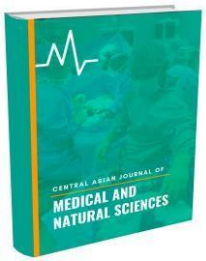

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Article

Enhancing Democratic Participation with Biometric and Technology-Based Voting Systems

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Abstract: Free elections are the most important part of democracy. People use elections to confirm their opinions and voices and choose someone whose ideas they agree with the most. Elections will let voters choose their representatives. The elections are not only to choose the winner, but also to give the winner credibility among voters who did not vote for them. This stresses the need of having free, fair, and secret elections. It means that independent, fair, and responsible electoral bodies are in charge of overseeing elections. The saying "today's teens, tomorrow's citizens" means that students should be involved with, trained for, and familiar with the election process. In this way, colleges and universities organize general elections for their student governments. This student will learn firsthand how to file nominations, check papers, withdraw, canvass, address, and, most importantly, vote. Voting with technology will be easier, more effective, and less likely to be hacked. Technology will make all votes safer and faster, making counting and automatic verification far more useful. It is hard to make a better voting system because there are so many important things that need to be done. It is important to keep the poll secret. There should be no way to tell which candidate obtains a certain vote in the voting mechanism. The authors used the Authenticated Voting Machine in the elections talked about in this work to make things easier and more open. The idea is still quite new. More study is needed to make it stable and theoretically sound. The model uses radio frequency and fingerprint recognition, as well as an OT-based system, to keep things safe.

Keywords: Filing Nominations, Winners Credence, Fingerprint Recognition, Autonomous Electoral Bodies, Improve Transparency, Authenticated Voting Machine

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1. Introduction

Elections are a big part of how democracy works [42]. Elections are held to assist kids learn about democratic system and develop leadership skills [60]. Technology has changed practically every profession in a big way, and the electoral process is no different. People use technology to help them do their jobs quickly, easily, and correctly. The traditional voting system that uses paper ballots is easy to use, but it isn't clear or free of mistakes [72]. We get around the problems with traditional paper ballots [56]. An Authenticated Voting System (AVM) was set up [48]. It uses two ways to prove who you are: biometrics and Radio Frequency Identification (RFID) [70]. During the admission procedure, each person's biometrics are registered and kept with other important papers

[44]. After the admission process is over, each person gets an RFID-based identity card [66]. The first proof of identity for the election is this ID card [69]. Only students who have a valid ID card can vote [61]. During the election, the voter puts the RFID card on the card reader [54]. The second step of authentication checks to make sure that the card belongs to the person who has it [71]. The student is accepted at the second level of biometrics by a fingerprint scanner built into the voting machine [62]. This fingerprint is checked against the one in the database [43]. Only that voter can vote if both fingerprints match [68]. An embedded system is a piece of computer hardware and software that is either fixed in its capabilities or may be programmed to do a certain job or work as part of a bigger system [39]. An embedded system could be in a car, a medical device, a camera, a household appliance, an airplane, a vending machine, a toy, or a mobile device [50]. Embedded systems are computer systems, but they might have very simple user interfaces (UIs), such on devices that are just meant to do one thing, or very rich graphical user interfaces (GUIs), as on mobile devices [63].

Microprocessors or microcontrollers can be used to make embedded system hardware [41]. In either case, the product is made up of an integrated circuit that is meant to do calculations for real-time activities [57]. Microprocessors and microcontrollers seem the same, but microprocessors only have a central processing unit (CPU), thus they need other parts like memory chips [67]. Microcontrollers, on the other hand, are made to work on their own [47]. The term "system on a chip" (SoC) is often used to describe the most powerful microcontrollers [64]. However, there is no clear definition of what this means in terms of RAM, clock speed, etc [55]. In 2013, the embedded market was thought to be worth more than $140 billion, and many analysts think it will be worth more than $20 billion by 2020 [52]. Many well-known computer businesses, like Apple, IBM, Intel, and Texas Instruments, make chips for embedded systems [65]. There are also many additional companies that people who don't work in the area may not know about. ARM has been a very important company in this area [58].

Compared to a normal enterprise desktop computer, a typical industrial microcontroller is not very advanced and usually needs a simpler, less memory-intensive software environment [49]. The simplest devices run on bare metal and are programmed directly using the chip's CPU machine code language [59]. Embedded systems often use operating systems or language platforms that are developed for embedded use, especially when real-time operating environments are needed [46]. Designers have come to the conclusion that systems with more powerful chips, like those in SoCs, are fast enough and that the jobs can handle small changes in reaction time, therefore near-real-time methods are fine [51]. Embedded firmware is a type of software that is stored into the memory of a device and works like ROM but can be changed more readily [40]. You can save firmware on non-volatile memory devices like ROM, programmable ROM, erasable PROM, or flash memory [53]. Embedded firmware is used to manage different parts of a device or system [45].

Literature Survey

An Electronic Voting Machine (EVM) is a simple electronic device that records votes instead of using paper ballots and boxes like in the past [4]. The right to vote, or just voting in elections, is what makes democracy work [22]. In all previous elections, whether they were state or central, a voter would mark their favorite candidate by putting the stamp next to their name and then folding the ballot paper in a certain way before putting it in the Ballot Box [10]. No more stamping, ballot boxes, or paper ballots [17]. The electronic voting machine has a basic box called the ballot unit that holds all of this information [5]. Biometric identifiers are thought to be more reliable for recognizing people than traditional token or knowledge-based approaches since they are hard to lose, fake, or distribute [2].

The most important part of democracy is the "vote," which lets people choose the candidates who will make up a good government that will meet their needs and wants

and improve their quality of life [6]. In developing countries such as India, the electoral commission utilizes a manual voting system facilitated by computerized voting machines [14]. Higher-ups keep an eye on this machine, which is in the middle of the polling booth [11]. Some illicit acts have caused polling places to be misused, which has taken away people's right to vote [7]. This doesn't happen very often in rural areas or big cities since educated people don't want to vote for candidates who represent their localities [16]. To make sure that everyone voted, automation was used [25]. But just a few wealthy countries have accepted this automated approach because security hasn't been guaranteed to a large level [23]. The major goal of the suggested system is to make a voting machine that is safe [1].

The system that has been suggested is mostly for our country [26]. It comprises three parts [35]. First, the Aadhaar card database is searched for information about people over the age of 18, which is now required [8]. A new voter ID with all the right information will be made automatically, and the person will be told about it via email [9]. The user can enter their ID and password when they vote [15]. Democracy is a very important and strong political force in big countries, and elections are held to build and improve democracy [18]. Pakistan is a democracy, yet it still uses manual and costly ways to hold elections [3].

That leads to lengthy procedures, fake entries, counting mistakes, abuse of ballot papers, and major problems with security, accessibility, and reliability [24]. But technology is a big part in stopping and making these difficult situations less bad [30]. It is the best, safest, most accurate, and fastest way to hold elections [33]. There are numerous technical approaches to use the electronic voting system around the world to say that it is easier and safer [12]. Unfortunately, all electronic methods can't be used in Pakistan right now because the country isn't ready for them [36]. This article proposes the Electronic Voting Machines System (EVMs) for Pakistan to provide transparency, accuracy, security, verifiability, and validity of voting through a cost-effective and expedited approach [13].

This paper proposes an online voting mechanism for the Indian election for the first time [27]. The proposed model is safer since the voter's security password is checked before the vote is added to the main database of the Election Commission of India [19]. The model offers an extra feature that lets voters check to see if their vote was cast for the right candidate or party [37]. In this approach, a person can vote from anywhere they want, even if it's not in their own district [29]. The suggested system will automatically count the votes, which will save a lot of time and allow the Election Commissioner of India to declare the results extremely quickly [31].

This research examines a secure analysis of electronic voting equipment [38]. A study of the electronic machine suggests that it is open to major threats [34]. For instance, an attacker who can physically get to a machine or its removable memory card for just one minute might install malicious malware [32]. This code could steal votes without anyone knowing [20]. An attacker might even write bad code that spreads automatically and surreptitiously from one computer to another while routine electoral procedures are going on [28]. To lower these risks, the voting machine's hardware and software will need to be changed, and the election process will need to be stricter [21].

System Design

As technology gets better, smart voting systems are becoming more and more popular [81]. However, many of them don't give the user a gadget [78]. Many voting systems do not have good electronic security systems, which is an issue because there is a lot of fraud. We can fix a lot of problems with security systems and make them work better by adopting biometric authentication technologies [74]. It has two levels of authentication: biometrics and radio frequency identification (RFID) [83]. Along with other important documents, the fingerprints of each voter are registered and kept during the admittance procedure. After the admittance process is over, every voter will get an RFID-based ID

card [76]. This ID card is the first proof of identity for the election [79]. Only people with valid ID cards can vote. During the election, the student puts the RFID card on the card reader. The second level of authentication is given to make sure that the person who has the card is the same person who voted [88]. In the second level, the voting system uses a fingerprint scanner to read the student's biometric information. This fingerprint is checked against the one in the database [94]. If both match, the voter's registered cellphone number will get an OTP [77]. Voters will only be able to vote if the OTP they entered is correct, see Figure 1 [89].

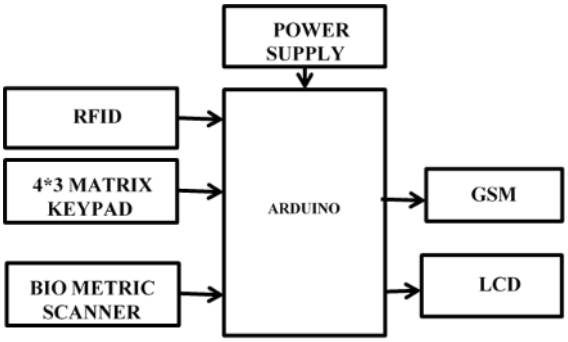

Figure 1. Block Diagram.

The earliest way to do this is to put your finger on a glass surface or a prism that is lit up by an LED [84]. When the ridges of fingerprints hit the surface, the light is absorbed, and between these crests, there is a total reflection. An image sensor records the light and dark patches that are left behind [80]. This method has certain problems in real life: the pictures taken with wet and dry fingers are extremely different, and the device is sensitive to dust and grime on the surface [73]. The unit is quite big, hard to use, and costs a lot of money [82]. It's possible to fool this method; if the skin is injured, the fingerprint isn't read correctly. It's also hard to recognize the fingerprints of older people since their skin isn't stretchy enough. This may lead to incorrect recognition in some situations [85]. If the stored fingerprint is obtained with less pressure, it could be falsely accepted [75].

2. Materials and Methods

The sensor is a silicon integrated circuit with a surface covered in numerous transducer elements (or pixels). It has a standard resolution of 500 dpi. There are two metal electrodes next to each other in each element. When the finger touches the surface, the space between the electrodes, which makes up a feedback path for an inverting amplifier, gets smaller. When the finger feels ridges, this decrease is even greater. When it feels the space between the ridges, it is less noticeable. Electrostatic discharge can damage the sensor. These sensors only work on skin that is normal and healthy. They don't work and aren't being used on skin with rough patches, calluses, or scars. It can also stop working if it gets wet, greasy, or dusty. Mechanical. There are tens of thousands of small pressure transducers on the surface of the sensor. Another design employs switches that stay open when a ridge presses on them and close when a valley presses on them. This just gives one piece of information per pixel, instead of a range of colors. In this example, thermal means that the finger's heat is detected, which is stronger when there is a ridge than when there is a valley.

The "Finger Chip" is a silicon component with a matrix of pixels. Each pixel is covered with a layer of pyroelectric material that changes the load distribution of its surface when the temperature changes [90]. The most significant use is to control who can use computers [93]. This is very crucial for PDAs and PCs. More and more devices now have sensors because the price has gone down. USB hard drives, USB memory modules,

and card readers are some other products that have fingerprint sensors integrated in. You can also find them in mice and keyboards. More and more, sensors are being utilized to protect online banking and change machines. In the future, identity cards and credit cards will securely contain the owner's fingerprint [92]. Digital signatures may also be used to verify emails [87]. Combining fingerprint sensors with door-opening systems can also make sure that people can get into rooms and use electronics directly.

Radio-frequency identification, or RFID, is a technology that lets a reader pick up digital data contained in RFID tags or smart labels (see below). Like barcoding, RFID uses a device to read data from a tag or label and store it in a database [95]. But RFID has a few benefits over systems that use barcode asset tracking software [91]. RFID tags may be read from a distance, but barcodes must be lined up with an optical scanner. This is the most important difference. RFID is one of the technologies that make up Automatic Identification and Data Capture (AIDC). With little or no human help, AIDC methods automatically find items, gather information about them, and put that information directly into computer systems. RFID methods use radio waves to do this. RFID systems include three main parts: an RFID tag or smart label, an RFID reader, and an antenna. An RFID tag has an integrated circuit and an antenna that send information to the RFID reader (also called an interrogator). The reader then changes the radio waves into a format that is easier to use. The tags send the information they collect to a host computer system through a communications interface, where it can be stored [86].

3. Results and Discussion

This technology uses inductive coupling to give power to the RFID tag from the reader. The reader has a coil that is connected to an AC supply, which produces a magnetic field surrounding it. Faraday's law of induction creates an electromotive force when the tag coil is close to the reader coil. The EMF makes the coil's current flow, which makes a magnetic field around it. Lenz's law says that the tag coil's magnetic field works against the reader's magnetic field. This will cause the current through the reader coil to go up. The reader picks this up as the load information. This approach works well for short-range communication. A Passive RFID system uses the EM wave propagation approach, which means that the reader's antenna sends out electromagnetic waves that the antenna picks up. This voltage is changed into DC power by being rectified and filtered, see Figure 2.

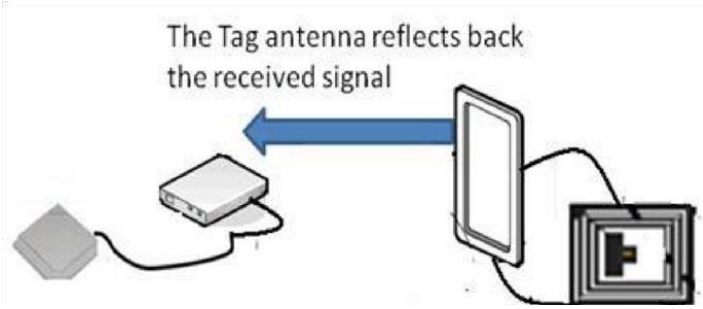

Figure 2. Passive RFID using Inductive Coupling.

Passive RFID using EM-wave transmission

A thought on how the Active RFID System works: In an active RFID system, the reader provides the signal to the tag through an antenna. The tag gets this information and sends it back with the information it already has. The reader gets this signal and sends it to the processor so it may do further work, see Figure 3.

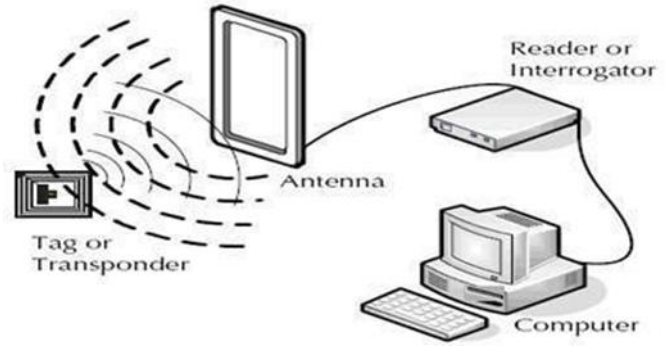

Figure 3. RFID Tags and Smart Labels.

An RFID tag is made up of an integrated circuit and an antenna, as was said above. The tag is also made of a protective substance that keeps the parts together and protects them from different weather conditions. RFID technology has been around since World War II, but the demand for RFID equipment is growing quickly. This is partially because the U.S. Department of Defense (DoD) and Wal-Mart have told its suppliers that they need to make sure that products can be tracked by RFID. Applications that now employ barcode technology are strong candidates for switching to a system that uses RFID or some combination, regardless of whether or not RFID compliance is necessary. RFID has a lot of benefits over barcodes, especially because an RFID tag can contain a lot more information about an item than a barcode can [96]. The basic idea underlying LCDs is that when you send an electrical current through the liquid crystal molecule, it tends to untwist. This changes the angle of the light that goes through the molecule of the polarized glass and the angle of the top polarizing filter. So, a small amount of light can travel through the polarized glass through a certain section of the LCD. That area will be darker than the others as a result. The LCD operates by blocking light. When making the LCDs, a mirror that reflects light is placed at the rear, see Figure 4.

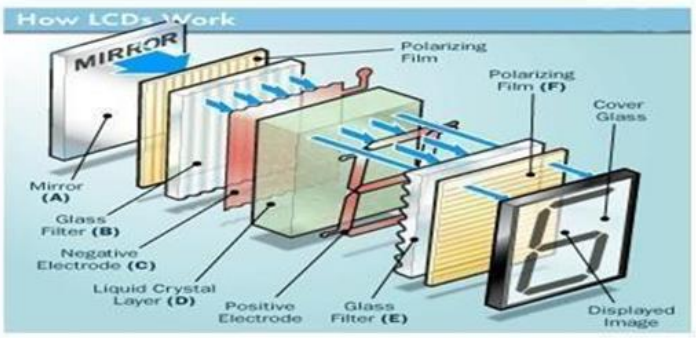

Figure 4. LCD Layer Diagram.

The second piece of glass has an electrode in the shape of a rectangle on the bottom and another polarizing film on top. It is important to remember that both parts are at right angles to each other. The light goes through the front of the LCD when there is no current. The mirror will reflect it and send it back. The current from the battery will make the liquid crystals between the common-plane electrode and the rectangular-shaped electrode untwist since the electrode is connected to the battery. So, the light can't get through. That specific rectangular space looks empty. Depending on the environment in which it is used, each cell's coverage area is different. You might think of macro cells as cells that have the base station antenna on a pole or a building that is taller than the normal rooftop level. Micro cells are cells with antennas that are lower than the average rooftop level. They are usually utilized in cities. Picocells are small cells that cover an area of a few dozen meters [97]. They are mostly utilized indoors. It connects the mobile stations to the network. The Mobile Service Switching Center is the main part of the Network Subsystem. It lets you

connect to networks like ISDN and PSTN. It also has the Home Location Register and the Visitor Location Register, which let GSM route calls and let people roam. It also has the Equipment Identity, see Figure 5.

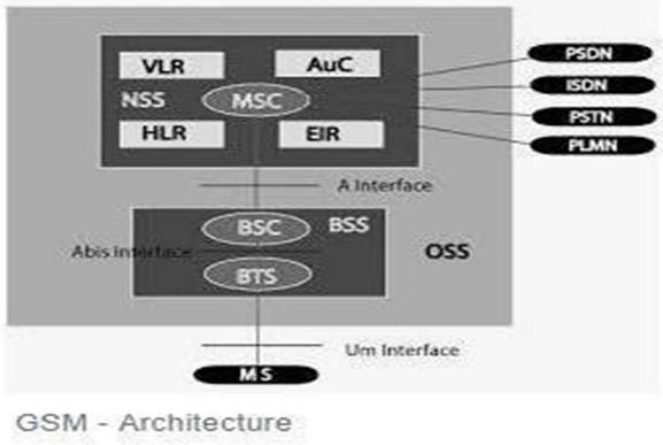

Figure 5. GSM Architecture.

Because GSM is a digital system, speech that is analog must be digitized. The GSM group looked at a number of speech coding algorithms based on how good and complex they thought the speech was (which is related to cost, processing delay, and power use once they were put into use). They finally chose a Regular Pulse Excited - Linear Predictive Coder (RPE-LPC) with a long-term predictor loop. The current sample is predicted by information from earlier samples that doesn't change quickly. The signal is made up of the coefficients of the linear combination of the preceding samples and an encoded version of the residual, which is the difference between the anticipated and actual sample. Speech is broken up into 20 (ms) samples, each of which is 260 bits long [98]. This means that the overall bit rate is 13kbps (kilobits per second). This is what is known as full-rate speech coding. Some North American GSM1900 carriers have recently started using an enhanced full-rate (EFR) voice coding technique. This circuit is a small power supply that gives you +5V. It's excellent for testing out digital circuits [99]. It's easy to find those transformers, but their voltage regulation is usually not very good, so digital circuit experimenters can't use them until they can get better regulation. This circuit can pump out +5V at about 150 mA, but if you add sufficient cooling to the 7805-regulator chip, it can go up to 1 A. The circuit contains protection against overloads and terminals, see Figure 6.

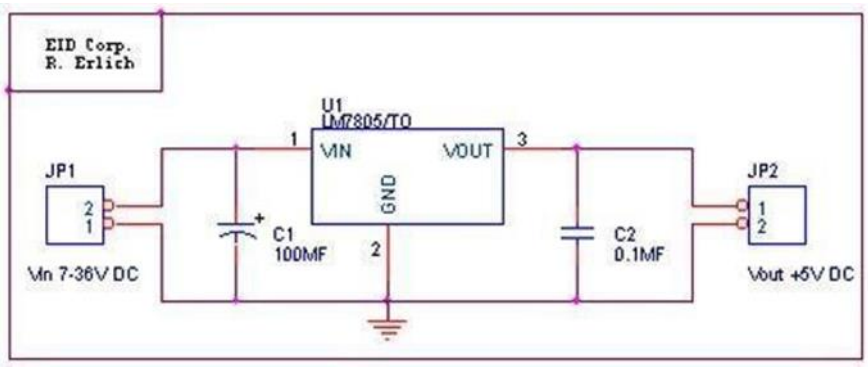

Figure 6. Circuit description.

We can change the circuit by replacing the 7805 chips with another regulator from the 78xx chip family that has a different output voltage if we need voltages other than +5V. The last digit in the chip code tells you what the output voltage is. Arduino is a platform that anyone may utilize to make electronic documents [100]. Arduino is made up of a physical circuit board that can be programmed (commonly termed a microcontroller) and

a piece of software that runs on your computer and is used to write and upload code to the board. This software is called an IDE (Integrated Development Environment). A lot of individuals who are new to electronics are using the Arduino platform, and for good reason. You don't need a separate piece of hardware (a programmer) to load fresh code into the Arduino board like you do with most other programmable circuit boards. You may use a USB cable instead. The Arduino IDE also employs a simpler form of C++, which makes it easier to learn how to program.

Finally, Arduino gives you a standard form factor that makes it easier to use by breaking up the microcontroller's functions into smaller parts [102]. Artists, designers, hobbyists, hackers, beginners, and anyone else who wants to make something that can be interacted with can use the Arduino hardware and software. Arduino can work with a lot of different things, such buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even your smartphone or TV! A lot of people use Arduino because it's flexible, the software is free, the hardware boards are cheap, and both the software and hardware are easy to learn. A lot of people have contributed code and released instructions for a wide range of Arduino-based projects. There are many different kinds of Arduino boards that can be used for different things. Some boards look a little different from the one below, however most Arduinos have most of these parts in common: Embedded C is the most widely used programming language in the software industry for making electronic devices. There is embedded software for each processor in an electronic system. Embedded C programming is very important for the CPU to do certain things [101]. We use a lot of technological equipment every day, like cell phones, washing machines, digital cameras, and more. All of these gadgets use microcontrollers that are coded in embedded C. The preceding block diagram's embedded C code makes the LED linked to Port 0 of the microcontroller flicker. When programming for embedded systems, C code is better than other languages. Because of the following reasons:

A programming language is a set of tasks and one or more functions. Most people know what application software is and how it works on a computer. Embedded software, on the other hand, is typically harder to see but just as hard to understand. Embedded software has set hardware needs and capabilities, and adding third-party hardware or software is rigorously controlled. Application software, on the other hand, can work with any hardware. When a device is made, embedded software must have all the drivers it needs. These drivers are built for that unique hardware [103]. The software needs a lot from the CPU and the chips that were chosen. Most embedded software engineers know how to read schematics and data sheets for parts to figure out how to use registers and communication systems. It is helpful to know how to change numbers from decimal to hexadecimal or binary and how to perform bit manipulation. [7] For software development, you need a cross-compiler, which runs on a computer but creates code that can be run on the target device. An in-circuit emulator, JTAG, or SWD is needed for debugging. Many times, software developers can see the whole kernel (OS) source code.

4. Conclusion

The authors of this study talked about a smart, safe, and verified voting system for college elections that used the Arduino flat-form IoT technology. To protect and keep voters safe. To protect the method's integrity, a two-layer security strategy is put in place. We think this strategy will help schools hold fair and open elections for their student councils. The system works as promised and is efficient, but it isn't flawless. There are some problems with the system. The system can only handle three candidates at a time because it only has three. Switches for voting. We can deal with this in our next project. Also, the method makes it possible to hold the election at any moment, and there is only one post. We can make the mechanism work for elections for any number of positions. The Arduino Mega board also has limited memory, which is another thing to keep in mind. We want to use a Raspberry Pi-based board for the AVM in the future. The built-in gadgets

speed up the procedure, letting the paper be changed and the data be saved in the cloud server with automatic voting. Get the voting process going. The system is still new, therefore more work needs to be done to make it flexible and useful. It's in beta right now, but we'll show you a better, bug-free, stable, and scalable device. in the work we do in the future.

REFERENCES

[1] K. Weldemariam, R. A. Kemmerer, and A. Villafiorita, "Formal specification and analysis of an E-voting system," in 2010 International Conference on Availability, Reliability and Security, Krakow, Poland, 2010.

[2] R. Boina, "Assessing the Increasing Rate of Parkinson's Disease in the US and its Prevention Techniques"," International Journal of Biotechnology Research and Development, vol. 3, no. 1, pp. 1–18, 2022.

[3] I. Khalifa, H. Abd Al-glil, and M. M. Abbassy, "Mobile hospitalization," International Journal of Computer Applications, vol. 80, no. 13, pp. 18–23, 2013.

[4] I. Khalifa, H. Abd Al-glil, and M. M. Abbassy, "Mobile hospitalization for Kidney Transplantation," International Journal of Computer Applications, vol. 92, no. 6, pp. 25–29, 2014.

[5] M. M. Abbassy and A. Abo-Alnadr, "Rule-based emotion AI in Arabic Customer Review," International Journal of Advanced Computer Science and Applications, vol. 10, no. 9, p.12, 2019.

[6] M. M. Abbassy and W. M. Ead, "Intelligent Greenhouse Management System," 2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS), 2020.

[7] M. M. Abbassy, "Opinion mining for Arabic customer feedback using machine learning," Journal of Advanced Research in Dynamical and Control Systems, vol. 12, no. SP3, pp. 209–217, 2020.

[8] M. M. Abbassy, "The human brain signal detection of Health Information System IN EDSAC: A novel cipher text attribute based encryption with EDSAC distributed storage access control," Journal of Advanced Research in Dynamical and Control Systems, vol. 12, no. SP7, pp. 858–868, 2020.

[9] M. M. and S. Mesbah, "Effective e-government and citizens adoption in Egypt," International Journal of Computer Applications, vol. 133, no. 7, pp. 7–13, 2016.

[10] M.M.Abbassy, A.A. Mohamed "Mobile Expert System to Detect Liver Disease Kind", International Journal of Computer Applications, vol. 14, no. 5, pp. 320–324, 2016.

[11] H. AbdulKader, E. ElAbd, and W. Ead, "Protecting online social networks profiles by hiding sensitive data attributes," Procedia Computer Science, vol. 82, pp. 20–27, 2016.

[12] I. E. Fattoh, F. Kamal Alsheref, W. M. Ead, and A. M. Youssef, "Semantic sentiment classification for COVID-19 tweets using universal sentence encoder," Computational Intelligence and Neuroscience, vol. 2022, pp. 1–8, 2022.

[13] W. M. Ead, W. F. Abdel-Wahed, and H. Abdul-Kader, "Adaptive fuzzy classification-rule algorithm in detection malicious web sites from suspicious URLs," International Arab Journal of e-Technology, vol. 3, pp. 1–9, 2013.

[14] M. A. Abdelazim, M. M. Nasr, and W. M. Ead, "A survey on classification analysis for cancer genomics: Limitations and novel opportunity in the era of cancer classification and target therapies," Annals of Tropical Medicine and Public Health, vol. 23, no. 24, 2020.

[15] F. K. Alsheref, I. E. Fattoh, and W. M. Ead, "Automated prediction of employee attrition using ensemble model based on machine learning algorithms," Computational Intelligence and Neuroscience, vol. 2022, pp. 1–9, 2022.

[16] R. A. Sadek, D. M. Abd-alazeem, and M. M. Abbassy, "A new energy-efficient multi-hop routing protocol for heterogeneous wireless sensor networks," International Journal of Advanced Computer Science and Applications, vol. 12, no. 11, 2021.

[17] S. Derindere Köseoğlu, W. M. Ead, and M. M. Abbassy, "Basics of Financial Data Analytics," Financial Data Analytics, pp. 23–57, 2022.

[18] W. Ead and M. Abbassy, "Intelligent Systems of Machine Learning Approaches for developing E-services portals," EAI Endorsed Transactions on Energy Web, p. 167292, 2018.

[19] W. M. Ead and M. M. Abbassy, "A general cyber hygiene approach for financial analytical environment," Financial Data Analytics, pp. 369–384, 2022.

[20] W. M. Ead and M. M. Abbassy, "IoT based on plant diseases detection and classification," 2021 7th International Conference on Advanced Computing and Communication Systems (ICACCS), 2021.

[21] A.J. John Joseph, F.J. John Joseph, O.M. Stanislaus, and D. Das (2022). Classification methodologies in healthcare, Evolving Predictive Analytics in Healthcare: New AI techniques for real-time interventions, p 55-73. IET.

[22] F. J. J. John Joseph, "Twitter Based Outcome Predictions of 2019 Indian General Elections Using Decision Tree," in Proceedings of 2019 4th International Conference on Information Technology, 2019, no. October, pp. 50–53.

[23] F. J. John Joseph and P. Anantaprayoon, "Offline Handwritten Thai Character Recognition Using Single Tier Classifier and Local Features," in 2018 International Conference on Information Technology (InCIT), 2018, pp. 1–4.

[24] F. J. John Joseph and S. Auwatanamongkol, "A crowding multi-objective genetic algorithm for image parsing," Neural Comput. Appl., vol. 27, no. 8, pp. 2217–2227, 2016.

[25] F. J. John Joseph and S. Nonsiri, "Region-Specific Opinion Mining from Tweets in a Mixed Political Scenario," in International Conference on Intelligent and Smart Computing in Data Analytics, 2021, pp. 189–195.

[26] W. M. Ead, M. M. Abbassy, and E. El-Abd, "A general framework information loss of utility-based anonymization in Data Publishing," Turkish Journal of Computer and Mathematics Education, vol. 12, no. 5, pp. 1450–1456, 2021.

[27] A. M. El-Kady, M. M. Abbassy, H. H. Ali, and M. F. Ali, "Advancing Diabetic Foot Ulcer Detection Based On Resnet And Gan Integration," Journal of Theoretical and Applied Information Technology, vol. 102, no. 6, pp. 2258–2268, 2024.

[28] M. M. Abbassy and W. M. Ead, "Fog computing-based public e-service application in service-oriented architecture," International Journal of Cloud Computing, vol. 12, no. 2–4, pp. 163–177, 2023.

[29] D. K. Sharma and R. Tripathi, "4 Intuitionistic fuzzy trigonometric distance and similarity measure and their properties," in Soft Computing, De Gruyter, Berlin, Germany, pp. 53–66, 2020.

[30] D. K. Sharma, B. Singh, M. Anam, R. Regin, D. Athikesavan, and M. Kalyan Chakravarthi, "Applications of two separate methods to deal with a small dataset and a high risk of generalization," in 2021 2nd International Conference on Smart Electronics and Communication (ICOSEC), Trichy, India, 2021.

[31] D. K. Sharma, B. Singh, M. Anam, K. O. Villalba-Condori, A. K. Gupta, and G. K. Ali, "Slotting learning rate in deep neural networks to build stronger models," in 2021 2nd International Conference on Smart Electronics and Communication (ICOSEC), Trichy, India, 2021.

[32] K. Kaliyaperumal, A. Rahim, D. K. Sharma, R. Regin, S. Vashisht, and K. Phasinam, "Rainfall prediction using deep mining strategy for detection," in 2021 2nd International Conference on Smart Electronics and Communication (ICOSEC), Trichy, India, 2021.

[33] I. Nallathambi, R. Ramar, D. A. Pustokhin, I. V. Pustokhina, D. K. Sharma, and S. Sengan, "Prediction of influencing atmospheric conditions for explosion Avoidance in fireworks manufacturing Industry-A network approach," Environ. Pollut., vol. 304, no. 7, p. 119182, 2022.

[34] H. Sharma and D. K. Sharma, "A Study of Trend Growth Rate of Confirmed Cases, Death Cases and Recovery Cases of Covid-19 in Union Territories of India," Turkish Journal of Computer and Mathematics Education, vol. 13, no. 2, pp. 569–582, 2022.

[35] A. L. Karn et al., "Designing a Deep Learning-based financial decision support system for fintech to support corporate customer's credit extension," Malays. J. Comput. Sci., vol.36, no.s1, pp. 116–131, 2022.

[36] A. L. Karn et al., "B-lstm-Nb based composite sequence Learning model for detecting fraudulent financial activities," Malays. J. Comput. Sci., vol.32, no.s1, pp. 30–49, 2022.

[37] M. A. Yassin et al., "Advancing SDGs : Predicting Future Shifts in Saudi Arabia ' s Terrestrial Water Storage Using Multi-Step-Ahead Machine Learning Based on GRACE Data," 2024.

[38] M. A. Yassin, A. G. Usman, S. I. Abba, D. U. Ozsahin, and I. H. Aljundi, "Intelligent learning algorithms integrated with feature engineering for sustainable groundwater salinization modelling: Eastern Province of Saudi Arabia," Results Eng., vol. 20, p. 101434, 2023.

[39] S. I. Abba, A. G. Usman, and S. IŞIK, "Simulation for response surface in the HPLC optimization method development using artificial intelligence models: A data-driven approach," Chemom. Intell. Lab. Syst., vol. 201, no. April, 2020.

[40] A. G. Usman et al., "Environmental modelling of CO concentration using AI-based approach supported with filters feature extraction: A direct and inverse chemometrics-based simulation," Sustain. Chem. Environ., vol. 2, p. 100011, 2023.

[41] A. Gbadamosi et al., "New-generation machine learning models as prediction tools for modeling interfacial tension of hydrogen-brine system," Int. J. Hydrogen Energy, vol. 50, pp. 1326–1337, 2024.

[42] I. Abdulazeez, S. I. Abba, J. Usman, A. G. Usman, and I. H. Aljundi, "Recovery of Brine Resources Through Crown-Passivated Graphene, Silicene, and Boron Nitride Nanosheets Based on Machine-Learning Structural Predictions," ACS Appl. Nano Mater., 2023.

[43] B. S. Alotaibi et al., "Sustainable Green Building Awareness: A Case Study of Kano Integrated with a Representative Comparison of Saudi Arabian Green Construction," Buildings, vol. 13, no. 9, 2023.

[44] S. I. Abba et al., "Integrated Modeling of Hybrid Nanofiltration/Reverse Osmosis Desalination Plant Using Deep Learning-Based Crow Search Optimization Algorithm," Water (Switzerland), vol. 15, no. 19, 2023.

[45] S. I. Abba, J. Usman, and I. Abdulazeez, "Enhancing Li + recovery in brine mining : integrating next-gen emotional AI and explainable ML to predict adsorption energy in crown ether-based hierarchical nanomaterials," pp. 15129–15142, 2024.

[46] J. Usman, S. I. Abba, N. Baig, N. Abu-Zahra, S. W. Hasan, and I. H. Aljundi, "Design and Machine Learning Prediction of In Situ Grown PDA-Stabilized MOF (UiO-66-NH2) Membrane for Low-Pressure Separation of Emulsified Oily Wastewater," ACS Appl. Mater. Interfaces, Mar. 2024.

[47] P. P. Dwivedi and D. K. Sharma, "Application of Shannon entropy and CoCoSo methods in selection of the most appropriate engineering sustainability components," Cleaner Materials, vol. 5, no. 9, p. 100118, 2022.

[48] A. Kumar, S. Singh, K. Srivastava, A. Sharma, and D. K. Sharma, "Performance and stability enhancement of mixed dimensional bilayer inverted perovskite (BA2PbI4/MAPbI3) solar cell using drift-diffusion model," Sustain. Chem. Pharm., vol. 29, no. 10, p. 100807, 2022.

[49] A. Kumar, S. Singh, M. K. A. Mohammed, and D. K. Sharma, "Accelerated innovation in developing high-performance metal halide perovskite solar cell using machine learning," Int. J. Mod. Phys. B, vol. 37, no. 07, p.12, 2023.

[50] G. A. Ogunmola, M. E. Lourens, A. Chaudhary, V. Tripathi, F. Effendy, and D. K. Sharma, "A holistic and state of the art of understanding the linkages of smart-city healthcare technologies," in 2022 3rd International Conference on Smart Electronics and Communication (ICOSEC), Trichy, India, 2022.

[51] P. Sindhuja, A. Kousalya, N. R. R. Paul, B. Pant, P. Kumar, and D. K. Sharma, "A Novel Technique for Ensembled Learning based on Convolution Neural Network," in 2022 International Conference on Edge Computing and Applications (ICECAA), IEEE, Tamil Nadu, India, pp. 1087–1091, 2022.

[52] A. R. B. M. Saleh, S. Venkatasubramanian, N. R. R. Paul, F. I. Maulana, F. Effendy, and D. K. Sharma, "Real-time monitoring system in IoT for achieving sustainability in the agricultural field," in 2022 International Conference on Edge Computing and Applications (ICECAA), Tamil Nadu, India, 2022.

[53] Srinivasa, D. Baliga, N. Devi, D. Verma, P. P. Selvam, and D. K. Sharma, "Identifying lung nodules on MRR connected feature streams for tumor segmentation," in 2022 4th International Conference on Inventive Research in Computing Applications (ICIRCA), Tamil Nadu, India, 2022.

[54] C. Goswami, A. Das, K. I. Ogaili, V. K. Verma, V. Singh, and D. K. Sharma, "Device to device communication in 5G network using device-centric resource allocation algorithm," in 2022 4th

International Conference on Inventive Research in Computing Applications (ICIRCA), Tamil Nadu, India , 2022.

[55] M. Yuvarasu, A. Balaram, S. Chandramohan, and D. K. Sharma, “A Performance Analysis of an Enhanced Graded Precision Localization Algorithm for Wireless Sensor Networks,” Cybernetics and Systems, pp. 1–16, 2023, Press.

[56] P. P. Dwivedi and D. K. Sharma, “Evaluation and ranking of battery electric vehicles by Shannon’s entropy and TOPSIS methods,” Math. Comput. Simul., vol. 212, no.10, pp. 457–474, 2023.

[57] P. P. Dwivedi and D. K. Sharma, “Assessment of Appropriate Renewable Energy Resources for India using Entropy and WASPAS Techniques,” Renewable Energy Research and Applications, vol. 5, no. 1, pp. 51–61, 2024.

[58] P. P. Dwivedi and D. K. Sharma, “Selection of combat aircraft by using Shannon entropy and VIKOR method,” Def. Sci. J., vol. 73, no. 4, pp. 411–419, 2023.

[59] S. K. Sehrawat, "Transforming Clinical Trials: Harnessing the Power of Generative AI for Innovation and Efficiency," Transactions on Recent Developments in Health Sectors, vol. 6, no. 6, pp. 1-20, 2023.

[60] S. K. Sehrawat, "Empowering the Patient Journey: The Role of Generative AI in Healthcare," International Journal of Sustainable Development Through AI, ML and IoT, vol. 2, no. 2, pp. 1-18, 2023.

[61] S. K. Sehrawat, "The Role of Artificial Intelligence in ERP Automation: State-of-the-Art and Future Directions," Transactions on Latest Trends in Artificial Intelligence, vol. 4, no. 4, 2023.

[62] Agussalim, Rusli, A. Rasjid, M. Nur, T. Erawan, Iwan, and Zaenab, "Caffeine in student learning activities," J. Drug Alcohol Res., vol. 12, no. 9, Ashdin Publishing, 2023.

[63] T. K. Lakshmi and J. Dheeba, "Classification and Segmentation of Periodontal Cyst for Digital Dental Diagnosis Using Deep Learning," Computer Assisted Methods in Engineering and Science, vol. 30, no. 2, pp. 131-149, 2023.

[64] T. K. Lakshmi and J. Dheeba, "Digital Decision Making in Dentistry: Analysis and Prediction of Periodontitis Using Machine Learning Approach," International Journal of Next-Generation Computing, vol. 13, no. 3, 2022.

[65] T. K. Lakshmi and J. Dheeba, "Digitalization in Dental Problem Diagnosis, Prediction and Analysis: A Machine Learning Perspective of Periodontitis," International Journal of Recent Technology and Engineering, vol. 8, no. 5, pp. 67-74, 2020.

[66] T. K. Lakshmi and J. Dheeba, "Predictive Analysis of Periodontal Disease Progression Using Machine Learning: Enhancing Oral Health Assessment and Treatment Planning," International Journal of Intelligent Systems and Applications in Engineering, vol. 11, no. 10s, pp. 660–671, 2023.

[67] M. Kommineni, "Develop New Techniques for Ensuring Fairness in Artificial Intelligence and ML Models to Promote Ethical and Unbiased Decision-Making," International Journal of Innovations in Applied Sciences & Engineering, vol. 10, Special Issue, pp. 13, Aug. 2024.

[68] M. Kommineni, "Investigate Methods for Visualizing the Decision-Making Processes of a Complex AI System, Making Them More Understandable and Trustworthy in Financial Data Analysis," International Transactions in Artificial Intelligence, vol. 8, no. 8, pp. 1–21, Jan. 2024.

[69] M. Kommineni, "Study High-Performance Computing Techniques for Optimizing and Accelerating AI Algorithms Using Quantum Computing and Specialized Hardware," International Journal of Innovations in Applied Sciences & Engineering, vol. 9, no. 1, pp. 48–59, Sep. 2023.

[70] M. Kommineni, "Investigate Computational Intelligence Models Inspired by Natural Intelligence, Such as Evolutionary Algorithms and Artificial Neural Networks," Transactions on Latest Trends in Artificial Intelligence, vol. 4, no. 4, p. 30, Jun. 2023.

[71] M. Kommineni, "Investigating High-Performance Computing Techniques for Optimizing and Accelerating AI Algorithms Using Quantum Computing and Specialized Hardware," International Journal of Innovations in Scientific Engineering, vol. 16, no. 1, pp. 66–80, Nov. 2022.

[72] P. Pulivarthy, "Enhancing Data Integration in Oracle Databases: Leveraging Machine Learning for Automated Data Cleansing, Transformation, and Enrichment," International Journal of Holistic Management Perspectives, vol. 4, no. 4, pp. 1–18, Jun. 2023.

[73] P. Pulivarthy, "Enhancing Database Query Efficiency: AI-Driven NLP Integration in Oracle," Transactions on Latest Trends in Artificial Intelligence, vol. 4, no. 4, pp. 1–25, Oct. 2023.

[74] P. Pulivarthy, "Gen AI Impact on the Database Industry Innovations," International Journal of Advances in Engineering Research, vol. 28, no. 3, pp. 1–10, Sep. 2024.

[75] P. Pulivarthy, "Semiconductor Industry Innovations: Database Management in the Era of Wafer Manufacturing," FMDB Transactions on Sustainable Intelligent Networks, vol. 1, no. 1, pp. 15–26, Mar. 2024.

[76] P. Pulivarthy, "Enhancing Dynamic Behaviour in Vehicular Ad Hoc Networks through Game Theory and Machine Learning for Reliable Routing," International Journal of Machine Learning and Artificial Intelligence, vol. 4, no. 4, pp. 1–13, Dec. 2023.

[77] P. Pulivarthy, "Performance Tuning: AI Analyse Historical Performance Data, Identify Patterns, and Predict Future Resource Needs," International Journal of Innovations in Applied Sciences and Engineering, vol. 8, no. 2, pp. 139–155, Nov. 2022.

[78] A. Dixit, P. Dhanalakshmi, P. T. Rameshchandra, K. S. Chachlani, B. J. Kukreja, Ananya, et al., "Effectiveness of online vs. in-person periodontal health workshops for public awareness," J. Pharm. Bioall. Sci., vol. 16, pp. S777–S779, 2024.

[79] A. Katariya and B. J. Kukreja, "A modification of fenestration technique (MOFT) to increase vestibular depth: A case series," Indian J. Dent. Res.

[80] A. Katariya, B. J. Kukreja, and S. C. Dinda, "A microbiological study to evaluate the effect of different concentrations of coenzyme Q10 in inhibiting key pathogens of periodontitis," Eur. Chem. Bull., vol. 12, no. 10, pp. 5826–5843, 2023.

[81] A. Singh, I. Menon, V. Aggarwal, B. J. Kukreja, P. Kukreja, and R. P. Singh, "Evaluation of quality of dental care and patient's perception for treatment received in dental institution in Moradabad, Uttar Pradesh," Int. J. Oral Care Res., vol. 3, no. 3, pp. 10–40, 2016.

[82] D. Singhal, R. Mohan, K. Krishna, B. J. Kukreja, and A. Singh, "Genetics: Application in periodontal disease," TMU J. Dent., vol. 4, no. 4, pp. 143–148, 2017.

[83] G. Yadavalli, P. Singhal, N. Gupta, B. J. Kukreja, B. Gupta, P. Kukreja, R. S. Makkad, and D. Mehta, "Evaluation of immunohistochemical markers in oral squamous cell carcinoma," Bioinformation, vol. 19, no. 13, pp. 1399–1404, 2023.

[84] K. Arora, V. Dodwad, B. J. Kukreja, and S. Nagpal, "A comparative evaluation of the efficacy of glycine air polishing following scaling and root planing & scaling and root planing alone in the treatment of chronic periodontitis: A clinical study," J. Dent. Specialities, vol. 1, no. 2, pp. 47–54, 2013.

[85] K. R. Anand, P. Kukreja, S. Kumar, B. J. Kukreja, and M. Sharma, "Nonsurgical treatment of ameloblastoma—Where are we?" Clin. Dent., vol. 7, pp. 26–28, 2014.

[86] M. Gera, S. Chaudhary, A. S. Dhillon, V. Dodwad, S. Vaish, and B. J. Kukreja, "Pink in, black out—a clinical study," J. Dent. Specialities., vol. 4, no. 1, pp. 31–35, 2016.

[87] M. Kumar, M. Goyal, B. Jha, S. Tomar, and A. Kushwah, "An innovative procedure for lip lengthening in a patient with a short upper lip and high angle skeletal class II pattern: A case report," J. Indian Orthod. Soc., vol. 30, pp. 1–8, 2021.

[88] M. Ray, B. J. Kukreja, A. Katariya, et al., "Evaluation of buccal pad fat combined with demineralized freeze-dried bone allograft in treatment of Grade II furcation defects: A clinical radiographic study," World J. Dent., vol. 15, no. 6, pp. 459–467, 2024.

[89] M. S. Dua, A. Dua, B. J. Kukreja, V. Dodwad, A. S. Sethi, and P. Kukreja, "Periodontal disease and preterm low birth weight," Int. J. Oral Care Res., vol. 2, no. 6, pp. 49–55, 2014.

[90] P. Kukreja, A. F. Qahtani, M. F. Qahtani, M. F. Qahtani, and B. J. Kukreja, "Use of stem cells in tissue engineering and reconstruction of the maxillofacial region," Int. J. Res. Med. Sci., vol. 8, no. 7, pp. 2740–2745, 2020.

[91] P. Mishra, S. Jha, D. Pandey, A. Thakur, and B. J. Kukreja, "Clinical and laboratory predictors of chronic immune thrombocytopenia in children: A study of 25 cases and review of literature," Int. J. Biomed. Adv. Res., vol. 10, no. 2, p. e5104, 2019.

[92] P. Tyagi, V. Dodwad, B. J. Kukreja, and P. Kukreja, "A comparison of the efficacy of scaling and root planing with application of pomegranate chip, pomegranate gel and scaling and root planing in sufferers with adult periodontitis - a prospective study," J. Indian Soc. Periodontol., vol. 25, pp. 41–46, 2021.

[93] P. Verma, U. Gupta, V. Dodwad, B. J. Kukreja, and K. Arora, "Evaluation of the clinical efficacy of a new desensitizing toothpaste containing nano-crystalline hydroxyapatite in dentine hypersensitivity patients: A double-blind randomized controlled clinical trial," J. Dent. Specialities, vol. 1, no. 2, pp. 42–46, 2013.

[94] R. Saleem, B. J. Kukreja, M. Goyal, and M. Kumar, "Treating short upper lip with 'Unified lip repositioning' technique: Two case reports," J. Indian Soc. Periodontol., vol. 26, pp. 89–93, 2022.

[95] R. Sood, A. Gulri, U. Gupta, B. J. Kukreja, and V. Dodwad, "Efficacy of biodegradable xanthan-based chlorhexidine gel (Chlosite®) and 0.2% chlorhexidine irrigation following scaling and root planing for the treatment of chronic periodontitis," Int. J. Oral Care Res., vol. 2, no. 6, pp. 1–7, 2014.

[96] S. Bansal, P. Kukreja, S. Kumar, M. Sharma, K. R. Anand, and B. J. Kukreja, "Anaesthetic efficacy of anterior middle superior alveolar nerve block for extraction of anterior maxillary anterior teeth," J. Dent. Specialities, vol. 2, no. 2, pp. 1–4, 2014.

[97] S. Gupta, K. K. G. Rangappa, S. Rani, R. Ganesh, P. Kukreja, and B. J. Kukreja, "Periodontal and dentition status among psychiatric patients in Indore: A descriptive cross-sectional study," J. Contemp. Dent. Pract., vol. 23, no. 12, pp. 1260–1266, 2022.

[98] S. S. Kumararama, M. Patil, B. J. Kukreja, M. Salkar, S. Verma, N. Pattnaik, et al., "Efficacy of antibiotics versus probiotics as adjuncts to mechanical debridement for the treatment of peri-implant mucositis," J. Pharm. Bioall. Sci., vol. 16, pp. S3389–S3391, 2024.

[99] T. Bera, B. J. Kukreja, C. Sharma, V. V. Gupta, P. Patel, P. Singhal, et al., "Relative contribution of trabecular and cortical bone to primary implant stability: An in vitro model study," J. Pharm. Bioall. Sci., vol. 16, pp. S3427–S3429, 2024.

[100] T. Mishra, B. J. Kukreja, R. Patel, M. Ghadage, P. Dalave, S. Kumari, et al., "In vitro evaluation of titanium exfoliation during simulated surgical insertion of dental implants," J. Pharm. Bioall. Sci., vol. 16, pp. S3383–S3385, 2024.

[101] Y. M. Talib, W. N. Albalushi, M. D. Fouad, A. M. Salloum, B. J. Kukreja, H. Abdelmagyd, "Bilateral inverted and impacted mandibular third molars: A rare case report," Cureus, pp. 2–9, 2023.

[102] S. Dahiya, U. Gupta, V. Dodwad, B. J. Kukreja, and P. Dasgupta, "The enzyme activity of alkaline phosphatase in gingival crevicular fluid of smokers and non-smokers with chronic periodontitis before and after phase I therapy," J. Pharm. Biomed. Sci., vol. 32, no. 32, pp. 1348–1353, Jul. 2013.

[103] Agussalim, S. N. Fajriah, A. Adam, M. Asikin, T. Podding, and Zaenab, "Stimulant drink of the long driver lorry in Sulawesi Island, Indonesia," J. Drug Alcohol Res., vol. 13, no. 3, Ashdin Publishing, 2024.