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Design and Implementation of Multi-Institutional, Multi-Lingual and Web based Election Management System

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Abstract – This paper describes the design and implementation of a multi-institutional, multi-lingual open-source web-based Election Management System (EMS). EMS has been developed as part of the Educational Resource Planning (EdRP) project and is available as SaaS. EMS provides the features to manage the election process with accuracy, integrity and agility. This also takes care of the public transparency and accuracy to maintain and establish trust and credibility. The system is initially implemented and tested in educational institution for electing various students representatives.

Keywords— Multi-Institutional, Multi-lingual, Election Management System

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1. INTRODUCTION

Election Management System (EMS) is a multi-institutional and multi-lingual web based system primarily developed as Educational Resource Planning (EdRP) module to support various educational institute in conducting elections to elect their representatives for various posts. It is a role-based access system that supports both the bio-metric authentication mode as well as unique id (UID) authentication mode and provides the mailing notice facility to its users. It also provides the facility of preferential voting, where voter can vote candidates in order of their preferences. Any institute desirous to use EMS is only required to send a valid request to EMS Server (http://202.141.40.218/EMS). The system, after verifying the authenticity of request, accepts the institute request and sends Instituteadmin user-id and password to the requesting institute. Now, the institute becomes fully authorized to access and use EMS for managing and conducting elections for its institute.

There are five entities involve in the EMS.

- ***Superadmin*** is the person who manages the EMS on server side. He receives registration requests from different institutes who wish to use the services of EMS. Superadmin has the privileges to accept or reject requests for registration from any institute after verification.

- ***Instituteadmin*** is the authority of any institute who will manage the whole election process for an Institute.

- ***ElectionManager*** can create, open and close elections. Election Manager will be able to manage requests of voters and candidates for registration. It will be the responsibility of Election Manager to authenticate voters, candidates and publish the result on time. Eligibility of candidates is based on Lyngdoh committee report.

- ***Voter*** may register themselves online and cast their votes. Voters can register themselves as a candidate and will be able to manage their account in a restricted manner. Voters will be able to interact with candidates online using services like Blog, Chat, bulletin boards, etc.

- ***Candidate*** can file nomination for a particular post in an election declared by the Election Manager online. Candidates will be able to campaign online and cast their vote in secure manner.

The EMS satisfies the desired key properties that an online election management system should possess, like accuracy, integrity, verifiability, secrecy and accessibility [1].

- ***Accuracy***- The term accuracy means the data should be correctly displayed to the user at any state of the system. In Election management system

the accuracy measures are for correct ballot, vote cast as intended and vote counted as cast [9].

- ***Integrity***- The integrity of electoral process depends on the provision that one person can cast exactly the same number of votes as defined in election configuration. Maintaining an accurate voter list, without duplicates or errors, is essential to the validity of the electoral process.

- ***Verifiability***- The verifiability in EMS can be achieved that are of two types i.e. voter verifiability and global verifiability [9].

  - In *voter verifiability* a voter can check or verify that his/her own ballot is published on bulletin board.

  - In *global verifiability* any one can check that all the votes in the election result correspond to the ballot published on the bulletin board.

- ***Secrecy***- Secrecy in election management system is related to voter's ballot. Hence, the authority of information gain should be in such a manner that a voter cannot prove how he/she voted [2]. This may be:

  - *Ballot Secrecy*: The system should restrict any provision of revealing the voter's vote by the user [9].

  - *Receipt freeness*: The voter cannot authorize to gain information so that he/she can prove to the coercer about how he/she voted [6].

- ***Accessibility***- Accessibility of the system depends on the provision that every user can interact with the system easily and properly.

- ***Auditable***- In the auditable phase, all the votes have been verified and counted to ensure that the voting process is accurately accomplished.

2. FUNCTIONAL CHARACTERISTICS

The prime requirement for EMS was to develop a web-based election management system, which provides multi-lingual, multi-institutional and role-based features. This section describes proposed functional characteristics of the system.

- ***Multi-Institutional***: India is growing hub for education. India has both private and public universities. It has a large number of universities supported by the Government of India and the state governments. Apart from these there are private universities supported by various bodies and societies. There are over 200 universities and 25,000 colleges of various types in the country. EMS provides the multi-Institutional facility, such that any university/institute desirous to use the services of EMS can use it free of cost.

- ***Multi-lingual***: In India there are 15 national languages recognized by the Indian constitution and these are spoken in over 1600 dialects. The national or official languages are Assamese, Bengali, Gujarati, Hindi, Kannada, Kashmiri, Malayalam, Marathi, Oriya, Panjabi, Sanskrit, Sindhi, Tamil, Telugu, Urdu and English (Associate Official). An estimated 850 languages are in daily use (Todd and Hancock 1986). 10 languages of India by number of native speakers as per the 2001 census is given in the Table 1. To capture the essence of multi-linguality, EMS supports multi-lingual interfaces [10].

Table 1. Linguistic Demography

Rank	Language	Speakers	Percentage
1	Hindi Dialects(23)	422,048,642	41.03%
2	Bengali	83,369,769	8.11%
3	Telugu	74,002,856	7.19%
4	Marathi	71,936,894	6.99%
5	Tamil	60,793,814	5.91%
6	Urdu	51,536,111	5.01
7	Gujrati	46,091,617	4.48%
8	Kannada	37,924,011	3.69%
9	Malyalam	33,066,392	3.21%
10	Oriya	33,017,446	3.21%

- ***Role-based***: EMS is a role based election management system. There are five roles defined in the system, namely, Superadmin, Instituteadmin, Election manager, Voter and Candidate. Each role has its own functions to do while it is the responsibility of the system to differentiate each role. Figure 1 shows how the different roles can interact with the services provided by the system through a single login interface. Instituteadmin, Election manager, Voter and Candidate can use a registration service for registering themselves into the system. On the other hand, Election Management Service can only be used by Instituteadmin and Election manager. The Voter and Candidate can use voting service. The E-campaign can only be used by candidate for interacting or communicating with the voters.

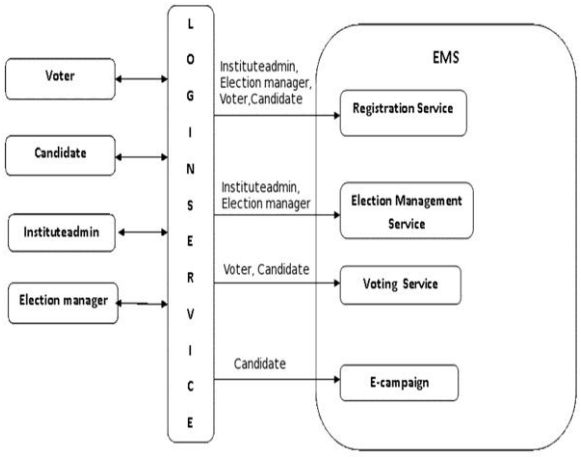

Figure 1. EMS-Role base system

3. FUNCTIONAL DESIGN

The functional module describes the functionality of different modules of EMS. It also describes how the entities interact with different modules of the system. The main interactions of various entities with different modules are described by using the use-case diagrams and class diagrams [8].

- ***Superadmin****:* Superadmin can manage its own account as well as manage the request for registrations submitted by instituteadmin, after validating he/she can accept/reject the request as per the criterion and also inform user for the process.

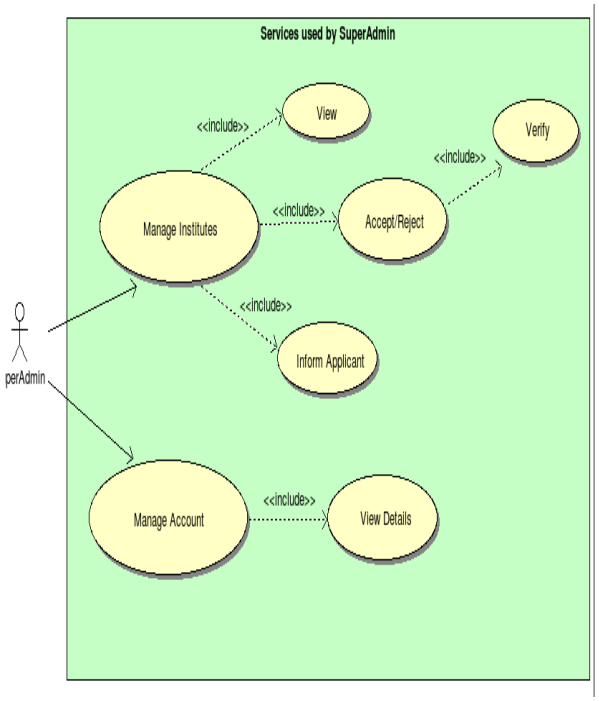

Figure 2. Use Case for Superadmin Module

- ***Instituteadmin:*** Instituteadmin sends request for registration to superadmin. Instituteadmin manages his/her own data; he/she can also create election manager by accepting the request or a fresh entry. Instituteadmin can also block/ permit election manager for further processing.

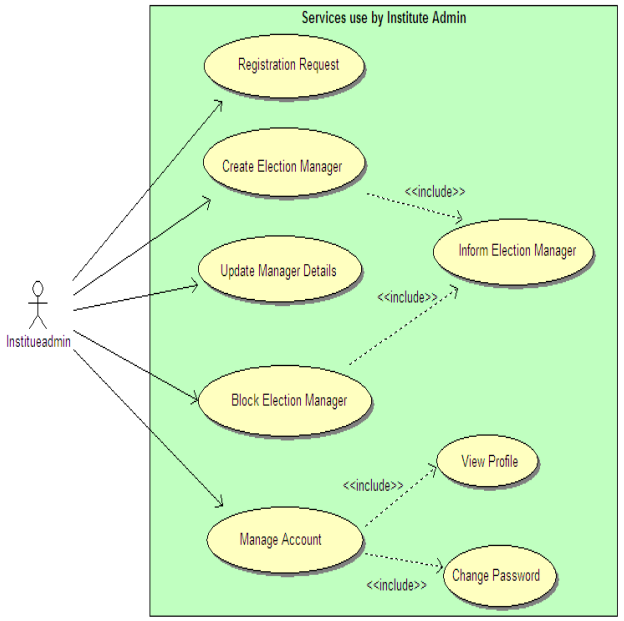

Figure 3. Use Case for Instituteadmin Process

- ***Election Manager****:* Election Manager sends request to institute admin to register himself/herself. He/she manages the candidate's and voter's request by either accepting/rejecting the request after validating the documents.

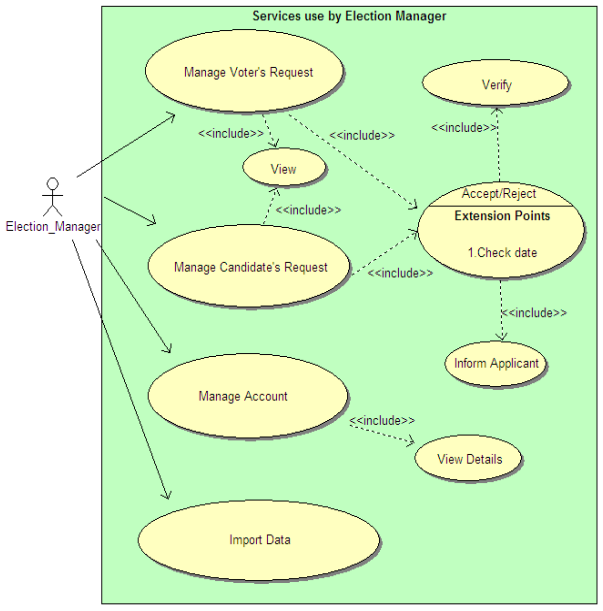

Figure 4. Use Case for Election Manager Module

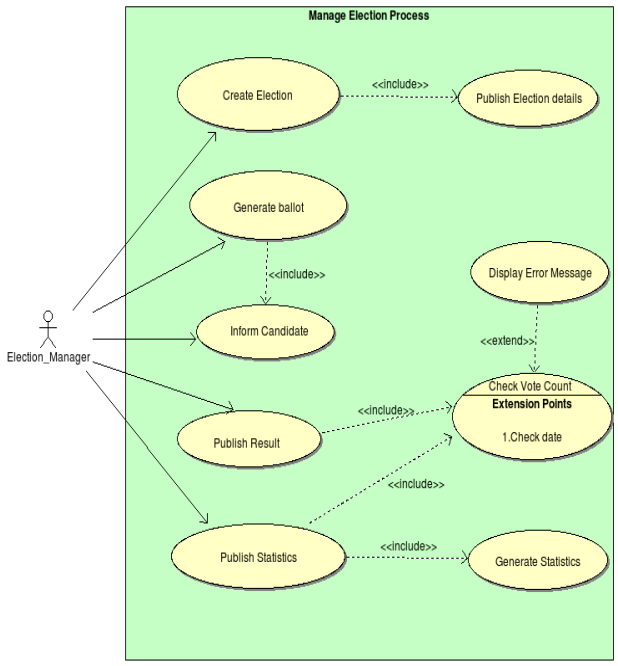

Figure 5. Use Case for Manage Election Process

- ***Voter:*** Voter can send the nomination request to ElectionManager and once the voter becomes registered, he/she can use voting service to cast their votes.

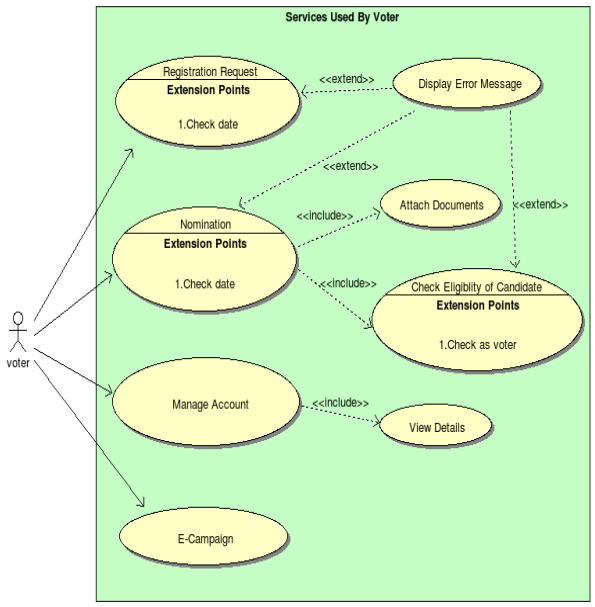

Figure 6. Use Case for Voter Service

- ***Candidate****:* A registered user can send its nomination request to the ElectionManager and after successful registration; he/she can use the Campaign service.

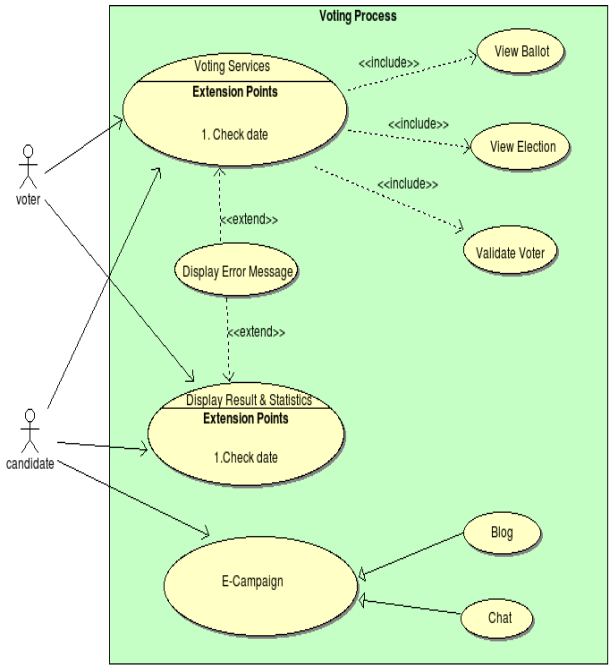

Figure 7. Use Case for Voting Process

The class diagram depicting the interaction of various classes of EMS is given in Figure 8. ElectionManager class interacts with Voter, Candidate and Superadmin class. This class provides the facility to manage the election process and to manage voters and candidates. There may be more than one Institute-level (local) Election Managers, who can manage one or more election process and can manage voters and candidates. This class also provides the functionality to manage their own information and manages privileges to accept or reject any request. ElectionManager can also upload the information of students from existing system if any.

Voter class interacts with ElectionManager, Election, Ballot, Result and Statistics class. One or more voter can interact with one Election Manager, can involve in one or more election, and can view result and statistics of any particular election. This class provides the facility to upload information and allow voter to make changes in their profile in a restricted manner. Using this class voter can interact with Election Manager and candidates.

Candidate class inherits the Voter class. This class interacts with ElectionManager, Election, Ballot, Result, Statistics and Campaign class. A candidate can file nomination for a post to Election Manager, can take part in single election at a time and can view result & statistics of a particular election. This class provides the facility to upload information and allow candidates to make changes in their profile in a restricted manner.

Election class manages election process and provides functionality to election manager to manage the election. This class is strongly connected with

four other classes that are Ballot, Result, Statistics and Campaign. The solid Diamond arrow shows the composition relationship. Composition usually has a strong life cycle dependency between instances of the container class and instances of the contained class.

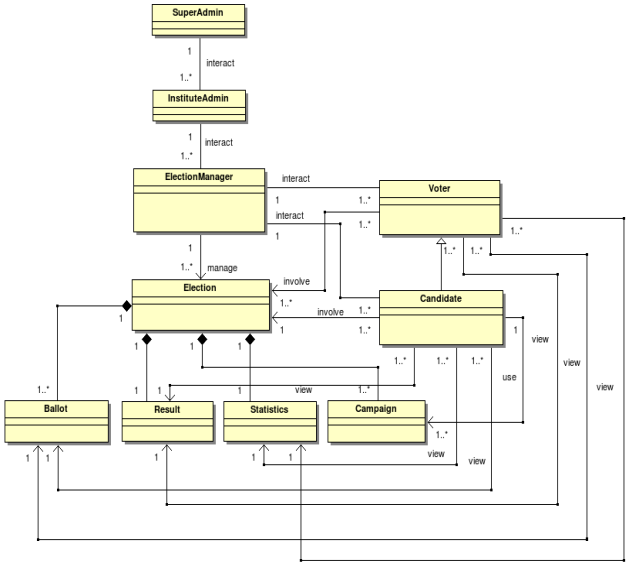

Figure 8. Class diagram of EMS

The overview of classes of Election Management System is given in the Table 2 given below.

Table 2. Overview of classes of EMS

Class	Overview
Superadmin	This class is used to maintain the system at the server side and to manage the request of the different institutions to provide the services of the system.
Instituteadmin	This class is designed to manage Election Managers (Institute-level local Admin).
ElectionManager	This class is designed to manage the information of Election Manager and to manage the voters and candidates requests.
Election	This class holds all the necessary information about elections. Election consist of ballots, results, statistics, and campaign.
Voter	Voter class is used to maintain the information of the voters.
Candidate	This class inherits the voter class.
Ballot	Ballot class is used to maintain the information of ballot.
Result	Result class holds information of the result of associated election.
Statistics	This class maintains the whole statistics of the associated election.
Campaign	Campaign class provides the way of interaction among the candidates and the voters.

The sequence diagram showing the objects participating in EMS and the messages they exchange arranged in a time sequence is given in Figure 9. In this diagram V stands for voters, C for candidates, BB for bulletin board, E for election, EM for Election manager, IA for Instituteadmin and SA stands for Superadmin.

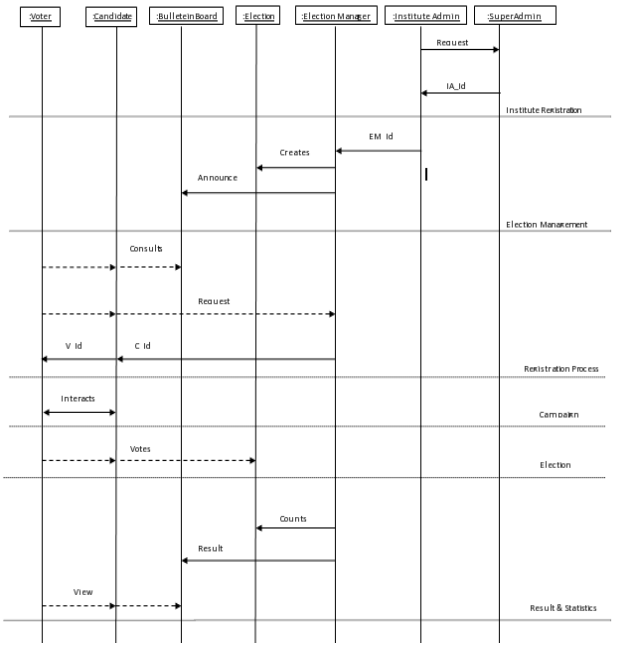

Figure 9. Sequence diagram

4. SYSTEM ARCHITECTURE

The *system architecture* of a system is the set of structures comprising of software elements and relations among them that are needed to reason about the system. The EMS follows layer based architecture and the core layers are described below.

- ***User Interface Layer***: This layer is an interface between user and an application layer, all the view pages belongs to this layer. It is also known as a presentation layer.

- ***Application Layer***: This layer works as a controller between business logic and the user interface layer. A request for a resource comes from user interface layer with a logical name and the controller map the request with its physical name and sends the control to the domain layer for further processing.

- ***Domain Layer***: Domain Layer also known as business logic layer, it has the core business logic implementation. Separating business logic with other layers helps to maintain or modify core business logic or implementation without affecting application layer and user interface layer.

- ***Data Access Layer***: Data Access Layer contains data access objects and/or persistent data that are directly interact with the database. Separation of this layer with Business logic layer helps to maintain the system or upgrade the database without affecting business logic.

- ***Infrastructure Layer***: Infrastructure layer is used to provide other services like email sending or interacting with legacy services like logger for tracing the user's activity.

The main services which are provided by EMS are given below.

- ***Registration Service***: This service involves registration of voters, candidates and Institutes at different levels. Registration of Voters and Candidates happens at institute level while institute registration takes place on server side.

- ***Election Management Service***: This service provides the facilities to institute admin and election managers. Using this service institute admin is able to create election managers, election managers is able to manage whole election process.

- ***Voting Service***: Voting service is fully dedicated to the eligible voters of the institutes. This service manages the voting process, authentication and anonymity of voters.

- ***E-campaign***: This service provides the facility to the candidates. Using this service candidate will be able to do their campaign online with the help of online tools such as chat, blog, e-news etc.

The relationship among various systems' component are depicted in the diagram given below.

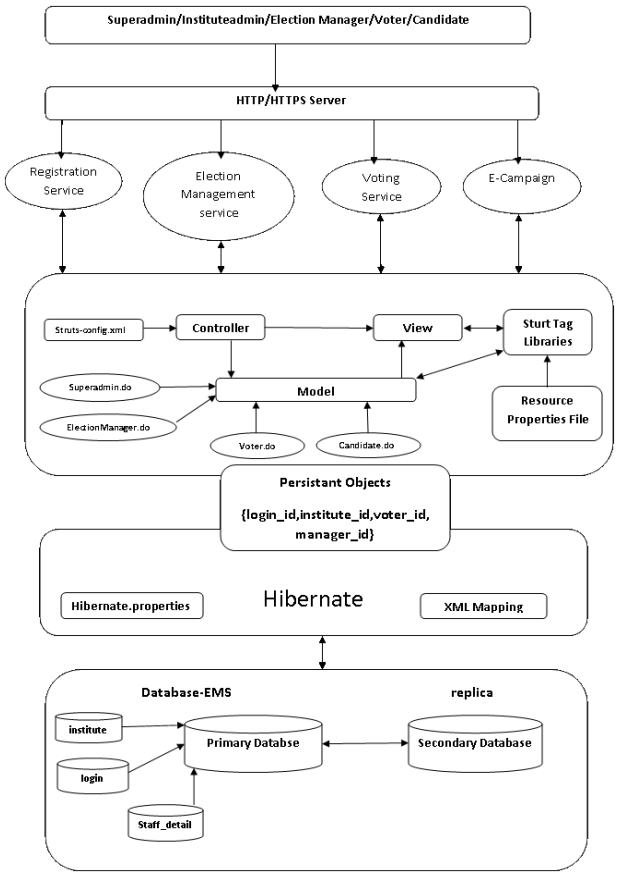

Figure 10. System Architecture of EMS

5. IMPLEMENTATION

Model View Controller (MVC) framework is followed in developing the EMS system. EMS is implemented using Struts framework as depicted in Figure 11 and Hibernate [4]. Hibernate not only takes care of the mapping from Java classes to database tables (and from Java data types to SQL data types), but also provides data query and retrieval facilities. It significantly reduces development time otherwise spent with manual data handling in SQL and JDBC [5]. Hibernates design goal is to relieve the developer from 95% of common data persistence related programming tasks by eliminating the need for manual, hand-crafted data processing using SQL and JDBC [7]. MySql is used as database as it is commonly used in web based applications for its speed and reliability.

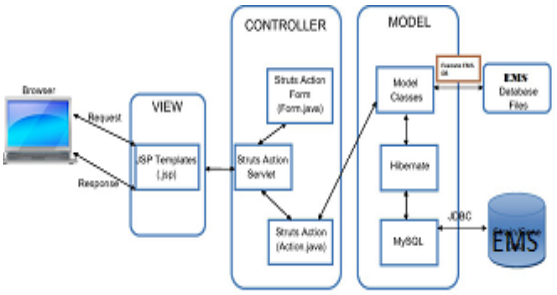

Figure 11. Struts Framework Architecture of EMS

Biometrics is an automated process of identifying or verifying the identity of a person based on physiological or behavioral characteristics. Example of physiological characteristic includes hand or finger images. Behavioral characteristics are traits that are learned or acquired. Examples of behavioral characteristics are dynamic signature verification and speaker verification. Biometric authentication requires comparing a registered biometric sample against a newly captured biometric sample [11]. In our system we use fingerprint reader i.e. the patterns of friction ridges and valleys on an individual's fingertips are unique to that individual. Fingerprints are unique for each finger of a person including identical twins. One of the most commercially available biometric technologies, fingerprint recognition devices for desktop and laptop access are now widely available from many different vendors at a low cost.

We are trying to incorporate Libfprint with our project. Libfprint is an open source fingerprint scanning solution that supports a reasonable number of fingerprint scanners under Linux environment. Libfprint can support various devices like AuthenTec AES2501, AuthenTec AES4000, Digital Persona U.are.U 4000B and UPEK TouchStrip where most of the results are complimentary but still some more efforts are needed towards visual scan feedback and communication with the user [3].

6. CONCLUSION

We proposed a web based election management system that is agile, transparent, accurate, verifiable and able to maintain the trust and credibility of its users. To address the accessibility requirement, EMS provides multilingual interface making the system easily accessible and user friendly. The system is designed using the reliable technologies like struts framework and hibernate that provides the better and secure environment. MD-5 encryption technology is used to provide better anonymity while user authentication is done by bio-metric authentication. EMS has been primarily developed for conduction elections at educational institute and university level. EMS has been successfully tested by conduction election at IIT, Kanpur. It is intended to further extend the functionality of EMS, so that it may be used by election commission of India for conducting various elections at country level.

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REFERENCES

Carroll, T.E. and Grosu, D. A secure and anonymous voter-controlled election scheme. *Journal of Network and Computer Applications*, 2009.

Delaune, S., Kremer, S and Ryan, M. Coercion-Resistance and Receipt-Freeness in Electronic Voting. *19th IEEE Computer Security Foundations Workshop (CSFW)*, 2006.

Drake, D. Fingerprint Abstraction Layer for Linux. School of Computer Science, The University of Manchester, 2008.

Goodwill, J. and Hightower, R. Professional Jakarta Struts. Wrox Press, 2003.

Holmes, J. Struts: The Complete Reference, 2nd Edition. McGraw-Hill Osborne Media, 2006.

Jonker H. L. and de Vink E.P. Formilising Receipt Freeness. Lecture Notes in Computer Science Volume 4176, pp 476-488, 2006.

King, G., Bauer, C., Andersen, M.R., Bernard, E., Ebersole, S., and Ferentschik, H. Hibernate Reference Documentation 3.6.0.CR2, 2008.

Rumbaugh, J. Object-oriented Modeling and Design. Prentice Hall, 1991.

Veronique, C. and Smyth, B. Attacking and Fixing Helios: An Analysis of Ballot Secrecy. IEEE 24th Computer Security Foundations Symposium, 2011.

www.en.wikipedia.org/wiki/Indian_census#Linguistic_demographics

Yoon, E. Robust biometrics-based multi-server authentication with key agreement scheme for smart cards on elliptic curve cryptosystem. The Journal of Supercomputing, 2010.