

# Multi-Agent Based M-Voting System

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**Abstract**—Multi-agent based m-voting system is capable of saving time, minimizing errors in voting and making voting easier. M-voting is an emerging area with wide application in all sectors of the Economy; m- voting is given a new dimension. M-voting is considered a brand new model which is based on use of mobile phone for voting in elections. The whole of M-voting in computing technology may be viewed as distributed, complex, dynamic because it has attributes such as network, popularization, personalization and lifelong. The object oriented design methodologies have been used in solving the voting problem. The voting problem is also being approached from artificial intelligence point of view. Many questions therefore arise about M-voting. One general question is how modern artificial intelligence models can be applied to the voting problem. An open direction of inquiry into this problem is the investigation of how multi-agents can be used to solve M-Voting. In this study, we focus on design of a multi-agent systems model, where the components in the M-voting scenario are intelligent and can reactively and proactively participate in solving the voting problem. An agent oriented methodology –Prometheus- was used in the analysis and design of the multi agent based M-voting system We see the overall solution to the multi agent based M-voting system as the settlement resulting from communications and negotiations of individual agents in the M- voting process. This is a multi-agent scenario.

**Keywords**—M-voting ; Multi-agent System;Agent;

## I. INTRODUCTION

Free elections are one of the main forms of political participation of citizens in democratic regimes. They are the mechanism through which citizens can express their judgement on the way government takes care of their interests, deciding on whom will represent them and who will govern. Thus, it is the legitimacy of the political power itself that is at stake in elections: the higher being the participation, the greater will be the legitimacy; on the contrary, a rising abstention erodes the representativity and legitimacy of elected governments. This is why voter turnout is commonly considered an indicator of the vitality of democracy, and is a major concern for political actors in democratic regimes. Some will not vote due to technical reasons such as the absence of their names on their polling station register, others because they were not motivated to go to a polling station that is far from their homes, a certain number because they were sick, or occupied with more important affairs in their point of view, because they have lost confidence on the candidates and political parties, or because they think their vote doesn't really make a difference cause of rigging and violence during voting.. In our paper, we design a feasible multi agent based M-voting System. With Multi agent based M-voting system, we can simplify the traditional electoral procedures and saving the cost of human resource and time.

## II. PAPER MOTIVATION

Examine the challenging M-voting problem. Several researchers are still working on it to make its performance better.

Multi agent systems are interesting in their own right. It is interesting to reflect on how they will change software development approaches in future. Meanwhile, using them in an area such as M-voting presents good opportunity to gain insight into their architecture and also use them to solve these interesting widely applicable problems.

Actually getting Multi-agent systems to interact in M-voting problem solving mode is even more interesting.

## III. SIGNIFICANCE OF THE PAPER

In this section, the reasons explaining why we are seeking a solution to this problem are Itemized.

- Multi agent based m-voting system is capable of saving time, costs , minimizing errors in voting and making voting easier
- The multi agent based M-voting system minimizes election characterized by violence, intimidation, non-reinforcement of the election offences, questionable decisions in election petitions and lack in electoral disputes resolution mechanism hence promoting true liberation.
- Citizen vote knowing their vote counts.
- Open the use of Multi-agents as an alternative strategy to solving M-voting problem.
- Add to Multi-agent system based frameworks for voting problem solving.
- At the heart of M-Voting operations, Multi-agent system based solutions may introduce flexibility, cost reductions, scalability and efficiency that would not have been realized otherwise.
- Multi agent computing, due to its widespread application in controlling or harmonizing operations, is interesting in its own right so a solution to it in any complex context may be transferable to other complex contexts.
- Using Multi-agent systems in M-learning introduces architectural revisions to the existing Computing framework that deviates from the currently common layered user, resource broker/information service, resources that are supported by conventional software.
- Conventional software is limited on autonomy and is less adaptive. The consequence is a possible revision of m-voting Computing architecture based on Multi-agent systems approaches.
- M-voting is an evolving area of interest with many potential benefits and there are many open areas of enquiry whose solutions are still of interest.

There are claims on advantages of Multi-agent systems by researchers that may be verified or questioned by Multi-agent

research such as this. Note that in [26] advantages of Multi-agent systems include:

- Handling large problems that a single agent (e.g. single OR algorithms) cannot handle, relevant to real life or complex scheduling problems as in Grid Computing;
- Appropriateness for problems that can be translated to society of autonomous agents naturally- so can M-voting tasks;
- Provide solutions in cases where expertise is distributed, relevant to collaborative work in voting;
- enhancing performance through concurrency that makes computations efficient, graceful recovery of failed components, extensibility as agents can come and go, robustness as uncertainty can be handled by agents, modularity that makes maintenance easier, responsiveness as agents can handle problems without propagating them, flexibility as agents can adapt, and reuse as agent functions can be used in different settings.

#### IV. ASSUMPTIONS/IMPLICATIONS

- Legal framework changed
- Awareness creation
- Internet connectivity
- Financial implication
- Political Good will and Commitment
- Stakeholder analysis and involvement(Government, mobile service provider, voters and IEBC)
- Change management

#### V. LITERATURE REVIEW

Reference [3] addressed the concepts of untraceable electronic mail and digital pseudonyms, which can apply for electronic voting for anonymity. In order to reduce the cost of human and material, moreover, to enhance the convenience in the task of polling, E-voting has taken the place of traditional voting in a considerable number of countries over the past few years. In this section, we aim to review literature we consider relevant to E-voting and M-voting. Evaluation of Voting Equipment In the recent years, voting equipments which were widely adopted may be divided into five types [13]:

- ✓ Paper-based voting: The voter gets a blank ballot and use a pen or a marker to indicate he want to vote for which candidate. Hand-counted ballots is a time and labor consuming process, but it is easy to manufacture paper ballots and the ballots can be retained for verifying, this type is still the most common way to vote.
- ✓ Lever voting machine: Lever machine is peculiar equipment, and each lever is assigned for a corresponding candidate. The voter pulls the lever to poll for his favorite candidate. This kind of voting machine can count up the ballots automatically. Because its interface is not user-friendly enough, giving some training to voters is necessary.
- ✓ Direct recording electronic voting machine: This type, which is abbreviated to DRE, integrates with keyboard; touch screen, or buttons for the voter press to poll. Some of them lay in voting records and counting the votes is very quickly. But the other DRE without keep voting records are doubted about its accuracy.
- ✓ Punch card: The voter uses metallic hole-punch to punch a hole on the blank ballot. It can count votes

automatically, but if the voter's perforation is incomplete, the result is probably determined wrongfully. (

- ✓ Optical voting machine: After each voter fills a circle correspond to their favorite candidate on the blank ballot, this machine selects the darkest mark on each ballot for the vote then computes the total result. This kind of machine counts up ballots rapidly. However, if the voter fills over the circle, it will lead to the error result of optical-scan.

Recent years, a considerable number of countries has adopted E-voting for their official elections. In this section, four empirical examples are enumerated as following.

America: Government of the United States hold election collaterally in several ways, in other words, each state can choose the suitable way to hold elections independently. Because there are some debates about E-voting, such as some vote casts were not counted, or election system crashed during the Election Day. Secretary of State Kevin Shelley established an "Ad Hoc Touch Screen Task Force" to research the debates on DRE in February 2003[4]. Shelly advanced that DRE should include voter verifiable paper audit trails (VVPAT) to solve electoral debates.

Japan: Japan adopted E-voting for local election in 2002, such as mayor and councilor election of Niimi city in Okayama prefecture in June 23, 2002; mayor election of Hiroshima city in February 02, 2003; and mayor election of Kyoto city in February 08, 2004. Take mayor and councilor election of Niimi city for example, electoral center surveyed the voters' reliability when the election finished. There are 83% of voters considered that E-voting system is trusted. 56% of them considered that the results of E-voting and paper-based voting are the same therefore E-voting is sufficient for reliable. The reasons why voters can't trust the E-voting system are voters worried about the abuses in E-voting system, and they can not make sure their ballot are recorded correctly.

Belgium: Election for the Federal Parliament is held in May 18, 2003. In order to assist voters in being familiar with E-voting system, electoral center held short-term training. Counting efficiency in the election with E-voting system was faster then convention. Belgium's compulsory voting system and E-voting complement each other, voters' satisfaction and attending willingness of join voting are improved obviously. Brazil: Brazil used E-voting in 1998. When the voter reaches the polling place, he shows his identity card for authenticating; if he is an eligible voter, he can get the ballot for E-voting. Brazil's E-voting system transmits votes to electoral center immediately, so that the count of votes can announce rapidly while the voting finished.

#### A. History of the Kenyan Electoral Process

Kenya achieved its independence from the British by the 1963 Kenya Independence Order in Council. The British set up a constitutional structure that was calculated to take care of the various interests and conditions prevailing at the time. It was a structure that had the potential to ensure the development of a democratic rule[23]. It provided for checks and balances between the various arms of government and it protected fundamental human rights. *Ibid*

The constitution provided for a decentralised structure based on eight regions of the country. Within the regions were county, urban, municipal councils and the City Council of Nairobi, the capital. Kenya was to be an independent multiparty democracy with the Upper House or Senate and the

Lower House of representatives[26] Having acquired independence, the ruling party or class set out to dismantle the system and centralize power. The federal structure of governance was abolished in 1964 and so was the bicameral legislature. *Ibid*

This was followed by the shift away from multiparty democracy to a one party state with the political power heavily concentrated in the presidency. By 1988, the country had become a one party state ruled by the only party, the Kenya African National Union (KANU). The problems that followed the setting up of the new system of government are well known to historians and observers. These are the problems that the current constitutional reform process has been addressing without much success. *Ibid*

Kenya has held elections regularly since its independence even if some of the elections, such as the 1988 elections, have been bogus and could be described as selections rather than elections. The first Electoral Commission was set up under section 48 of the 1963 Kenya Independence Order in Council. Its members were the Speaker of the Senate as the Chairman, the Speaker of the House of Representatives as the Vice-Chairman, a member appointed by the Governor General acting on the advice of the Prime Minister and a member representing each region appointed by the Governor General acting on the advice of the President of the Regional Assembly of the region. The regions were eight; therefore, the Commission had eleven members including the Chairman. As the centralization of power by the Executive increased, so were the functions became the delineation of the constituencies that were directly affected by the administrative boundaries which were set out by the Office of the President. *Ibid*

Registration of voters and the elections were carried out by the Director of Elections, a civil servant at the office of the Attorney General. The same office in the Registrar General's department later registered political parties at the whims of the establishment. During elections, District Commissioners in charge of districts were the Returning Officers and the clerks under them were the Presiding Officers and voting clerks. Except in the south, Kenya is surrounded by sister states which have experienced serious political upheavals that were more serious than Kenya's own political assassinations. These countries experienced violent changes in government and in one case, peace has yet to return after 14 years of anarchy. Kenyan leaders and people did not therefore want to see that violence hence under pressure from the civil society and political dissent, the government of the day reverted to multi partyism in 1991. *Ibid*

Multiparty democracy in the developing world is impossible without an independent and effective Electoral Commission. This is why we need a multi agent based M-voting Systems.

### B. Comparison of E-voting System

Besides many vendors to develop and sell commercial electronic election machines, there are various open source E-voting systems. We cite some examples as following [6] [11]:-

(1) AccuVote-TS: AccuVote-TS's vendor is Diebold Election Systems. This system includes touchscreen, card reader, keyboard, headphone, and paper tape printer. The voter selects his favorite candidate on touchscreen, and the vote will be printed on the paper tape. Its design balances the policy, electoral procedure and technology. But all the electoral information (including identity authentication, audit, or

counting of votes) are stored in Microsoft Access database without setting password so there are high risks of attack.

(2) iVotronic: The vendor of iVotronic is Election Systems and Software (ES&S). iVotronic provides multi-language, and uses flash memory to save voting records. Electoral workers use PEB (Personal Electronic Ballot, a device which is similar to disk) to start polling machine up. When the election is finished, the workers use PEB to access voting records in the polling machine, then delivers PEB to electoral center or transmits data from network. Because the PEB's password is only three characters, the risk of password breaking exists. This system have made mistake in the past elections, such as the number of voters is not corresponding between master server and backup server, the candidate selected on the ballot is not the voter's selection, and so forth.

(3) eSlate 3000: Hart InterCivic invented eSlate 3000. The voter gets a personal identity number (PIN) as four digits from electoral workers, then goes to the booth to input the PIN into polling machine to login. He can rotate selector wheel to select the candidate whom he want to poll for. Each terminal connects to the server which is named JBC (Judges Booth Controller). Counting of votes will send to JBC from every terminal by network, then save it in MBB (Mobile Ballot Box). This system doesn't encrypt voting data, so there are some risks of data security. Furthermore, the electoral functions are not protected with password, anyone, even the voter, can finish the election[14][13].

(4) AVC Edge: AVC Edge is a multi-language polling machine which is manufactured from Sequoia Voting Systems. This machine includes touchscreen and flash memory for saving voting recorded, and its electoral procedure is similar to a foregoing E-voting machine, Accu Vote-TS. There were some stumbles when this machine operated in the elections. For example, the E-voting system crashes when the user chose language; the counting of votes is not correct; and the ballot became blank because of the system breakdown.

(5) SAVIOC: SAVIOC is an open source E-voting system and all the source code and software can download from its official website [7][8]. This system is written in C language, and it can be saved in disk with FreeDOS. This system operates from disk, so hard disk is not necessary and the discarded computer is enough. This system is not connected to any networks and most of keys on the keyboard are disabled, attackers can't find the way to invade. SAVIOC's advantages are its simple disposition and low cost, but on the other hand, there are short of GUI and ease of use on SAVIOC.

### C. Multi-Agents Systems (MAS)

Multi-agent systems are a new paradigm for understanding and building distributed systems, where it is assumed that the computational components are autonomous: able to control their own behavior in the furtherance of their own goals[1]. Agent-based systems technology has been hailed as a new paradigm for conceptualizing, designing, and implementing software systems which are distributed in nature. Agents are sophisticated computer programs that act autonomously on behalf of their users, across open and distributed environments, to solve a growing number of complex problems. Increasingly, however, applications require multiple agents that can work together. In particular, multi-agents have shown their potential to meet critical needs in high-speed, mission-critical, content-rich, distributed information systems where mutual interdependencies, dynamic environments, uncertainty, and sophisticated control play a notable role [10]. Multi-agent

systems approach has offered the following advantages over a single agent or centralized approach [1][26]:-

1. Multi-agent system (MAS) distributes computational resources and capabilities across a network of interconnected agents.
2. MAS models problems in terms of autonomous interacting component-agents, which is proving to be a more natural way of representing task allocation, team planning, user preferences, open environments, and so on.
3. MAS efficiently retrieve, filters, and globally coordinate information from sources that are spatially distributed.
4. MAS provide solutions in situations where expertise is spatially and temporally distributed.
5. MAS enhance overall system performance, specifically along the dimensions of computational efficiency, reliability, extensibility, robustness, maintainability, responsiveness, flexibility, and reuse. MAS clearly contain many agents within the contextual environment. In addition to inter-agent communication, we need to recognize that, within MAS, agents need to both compete and cooperate. Although essentially selfish in their autonomy, agents act like humans: sometimes aiming to fulfill their own goals at the expense of all other agents/humans but mostly in a more social structure in which it is recognized that collaboration and sharing of work is mutually beneficial as well as individualistically profitable[2]. Thus, the notion of agents organized to work within a social structure is also a very strong driver in Agent oriented methodologies [24].

## VI. PAPER METHODOLOGY

### A. Approach

In this section we look at how we will approach the problem. We seek to answer most of the questions raised in the earlier section of this paper. We begin by developing designing a Multi-agent M-voting system by defining all the necessary interaction, communication and cooperation policies and processes.

### B. Design the System-Prometheus Methodology

Agent-Oriented Methodologies presents, analyzes and compares the most significant methodological approaches currently available for the creation of agent-oriented software systems [2]. There are different agent-oriented methodologies developed so far e.g Gaia[17], Prometheus[17], MaSE [22], CommonKADS[16]. Prometheus is an iterative methodology covering the complete software engineering process i.e. Analysis, Design, Detailed design, & Implementation. It has a complete-lifecycle methodology for analyzing, designing and developing heterogeneous MAS[17]. It uses a goal-driven development and is independent of a particular multi-agent system architecture, programming language, or message passing system. The following activities were carried out: a) the system specification phase focused on identifying the basic functionalities of the system, along with inputs (percepts), outputs (actions) and any important shared data sources. b) The architectural design phase used the outputs from the previous phase to determine which agents the system will contain and how they will interact. c) The detailed design phase looks at the internals of each agent and how it will accomplish.

## VII. ANALYSIS AND DESIGN OF MULTI-AGENT BASED M-VOTING SYSTEM

### A. System Specification

The system specification activities are as follows: identifying the basic functionalities of the system, along with inputs (percepts), outputs (actions) and any important shared data sources.

The voter has to cast vote on the following elective positions: (1) President, (2) Governor, (3) Member of Parliament (4) Women Representative, (5) Senator (6) Member of county assembly. For the voter he/she should be able to register as a voter with the independent electoral commissions the same way you register for M-pesa. Each voter will have his/her password. Those voters without Mobile phone can vote using voting booth set up by IEBC. IEBC will have a mobile phone which is touch screen and their password is their finger prints especially those who haven't gone to school.

### B. Goal Diagram

The system parent goal is for the voter to elect their favourite candidates in a free and fair manner using less time. The subsidiary goal include presidential voting, gubernatorial, Member of Paliament(MP), senatorial, women representative and Member of county assembly. The subsidiary goal contributes to the achievement of the parent goal. Figure 1 below shows the goal diagram

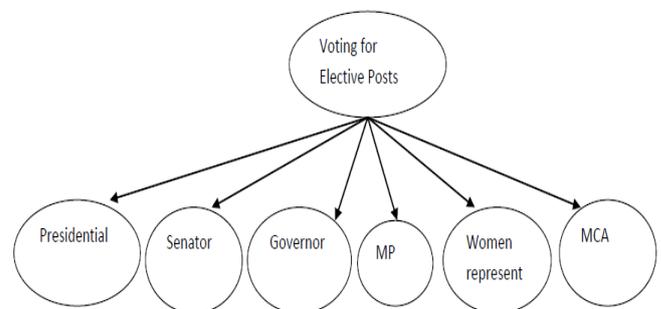


Figure 1: Goal diagram.

The main actors in the multi agent based M-voting system are as follows:-

a) Voter

The voter does the actual voting using the Mobile device

b) Independent Electoral and Boundary commission (IEBC) oversee the election and announce the winners.

### C. Percepts/Actions

Percepts: The voter selecting the candidate of choice for each seat starting from presidential, senatorial, gubernatorial, Mp, Women representative and MCA on the phone drop down or in the case of those voting through polling station from the touch screen you select the candidates Photo for each elective post. The information is captured and added to database Actions: Results for each candidate are displayed on big screens across the counties and at national level after one hour of voting. IEBC official can also query the database in case they want to find the fine details about voting patterns

### D. Architectural Design

Multi agent based M voting system Eight types of agents: (Voter Agent, IEBC Agent, Presidential Agent, Senatorial Agent, gubernatorial agent, Women rep Agent, Member of parliamnet(Mp) agent and Member of county assembly Agent. The Voter Agent should be developed using LEAP which is an add-on of JADE. It has been implemented on mobile devices

which the user possesses like the normal mobile or smart phone. It accepts selection from dropdown menu and allows selection of preferred candidates from a touch screen board. Figure 2 shows the technological infrastructure.

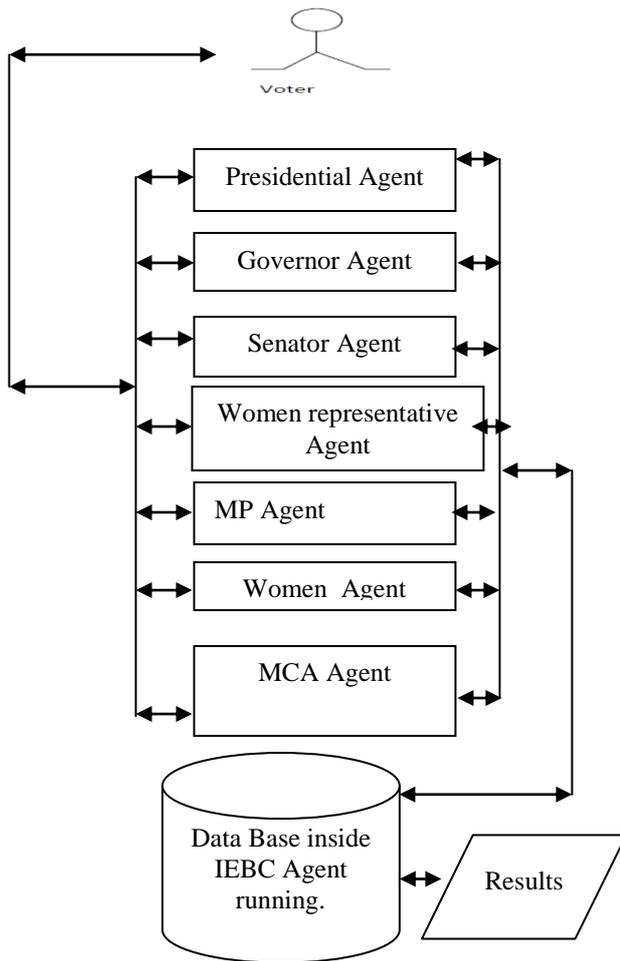


Figure 2: Technological Infrastructure : System Overview Diagram

TABLE I. AGENT DESCRIPTORS

No	Agent type	Description
1	Voter Agent	Sends voters response on all the six elective position as per users choice to other agents. Communicates with all the six agent.
2	IEBC Agent	Resides in the database, Requests to databases This is the agent that is used by IEBC to query the database . The agent also Communicates with all the agent before storage. The agent is able to display the results of each candidate in each elective seat by communicating with various displays distributed across the country
3	Presidential Agent	Receives information from voters agent on preferred presidential candidate and stores the results in the database

4	Senator Agent	Receives voters choice of senator and stores the results in the database depending on the county
5	Governor Agent	Receives voters choice of governor and stores the results in the database depending on the county
6	Member of Parliament Agent	Receives information from voter agent for each constituency and stores the information in the database Communicates with IEBC agent before storage is done.
7	Women representative Agent.	Receives voters choice of women representative from Voter Agent and stores the results in the database depending on the county.
8.	Member of County Assembly (MCA) Agent	This agent is a collection of several agents for each ward in the country. Collects various results of each ward from the voter Agent and computes the result Stores results in the database

### CONCLUSION

This paper indicates direction of research that is intended. It sets out the central theme as Multi-agent based M-voting System". The results of investigations culminate into a proposed multi-agent system based M-voting system which can enable voters cast their vote democratically hence promoting liberation in Kenya. The Implementation of the Multi-agent Based M-voting System should be done using (JADE) Java Agent Development Environment and use object oriented database to store knowledge. JADE is a set of Java classes that allow a developer to build a FIPA-compliant multi-agent system quite.

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#### DEFINITION & ACRONYMS

An agent: is a small, autonomous, or semiautonomous software program that performs a set of specialized functions to meet a specific set of goals, and then provides its results to a customer (e.g., human end user, another program) in a format readily acceptable by that customer .

IEBC: Independent Electoral and boundary Commission

MP: member of Parliament

MCA: Member of County assembly

Multi-agent System: is a system composed of multiple interacting agents.

M-Voting: Mobile Voting. Voting using a mobile gadget.