for the electronic management of all electoral stages of the Egyptian students' union. The prerequisites of the first electoral stage include:

- **Voters Community of 1st Stage:**

The system administrator prepares the voters community of the first electoral stage by obtaining a copy of all students' data from the student affairs sector with the beginning of the academic year. Then he filters these data and only stores in the database the important student data such as name, date and place of birth, phone number, mobile number, email address ... etc. After that, the proposed system generates the secret Verification code automatically for all voters of the first stage – faculty students – and sends it either electronically via the registered emails or manually through the students care department within faculty.

- **Candidates List of 1st Stage:**

The system administrator prepares the candidates list of the first electoral stage by providing a nomination form that enable faculty students to run for the higher level. Any student wishes to be a member of a specific committee, s/he must fill out all items of this form and delivers it to the system administrator who adds the eligible students to the final candidates list and excludes the others who do not meet the nomination criteria specified for this level.

The prerequisites of the second electoral stage include:

- **Voters Community of 2st Stage:**

The system administrator prepares the voters community of the second electoral stage from the outcomes of the first electoral stage – committees members – with the announcement of the second electoral stage. After that, the system generates the secret Verification code automatically for all voters of the second stage and sends it either electronically via the registered emails or manually through the students care department within faculty.

- **Candidates List of 2st Stage:**

The system administrator prepares the candidates list of the second electoral stage by providing a nomination form that enables committees members to run for the higher level. Any committee member wishes to be a president or deputy president of a specific committee, s/he must fill out all items of this form and delivers it to the system administrator who adds the eligible members to the final

candidates list and excludes the others who do not meet the nomination criteria specified for this level.

The prerequisites of the third electoral stage include:

- **Voters Community of 3st Stage:**

The system administrator prepares the voters community of the third electoral stage from the outcomes of the second electoral stage – committees presidents and vice-presidents – with the announcement of the third electoral stage. After that, the system generates the secret Verification code automatically for all voters of the third stage and sends it either electronically via the registered emails or manually through the students care department within faculty.

- **Candidates List of 3st Stage:**

The system administrator prepares the candidates list of the third electoral stage by providing a nomination form that enables committees presidents and vice-presidents to run for the higher level. Any committee president or vice-president wishes to be a president or vice-president of the council, s/he must fill out all items of this form and delivers it to the system administrator who adds the eligible members to the final candidates list and excludes the others who do not meet the nomination criteria specified for this level.

2) Verification Module

The main goal of this module is to check the validity of the system login data. Once the system is running at any time, the system requires the login details (username, password and login type). Then, the system matches the data entered with the reference one stored in the database. If the system reports a valid login, the current logged-in user is passed to the next stage according the login type; otherwise, the entry request is rejected.

3) Voting Module

The main goal of this module is to enable the voters to cast their ballots in the Egyptian students' union elections remotely and simply. Once the online voting of a certain stage starts, the system displays the stage candidates to the voter. Then, the system allows the voter to choose the preferred candidates under the stage rules. When the voting process of a certain voter is fully done, the voting outcome is saved in the database and the current voter ID is blocked to prevent multiple voting.

4) Counting Module

The main goal of this module is to prepare all statistics needed for the electronic announcement of the outcomes of all electoral stages of the Egyptian

students' union elections. Once the online voting of a certain stage ends, the system tallying the obtained votes to exclude the invalid votes and to only compute the accepted ones. When the voting result of a certain stage is prepared completely, it is sent to the electoral supervisory committee electronically for signing then to the faculty dean for adopting.

5) Announcing Module

The main goal of this module is to declare the outcomes of all electoral stages of the Egyptian students' union elections electronically in the specific real-time. Once the final result of a certain stage is approved by the relevant officials, the proposed system displays a clear and accurate description of the stage results.

B. System Development

To convert the system framework into a real software product, a wide range of technical options in the published scientific literature are available. As a result of progress in Web applications over the last few years, we decided to design the proposed software in the form of an online Web site to exploit the powerful features of Web technology such as flexibility, simplicity and ease of casting vote from any internet-connected electronic means anywhere in the world during the election period.

Sample screenshots of the proposed system pages are shown in Figures 3-9.

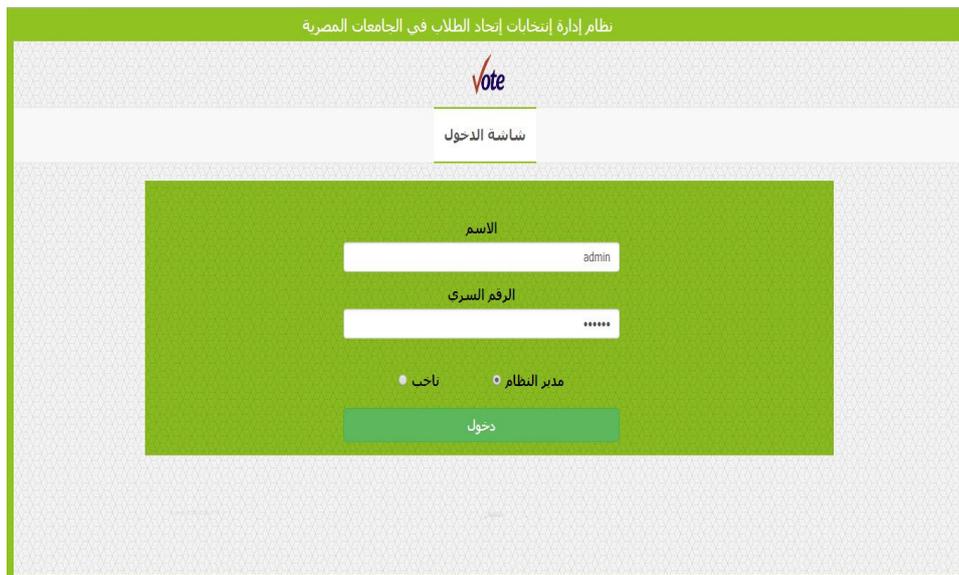


Fig 3: System login page

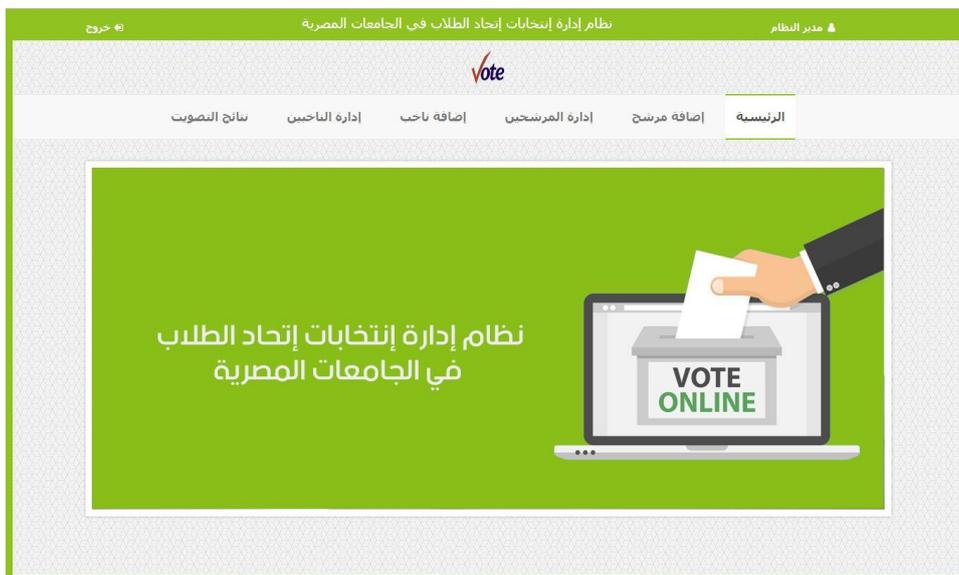


Fig 4: System administrator main page

نظام إدارة إنتخابات إتحاد الطلاب في الجامعات المصرية

مدير النظام

خروج

الرئيسية إضافة مرشح إدارة المرشحين إضافة ناخب إدارة الناخبين نتائج التصويت

برجاء إكمال بيانات الحقول الآتية:

اسم المرشح
خالد ناخي

اللجنة
اللجنة العلمية

العرقه
الفرقة الثانية

إيميل المرشح
khaled.nagy@yahoo.com

الصورة
khaled.jpg Choose File

حفظ

Fig 5: Add new candidate page

نظام إدارة إنتخابات إتحاد الطلاب في الجامعات المصرية

مدير النظام

خروج

الرئيسية إضافة مرشح إدارة المرشحين إضافة ناخب إدارة الناخبين نتائج التصويت

برجاء اختيار اللجنة

- اللجنة العلمية
- اللجنة البنافية
- اللجنة الفنية
- اللجنة الرياضية
- لجنة الاسر
- لجنة الجواله والخدمة العامة
- اللجنة الاجتماعية والرحلات

Fig 6: Candidates management page

نظام إدارة إنتخابات إتحاد الطلاب في الجامعات المصرية

مدير النظام

خروج

الرئيسية إضافة مرشح إدارة المرشحين إضافة ناخب إدارة الناخبين نتائج التصويت

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نوع الناخب
 ذكر أنثى

حفظ

Fig 7: Add new voter page

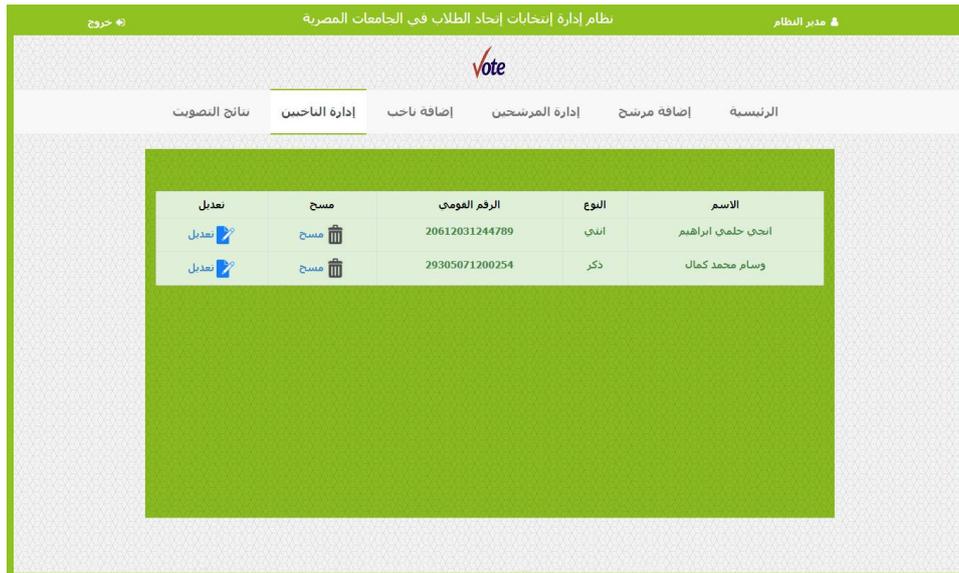


Fig 8: Voters management page



Fig 9: Voting page

VI. TESTING & RESULTS

In today's digital world, software packages spread extraordinarily everywhere over the internet. This rapid prevalence has many positive merits but also it has some negative effects, for example the intentional disregard of performing testing and evaluation process where many developers assume that once the software product is developed, it will work with a flawless performance. But in practice, this is not assured as software applications are often produced with frequent problems. Therefore, the testing and evaluation process has become a critically important phase in software development life cycle [19]. The main goal of testing and evaluation phase is to make sure that, the

software product meets their expectations, or needs improvement [20].

To evaluate the performance of the proposed system, the system prototype underwent an integrated in-depth evaluation process. The evaluation team includes two groups of members. Group-A; includes a number of experts in computer science while Group-B; includes a number of normal end users. The tool used for data collection process is the Questionnaire which includes a series of multiple-choice questions that covering various evaluation areas. The feedback from evaluation team is grouped, analyzed and simply described with descriptive statistics. The obtained results are shown below in Table 1.

Table 1. The outcomes of the proposed system evaluation

Jury Number		1	2	3	...	N	Average [%]
Satisfaction Ratio	Expert	98.96	95.39	97.47	99.51	96.07	97.48
	End User	100	97.52	99.58	100	98.89	99.20
Overall Average [%]							98.34

The data presented in the previous table can be summarized in main points as follows:

- The proposed system has been evaluated by two human viewpoints: experts and end users.
- The feedback toward the proposed system performance is varied between experts and end users.
- The total average of the experts’ satisfaction is 97.48%.
- The total average of the end users’ satisfaction is 99.20%.
- The overall average of the system’s validity and acceptance is 98.34%.

These positive results confirm that, the proposed system has achieved its goals clearly. And it also confirms its usability on a large scale for managing the electoral processes in various faculties in the Egyptian universities.

VII. CONCLUSION

In digital age, modern technologies have immense role on supporting students’ rights in all sectors of society, particularly education. This paper utilizes one of the most important technical means – Web technology – for building an electronic system to completely manage the electoral process of the students’ union in Mansoura University.

Our Web based system consists of a set of sub-modules which compatible with each other to achieve the major goals of the system. The system evaluation process is conducted by a testing team who divided into two categories. The results of the evaluation process indicate that, the system has been accepted with minor modifications.

Future work focuses on the development of the current system. Areas of development plan include three major aspects. Embedding all faculties in Mansoura university is the first development aspect. Embedding all faculties in all Egyptian universities is the second development aspect. Transition/Switch to Android environment is the third development aspect.

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