



Design and implementation of security mechanism by user authentication for voting system based on Fernet encryption and Blockchain technique

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Abstract

In this research article, the design and implementation of security mechanism by user authentication for voting system based on Fernet encryption and Blockchain technique is presented along with the simulation results. Blockchain is a technology that has gained a lot of attention recently because it uses an immutable distributed ledger to offer security and anonymity. It serves as the foundation for bitcoin, the most well-known cryptocurrency. It is commonly used in situations where trust is given top priority because of its reliable consensus mechanism and tamper-proof data storage. The key is a unique, random string of data that is used to both encrypt and decrypt the message. Without the key, Fernet promises that a message that has been encrypted with it cannot be altered or deciphered. Data may be transferred and stored securely in cloud systems using these technologies. In this paper, we provide a method for developing a trustworthy, impenetrable, and effective voting system using Blockchain technology along with Fernet encryption method. The application voting uses several security layers and OTP to prevent unauthorized access and manipulation of votes. We have also implemented a two-factor authentication (2FA) system and a third-party audit system to ensure the integrity of the voting process. We have also made our system tamper-proof by using hashing cryptographic techniques by encrypting the votes. The system is also equipped with an automated alert system to notify the user of any suspicious activity. Finally, we have tested the system and have found it to be secure and reliable.

Keywords Blockchain, Security, Bitcoin, Fernet encryption, Privacy, two-factor authentication, integrity, hashing, cryptographic techniques.

1. Introduction

Voting systems that let people cast votes online have been the subject of extensive investigation. Blockchain is a decentralized digital ledger that records information in a secure and distributed manner. It is used to securely store and share data across multiple locations. It is immutable, meaning that once a transaction is recorded, it cannot be changed or deleted [1]. The data stored on the Blockchain is secured using cryptography, which ensures that only authorized users can access the data. Fernet encryption is a form of symmetric encryption that uses a secret key to encrypt and decrypt data. It is a more secure form of encryption than traditional methods, as it is more difficult to break. It also provides confidentiality, integrity, and authentication. The secret key is shared between two parties and is used to encrypt and decrypt data [2].

By combining Blockchain and Fernet encryption technology, the voting process will be secure and immutable. The voter will cast their vote via the Blockchain, and the vote will be encrypted using Fernet encryption. This will ensure that only the voter and the election officials will have access to the vote, and that it cannot be altered or tampered with. Furthermore, the Blockchain will provide an immutable record of the vote, ensuring that it is not altered or removed [3]. After Bitcoin, the first cryptocurrency, entered and became widely accepted in people's daily lives, Blockchain technology began to shine brightly and is now a popular idea in the modern

software industry. Before, Blockchain was primarily used for transactions, but because of its high level of transparency, several thesis and studies now argue that it can be used in a variety of other contexts. One of the significant industries that can be entirely safeguarded utilizing Blockchain technology is voting. Using the comparison of digital cash, the concept behind voting using Blockchain technology is presented [4].

We would provide each voter a wallet containing their login details, as per our suggested concept. The addition of a coin to the voter's wallet will limit their ability to cast multiple votes. The coin will be sent to the candidate's wallet after the user votes for a particular candidate. Blockchain offers numerous commercial advantages [5]. Using Blockchain can reduce transaction costs since it acts as a reliable middleman. Since the data cannot be changed once it has been added to the chain, it is immutable. However, more and more different applications are utilizing Blockchain because there are no modifications made during transactions, blocks cannot be modified, and Blockchain itself is a complete distributed record. Voting is one of these applications [6].

It is best to use Blockchain technology for electronic voting applications since they are practical, secure, and scalable. Election polling is an expensive and complicated process. Here, we describe a cutting-edge proposal for secure, cost-efficient, and privacy-preserving election polling that makes use of Blockchain storage, internet connectivity, and Fernet encryption [7]. Both of these are systems' applications, one all online application is for the election officer, while the other is for the booth manager and users who will be voting. As the administrator user, the election officer must set up the voting equipment. Booth managers are the district managers that oversee the entry of voter data into the system. They may view election results and candidate information thanks to a retrieval system that they have access to. The Votes are transformed into encrypted data on a Blockchain [8].

2. Review of Previous Work

A number of researchers have worked on the proposed topic presented in this paper. Here follows a brief review of the same in the following paragraphs. J. Deepika, S. Kalaiselvi, S. Mahalakshmi, S. Agnes Shifani, "Smart Electronic Voting System Based On Biometric Identification-Survey" [9], authors, a quick and secure biometric voting system based on RFID technology was suggested. There are two phases to the verification process in this study. First, the verification data that is already stored in LPC 2148 is verified using an RFID tag that holds that data. The RFID is then checked to see if it belongs to that specific individual or not using the fingerprint scanner. Due to the employment of RFID technology, this paper's disadvantage is cost maximization [10].

Rohan Patel, Vaibhav Ghorpade, Vinay Jain and Mansi Kambli, "Fingerprint Based e-Voting System using Aadhaar Database" [2], The proposed system is a secure online e-voting system that uses a backend UIDAI or Aadhaar-based authentication system. The system is designed to ensure that only eligible voters are able to cast their votes [11]. The system authenticates the voter using their UIDAI or Aadhaar card, and then verifies their eligibility by calculating their age. Once the voter is authenticated and their eligibility is verified, the voter is allowed to cast their vote. The system also provides a secure voting environment by encrypting the votes and storing them in an immutable distributed ledger [12].

The system also ensures that the votes are accurately counted and securely stored. Overall, the proposed system is an innovative and secure way to conduct online e-voting. It eliminates the need for pick cards and ensures that only eligible voters can cast their votes. It also provides a secure voting environment and ensures the accuracy of the votes [13]. To make electronic voting a reality in India, planned associate integration of the CIDR is required. This project uses a client-server web-enabled software architecture. A user interface collects Aadhaar numbers from voters, offers a voting partner interface, and displays confirmation, result, and problem information. For this strategy to work, high-speed web connectivity is required. Although a computer is necessary to operate this software, we cannot guarantee that everyone has computer handling skills. Voters may thus fall prey to social engineering [14].

B.Mary Havilah Haque, G.M.Owais Ahmed, D.Sukruthi, K.Venu Gopal Achary, C.Mahendra Naidu, "Fingerprint and RFID Based Electronic Voting System Linked with AADHAAR for Rigging Free Elections" [3], The usage of the Aadhaar Card's fingerprint or iris data for the voting system has been explored by the author in this paper. The benefit of this initiative is that if a drunk individual enters a voting place, a buzzer will warn a designated person or a policeman who is on election duty [15]. The proposed system is a secure online e-

voting system that uses a backend UIDAI or Aadhaar-based authentication system. The system is designed to ensure that only eligible voters are able to cast their votes. The system authenticates the voter using their UIDAI or Aadhaar card, and then verifies their eligibility by calculating their age. Once the voter is authenticated and their eligibility is verified, the voter is allowed to cast their vote [16].

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Y.Takabatake, D.Kotani, and Y.Okabe, "An anonymous distributed electronic voting system using Zerocoin" [4], The technique was tested by a simulated experiment. The results of the experiment showed that the proposed technique had a high accuracy rate of more than 95%, and that it was able to protect the privacy of the voter [19]. The proposed technique is also well-suited to large-scale voting systems, as it can be easily integrated into existing Blockchain networks. The technique can also be used for other types of elections and voting systems, such as local and national elections. The paper also discusses potential issues and limitations of the proposed technique, such as scalability, cost, and security [20].

Overall, the paper provides a reliable and secure Blockchain-based voting technique that can be integrated into existing networks and used for various types of elections and voting systems. The intermediate unit gathers the coins (votes) that the voters have submitted and uses the currency's wallet to change them into another currency. Consequently, the intermediary units transmit fresh coins to the candidates [21]. It is excellent in every way and highly educational. However, it does not go into detail or address the implementation-related issues. Work on implementation is what we prioritize. We want to provide a remedy for elections in our beloved nation. We'll make sure it functions so that the election commission can simply set up elections when necessary and that everyone can cast a vote and keep track of it [22].

X. Sun, Q. Wang, P. Kulicki, and M. Sopek, "A simple voting protocol on quantum Blockchain" [5], A voting mechanism based on quantum Blockchain has been suggested by the authors. This protocol meets fundamental security criteria including anonymity, bindingness, non-reusability, verification, eligibility, fairness, and self-tallying. They also employed additional quantum methods, such as quantum key distribution, quantum bit commitment, and quantum secure communication, in addition to the quantum Blockchain (QKD). Its primary drawback is that it lacks auditability and uniformity [23].

3. Related works

On election day, we should be able to use a voting system to cast our votes, store them securely, and have them counted. In Electronic voting devices that store the results which are utilized in traditional EVS, there is no internet connection. The booth manager must manually read the results from each EVM and add them in order to get the overall number of votes cast for the candidate. Computers that are networked will be employed in certain other systems. It might be the internet or a local network [24]. Data should be transferred carefully throughout the network to prevent vote tampering. Before sending Data across a network, it must first be encrypted using secure methods. The format in which data must be conveyed, how it must be stored, and other requirements should be regulated by regulatory agencies. All rules established by the regulatory body must be followed by the electronic voting system. Most of the current research focuses on security, accuracy, respectability, speed, protection, and review capacity; nevertheless, the frameworks in place are somewhat defenceless against attacks [25].

4. Proposed System

The system used for polling during elections is costly and complex. Here, we present an innovative approach for election polling that makes use of web technologies with GPRS connection, cloud data storage, and Fernet encryption to be cost-effective, safe, and privacy-preserving. Two different user categories participate in the elections under the proposed system. Election officers and booth managers are one and the same. Voter

functionality was built into the booth manager system where voters will cast their votes [26]. The election officer must configure the election polling setup as they will act as the admin user. The area managers who supervise entering voter data into the system are known as booth managers. They have access to a retrieval system that enables them to see voting results and candidate information. Voters must visit the booth where the booth manager will verify their identity and let them cast their votes on the laptop that houses our voting machine [27].

5. Benefits of the Proposed System

- A decentralized design.
- An open system for casting votes.
- Vote manipulation is virtually unheard of.
- Votes are accurately and securely kept in a transparent manner in the cloud.

6. Structure of the System

The recommended architecture consists of three parts namely, viz. [28],

- Officer of Election
- The voting process
- The booth manager

The election officer adds each candidate, assigns booth managers, and examines the results after each vote. The booth manager will look over the voter's identification and voting assistance. The candidate that the voter chooses will receive their vote [29].

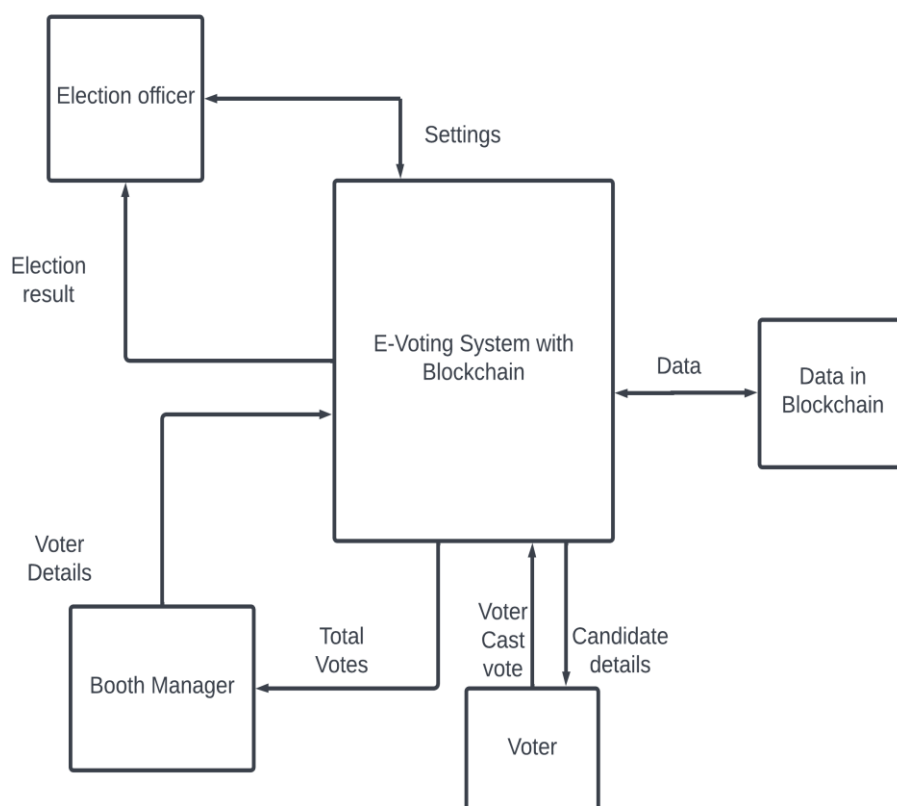


Fig. 1: Overview of the blockchain-based electronic voting system design

7. FERNET (SYMMETRIC) ENCRYPTION

Fernet works by generating a key which is then used to encrypt and decrypt messages, and a message authentication code (MAC) which is used to ensure the authenticity of the message. It is an open source project. Fernet avoids a lot of the issues and pitfalls that a naive developer could encounter while creating such a system by [30]

- Using strong encryption algorithms: Fernet uses the AES-128-CBC and HMAC-SHA256 algorithms to make sure that data is encrypted securely and cannot be decrypted without the correct key.
- Using a complex key structure: Fernet generates a symmetric key which is composed of several different components. This makes it difficult for an attacker to guess the key and decrypt the data.
- Using a secure key storage system: Fernet stores the key in an encrypted format, making it difficult to access even if an attacker gains access to the system.
- Using a secure message authentication code: In addition to the strong encryption algorithms, Fernet also uses a message authentication code (MAC) to ensure that the message has not been altered during transit. This prevents an attacker from being able to manipulate the data without being detected.

8. Creation of Key

```
from cryptography.fernet
import Fernet
import base64
```

```
key = Fernet.generate_key()
```

Every time you use the generate_key method, a new random value will be used as the key.

Encryption of the Message

Prior to encrypting a message, we must first create a Fernet object using the previously generated key. The data we intend to encrypt is then passed to the encrypt method in the form of a byte array.

```
cipher = Fernet(key)
```

```
message = "qwerty".encode('utf-8')
```

```
token = cipher.encrypt(message)
```

Our message string will be transformed into a bytes array using the encode("uft-8") technique. A byte array must be loaded into memory before any image or other data can be encrypted. A token holds the encrypted communication [31].

9. Decryption of the Message

The same key that was used to encrypt the data must be used to build a Fernet object once more in order to decode a message. Then, we call the decrypt method and feed it a byte array containing the data we want to decrypt. The function returns the original, unencrypted message [32].

```
cipher = Fernet(key)
```

```
decoded = cipher.decrypt(token)
```

Results & Discussions

The figures 2 below shows the login web page of election officer whose authentication is done by user name and password of election officer. Upon successful login of authorized officer, officer menu page is as show in figure 3 below.

Figure 2: Officer Login page

Figure 3: Officer Menu page

The complete working of election officer and duties are discussed as below:

Registering a voter: This refers to the process of enrolling eligible individuals as voters. Election officers are responsible for verifying the eligibility of potential voters, collecting necessary information, and ensuring their inclusion in the voter registry. Figure 4 below shows the page of voter registration form.

Figure 4: Voter Registration form

Registering a candidate: Election officers also play a crucial role in the candidate registration process. They collect the required documents and information from individuals aspiring to run for office, ensuring that they meet the eligibility criteria set forth by the election laws. Figure 5 below shows the page of candidate registration form.

Field	Value
First Name	meisha
Last Name	iyer
Date of Birth	1/1/01
Address	Bangalore
Email ID	meisha@gmail.com
Contact No.	888899999
Pincode	560074
Party	BJP

Figure 5: Candidate Registration form

After successful registration, voter can cast his valuable vote by selecting searching his area with the help of pin code in the voting window page. First level of authentication is done checking his username and password, Second level of authentication is done with the process of verifying OTP sent to voters registered email id. Upon successful authentication of voter by two-factor authentication, voter can cast his vote and the same can be seen in the figure 6 below. After entering the OTP by authentic user, this voter can cast his vote and his vote will then enter into blockchain for security and cannot be altered or changed by any intruder. This process can be seen in the figure 7 below.

CANDIDATE NAME	PARTY
meisha iyer	BJP
priyamvada kant	CONGRESS
jinal sharma	JDS

Figure 6: Voting window to cast vote & OTP input page

CANDIDATE NAME	PARTY
meisha iyer	BJP
priyamvada kant	CONGRESS
jinal sharma	JDS

Enter Voter ID: 22222
Select DOB: 1/1/2001
VOTE NOW
BACK

Info: Vote Added in Blockchain!
OK

Figure 7: Voting window for casting vote

Registering a Booth manager: The role of a booth manager involves overseeing the operations and activities at a polling booth during an election. Election officers may be responsible for appointing and coordinating booth managers to ensure smooth functioning, including managing queues, verifying voter identities, and addressing any issues that arise on the day of the election. Figure 8 shows the page of booth manager registration form.

BOOTH MANAGER REGISTRATION FORM

Full Name
Date of Birth
Address
Email ID
Contact No.
Pincode
User Name
Password

Register Clear
Back

showinfo: Booth Manager registered successfully!
OK

Figure 8: Booth manager registration form.

Counting votes: After the voting process concludes, election officers are responsible for counting the votes cast. This involves organizing and tallying the ballots to determine the results of the election accurately. The counting process may take place at a designated counting centre, and election officers typically follow specific protocols and guidelines to maintain transparency and integrity during this stage. Figure 9 below shows the booth manager menu for the process of opening voting window and count total votes. Figure 10 shows the page of total votes casted and winning party in elections of a constituency.



Figure 9: Booth manager menu

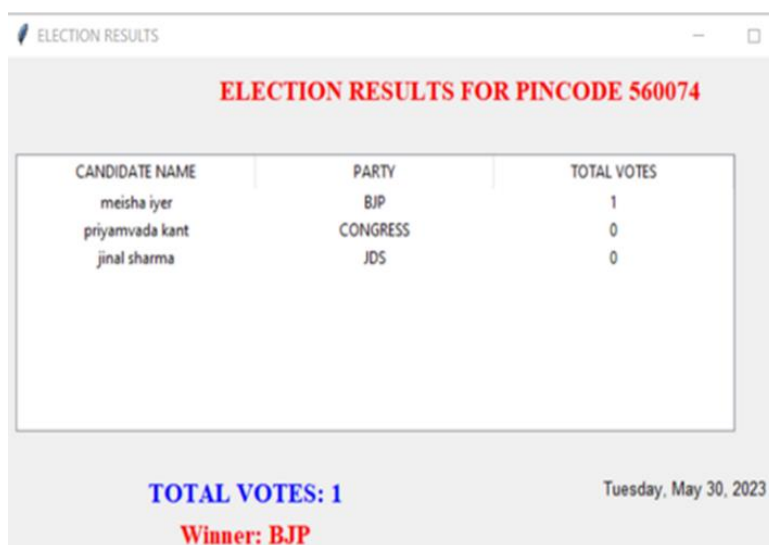


Figure 10: Elections results for constituency

10. Conclusion & Future Scope

Many applications where security and transparency are crucial are favored by blockchain technology. However, voting has not largely adopted it. As stated in our application, we can develop a reliable electronic voting system that will revolutionize how elections are conducted in the future if we combine Fernet encryption and blockchain technology. Not only will it protect the data, but it will also increase voting process openness. Election costs will be lower as well because it does not require any upkeep from a centralized body. Additionally, it will boost voter turnout, maintaining the democratic ideals of democracy. When data is kept in the cloud, fernet encryption will help to further improve the integrity of the data. Additional features could be incorporated to this system and to this software to make it even better.

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Mr. Sandeep K.V. born on 3rd September 1987, received his B.E. in Telecommunication Engineering from SJC Institute of Technology, VTU, Belagavi in the year 2009, M.Tech. in Computer Applications In Industrial Drives from National Institute of Engineering, Mysore, VTU, Belagavi in the year 2012 and currently pursuing Ph.D. degree in part-time category from VTU, Belagavi at the VTU Research Centre of ECE Dept. of Dayananda Sagar College of Engineering, Bangalore. He is currently working as Assistant Professor in the Department of Electronics and Telecommunication Engineering at Dayananda Sagar College of Engineering, Bengaluru, India, since 10 years. His research interests include Security in Internet of Things, Blockchain, Communication and Networks, wireless networks, applications on IoT etc. He has arranged 10+ seminars and Invited Talks at DSCE, Bangalore, attended 50+ workshops, FDPs and webinars. He has also published 30+ papers at various National, International Conferences & Journals. Guided and guiding 25+ UG and PG projects. He is having an overall experience of 11+ years in teaching and research.



Dr. T.C. Manjunath was born in Bangalore, Karnataka, India on Monday, the 6th of Feb. 1967 & received the B.E. Degree (Bachelor of Engg.) from the Karnataka's No. 1 Engg. College - R.V. College of Engg (Bangalore Univ., Karnataka, India) in the year 1989 in First Class, M.E (Master of Engg) degree in Automation, Control & Robotics from the prestigious 75-year-old Govt.'s LD College of Engg, (Gujarat Univ, Ahmedabad) in the year 1992 with First Rank (FCD) for the entire university and Ph.D. in Systems & Control Engineering from the prestigious Indian Institute of Technology Bombay (IIT Bombay) in the year 2007 respectively and worked on the advanced vibration control strategies for smart intelligent structures which were used in the aerospace engineering with practical implementations, leading to 30 publications in IITB during his Ph.D. tenure along with the best research scholar award for the entire IIT Bombay.

He has got a teaching (academic), research & administrative experience of more than 34+ years in various engineering colleges all over the country (Karnataka, Gujarat, Maharashtra) and spent his entire career after graduation in the field of academics, research & administration only. He has worked in the levels of Lecturer-Asst. Prof (>18+ yrs), PG Coordinator, Prof-i/c HOD-Prof. & Head (>7+ yrs), Director-Research, i/c Principal & as Full time Principal (9 yrs approx) in various institutions where he has worked so far across the country. Currently, he is working as Professor & Head of the Dept. of Electronics & Communication Engg of the renowned 44 year-old Dayananda Sagar Group's 'Dayananda Sagar College of Engineering' in Bengaluru, Karnataka, India since more than 6+ years, which is an autonomous institution affiliated to VTU. He has also worked as a Project Assistant and as a Research Engineer in the Systems and Control Engineering of IIT Bombay and worked on vibration control of space launch vehicles in IITB during his research tenure for a period of nearly one year, a funded project from ISRO under the guidance of his supervisor.

He has published more than **1000+** papers in various National, International Journals and Conferences in India & abroad (with 100+ Scopus Q-Series SCI WOS IEEE Springer, Wiely, Elsevier, etc...) and published more than a dozen textbooks (20 nos) with editions, notable among them being ('Introduction to Robotics' - 1st

edition, 'Fast Track to Robotics' - 4th Edn., 'Fundamentals of Robotics' in 2 volumes, Vol-1 and Vol-2 along with a CD which contains about 200 C / C++ programs for performing various simulations on robotics – 5th edition, 'Examination Security System - Design & Development of Examination Mechanism Using Electronic Box' from Germany costing around 49 Euros, 'Microcontroller & Applications Theory', 'Basic Electronics', 'Computer Communication Networks', 'Optical Communication & Networking', 'Emerging Trends in Engg. & Tech.', 'Recent Advances in Engg. & Tech.', 'Recent Developments in Computing, Electronics and Mechanical Sciences', 'Contemporary Research in Electronics, Computing and Mechanical Sciences', 'Recent Developments in Engg. & Tech.', 'Signals & Systems', 'Playing Smart – Artificial Intelligence, Deep learning and its techniques, Computer Vision and Techniques, Image Processing and Machine Vision, Digital Signal Processing, Computational Intelligence, Electronic Devices & Circuits for Computer Engineers, Basic Electrical & Electronics Engineering & still many books are under the pipeline in press.

He has also published a number of 'book chapters' in various edited books from renowned publishers (30+ nos). He has also published a research monograph in the International level from the Springer-Verlag publishers (Europe) based on his Ph.D. thesis topic titled, "Modeling, Control & Implementation of Smart Structures", Vol. 350, LNCIS, costing €114.39 Euros.

He is a member of 30 professional societies across the world. Some of them are a member of IEEE for the past 22 years (currently Sr. Member of IEEE), Sr. member of IIEM, SPIE student member (USA) and IOP (USA) student member for 4 years, life member of ISSS-IISc (India), life member of additive manufacturing society of India (LMAMSI), life member of the ISTE (India), life member of ISOI (India), life member of SSI (India), life member of the CSI (India), Life member of IMAPS, Sr. Member of IACST (Singapore) and life member cum fellow of the IETE (India), AMSI, Life member of IAENG, Life member of Inspira Research Association, Chartered Engineer from IE (I) and a Fellow of the Institution of Engineers (FIE), Member of ACDOS - Automatic Control & Dynamic Optimization Society, Member of ACCS-Advanced Computing & Communications Society. He was also an EC & GC member of the IETE (Bangalore) for 2 years.

He has given (delivered) a number of guest lectures / invited talks / expert talks and seminars in many institutions across the length & breadth of the country (>50 times) and participated (attended) in more than 200 CEP / DEP courses, seminars, workshops, symposiums (with certificates), besides conducting >300+ courses, i.e., workshops, FDP's conference, symposiums, SDP's in the institutions where he worked. He was awarded with the "Best research scholar award in engineering discipline" for the academic year 2006-07 for the entire institute from the Research Scholars Forum (RSF) from Indian Institute of Technology Bombay IITB. This award was presented in recognition of the significant contribution to the research (amongst all the researchers in all disciplines) in IIT Bombay, where he published 30 research papers (all of them were free & refereed ; 1-monograph from springer, 14 Journals-all refereed & free journals-abroad, 15 conferences). He is also a Sr. Typing (First Class with Distinction) specialist from the commerce institutes association of karnataka and a United Nations certified candidate along with 82nd position in the tenth standard merit list all over Karnataka. He is also an Hindi-Rastrabhasha (DBHPS) holder.

Also, he was conferred with the best paper awards (20 times) in a number of national & international conferences. He was also conferred with the prestigious Rajiv Gandhi Education Excellence Award, Global Education Achiever of India award, Rashtriya Vidya Gaurav Gold Medal Award & International educational excellence award (in recognition of sterling merit excellence performance and outstanding contribution for the progress of the nation & world-wide) from New Delhi in the year 2013, Global Outreach Research Award Recipients-2019 for his life time achievements in research (life time achievement award-2020) from ESNA & Global Outreach Foundation, all the previously mentioned awards was awarded w.r.t. his achievements in the field of education, overall life time performance, academics, administration & research.

He was also instrumental in getting a no. of Research centres (along with M.Tech. programmes & new UG programmes in the engineering colleges where he has worked so far as the administrative head, i.e., as principal. He was also responsible for getting AICTE grants under MODROB scheme for the development of the Robotics & Mechatronics Labs in one of the colleges where he worked. Apart from which, he has brought a number of grant-in-aid for the conduction of various events like workshops, conferences, seminars, projects, events, etc., wherever he has worked [from VTU, DST, IETE, CSI, IEEE, IE(I), DRDO, ISRO, VGST, KSCST, Vodafone, Uninor, etc.] from different sources. In the current college where is working as Prof. & Head, 70+ research scholars were pursuing Ph.D. in ECE Dept. VTU R & D centre and 22 of them have already completed.

He has visited Singapore, USSR-Russia, United States of America and Australia for the presentation of his research papers in the various reputed international conferences abroad. His biography was published in the 23rd edition of Marquis's Who's Who in the World in the 2006 issue. He has also guided more than 100+ projects (B.E. / B.Tech. / M.E. / M.Tech.) in various engineering colleges where he has worked, apart from guiding a couple of research scholars who are doing Ph.D. in various universities under his guidance (9 Ph.D's have already come out from VTU & 6 more are pursuing). Majority of the B.E. & M.Tech. works what he has guided were converted into research papers. Many of his guided projects, interviews, achievements, the events what he had conducted so far till date have appeared in various state & national level newspapers and magazines (more than 300 times). He has also reviewed many research papers for the various national & international journals & conferences in India & abroad (more than 200 times). He has more than 100+ scopus indexed, web of science, IEEE, Elsevier papers along with more than 25,000+ citations in the google scholar portal with more than 50 in h-index & more than 500 in i-10 index. He was also associated with NBA, NIRF works & ISO works in the DSCE w.r.t. his department and a number of other types of survey activities from reputed organizations.

He has also organized a number of state & national level sports tournaments like yogasana, chess, cricket, volleyball, etc. where he had worked as a employee. He is also an (50+) editorial board / advisory board / reviewer member and is on the panel of many of the national & international Journals as editor, reviewer, committee member etc... He has also served on the advisory / steering / organizing committee member of a number of national & international conferences in the country & abroad. He has given many keynote / invited talks / plenary lecturers in various national & international conferences and chaired many sessions, was judge, special invitee, guest of honor & was chief guest on various occasions.

He has also conducted / organized / convened / coordinated more than 300+ courses / Workshops / Training Programmes / Hands on workshops / Symposiums / STTP's / FDP's / Technical paper fests, Student level competitions, etc., in various engineering colleges where he worked so far. Till date he has given more than 1 dozen webinars on hot topics to various organizations in the world. He has also taken many administrative initiatives in the college where he has worked as HOD, Principal, PG Coordinator, Research Director & also where he is currently working as Prof. & Head in ECE Dept of DSCE, besides conducting all the semester university exams successfully as chief superintendent, deputy chief superintendent, squad member, BOE & BOS Chairman, etc. Some of the special administrative achievements as Faculty, HOD, Principal & Head of the Institution are

He improved the results of the various branches in Atria Inst. of Tech. / BTL Inst. of Tech. / HKBK College of Engg. / Dr. Ambedkar Inst. of Tech. / Nandi Inst. of Tech. & Mgmt. Sciences, where he was working as the principal. He gave more importance to the development of the in-house projects for the final year students & initiated the Project Open-Day, where all the final year students used to exhibit their project works on a single platform. He has also motivated many of the faculties to take up consultancy works & did it efficiently, so that the college got some good income (revenue generation scheme), besides sending large no. of students towards the internships (1000+) in various industries. He made the faculties to take up research (Ph.D) work or do M.Tech. by compelling them constantly to pursue for higher studies as a part of the career enhancement project.

As an administrative head, he made the faculties to publish paper in either national / international journals & conferences at least one or two in an academic year. He started the student chapters (professional societies) in all the branches such as IETE, IEEE, ISTE, IEI, CSI, SAE, ISOI & also conducted a number of events under their banners, which were very much useful to the students & staff members. He brought in power decentralization by developing the habit of making coordinator-ships for various works, getting the work done by monitoring and following it up successively. He was also involved in TEQIP-2 & 3 process in Dr. AIT along with the development of many of the autonomy and world bank works & brought crores of rupees as TEQIP grants while he was the Principal in Dr. AIT.

He was also a BOS member & BOE member in the some of the university panels. He conducted a number of exams from the public sectors & private sectors such as GATE exams, CET / COMED-K, KPSC, TCS, Police Exams, Inst. of Civil Engineer exams & conducted a number of state & national level examinations like Defense, PG entrance exams, Medical, KPTL in the college where he had worked as administrative head, so that the college could get some revenue (under the banner of revenue generation scheme). He started the weekly

monitoring of the staff & students by making the proctoring or the mentoring process very strong. He developed the counseling of student data booklets & that of the faculty work-diary, besides the monthly newsletter & the research bulletin (samshodhana saara) in all the places where he has worked.

All the laboratory manuals were developed in-house, printed & given to the students (both in the hard as well as in the soft copy). All the laboratory experiments were videographed individually & given to the students and put on the departmental portal also. The notes of the different subjects were put in the moodle server of the departmental portal so that the students could use it for their study purposes. He used to conduct the academic & governing council meetings regularly along with the HOD's meetings & staff meetings time to time. He had looked after the NBA process (6 times) in Fr. CRCE, Atria IT, HKBKCE, BTLITM, Dr. AIT & in DSCE and got NBA in all the colleges mentioned previously. He has also looked after the NBA NAAC process in DSCE and was the NAAC coordinator for couple of criterias. He conducted the prestigious 7th IETE ICONRFW & the 28th Karnataka State CSI Student Convention in HKBKCE when working as a Principal. He introduced the scheme of best lecturer award / best HOD award / best non-teaching award / service awards concept / Principal cup / Departmental cup, etc. in the colleges where he worked as administrative head in few colleges for the various staff members. He also conducted a number of national & international conferences in the colleges where he worked such as the NCECON-14, NCECON-19, SIETCON-17 & 18, ICRTEMP-20.

He created a record placement of more than 3000 students in Atria Inst. of Tech. / HKBKCE / BTLIT / Dr. AIT / NITMS / DSCE with the help of the college placement department & with the help of placement coordinators of the department and institution when he was worked as the Principal & currently where he is working as the Head of the Department. He helped the management to fill up many of the student admissions in the first year of UG (B.E.) & in PG (M.Tech.) course by doing extensive marketing from different angles and sources. He created a number of hobby-clubs, start-up, e-club, EDC cells, Innovation & Incubation centres, centre of excellences in the institute for the staffs & students to work towards development of prototypes, models, and projects. He started the faculty seminar series in the institute so that every faculty gives a lecture of 45 mins with 15 mins discussion at least once in a month in many colleges. Many of the subjects were treated with project-based learning concepts in the autonomous colleges. He introduced many new subjects in the autonomous colleges such as 5G Communications, AI, ML, DL, AI & Robotics, etc. to enrich the curriculum with current technology subjects.

He introduced the concept of coaching class/tutorial classes for weak students & remedial class concept for failed students, slow learners, which yielded successful results apart from the training of top 10 students for getting ranks. He made students to get university ranks in BTL & HKBKCE in the UG & in PG streams when he was working as Principal. He started the On-line courses, Certificate oriented courses of 1/2/3 months & 6 months for various types of people, especially on weekends when he was the Principal. He made students to participate in competitions outside the college & win a number of prizes, brought laurels to the institution (brought awards, prizes & certificates from the students more than 50 times). He helped the students to get some financial assistance using sponsors for conducting the cultural events & other activities such as the workshops, FDPs & Conferences. He was on the panel of Local Inspection Committee (LIC) member of inspecting various engineering colleges of VTU a number of times & he is also a registered & recognized research supervisor in the Visvesvaraya Technological University & went as expert panel member for conduction of research interviews in couple of universities, faculty selection panel member for appointment purposes, etc...

He brought a project grant of nearly Rs. 4 crores till date in the various organizations where he has worked so far with help of faculties under various funded projects scheme such as DST, ISRO, KSCST, VTU, IET, DRDO, TEQIP, VGST, AICTE, MHRD, etc.... along with a number of research proposals being submitted to various organizations. He developed the Innovation & Entrepreneurship Development Cell in HKBKCE & did a number of programs under its belt. He was responsible for some of the UG students of HKBKCE to make them establish a start-up company in the college itself by name 'pentaP systems Inc'. He also developed a number of hobby clubs in the departments such as the 'e-club' robotics club, nano-club, micro-club, which was used to conduct a large number of activities w.r.t. technical & non-technical problems. He made 20 MOU's with reputed firms & sectors with the college and utilized all the advantages of the signed MOUs with the companies, used the MOU banner to get projects, conduct seminars, conferences, workshops & FDPs in the various colleges where he worked & currently working.

He streamlined many of the process in the office level & that of the departmental level by developing new & newer formats for the smooth conduction of various processes along with excellent documentation. He underwent the one-week NUS-Leadership training programme in Singapore @ National University of Singapore-NUS, sponsored by TEQIP-II SPFU MHRD GOK DTE & Govt. of India in the year Sept. 2015 when he was the Principal of the Govt. Aided Dr. Ambedkar Inst. of Tech in Bangalore. He developed the culture of making up of small / mini hobby projects by the students along with the development of a number of alternate assessment tools, i.e., the AATs. He developed the systematic documentation of entire departments & that of the college as HOD & Principal. He also on many occasions made the students to work upon the project-based learning, i.e., whatever is taught in the theory, the same is carried out in practicals in few subjects. He conducted a no. of AATs such as Surprise Test, Seminar, Quiz, Role Play, Group Discussion, Case Study, E-Course Certification, Mini Projects, Developing Products, Building, Models, Paper Presentation, Poster Publication, Programming Contest, General Science & Technical Quiz, Hackathons, Demonstrations, Analysis, Optimization & comparison of theoretical concepts using modern tools.

He has got 160+ Patents from the Govt. of India & the Australian Govt, out of which few of them were granted & the rest published with the remaining in the process of getting granted, filed & published. He also has got very good experience in the autonomous curriculum of the VTU course in the context of make up exams, fast track exams, supplementary exam and also got good ideas about BOS/BOE/COE, CIE, SEE, Curriculum Design, etc... as he has worked for more than 6 years in the autonomous colleges. Under industry-institute interaction, he conducted a number of industry-oriented courses like CADD course, ANSYS course, PCB Designing course, Quadcopter course, IOT Course, Oracle course, Infosys campus connect courses (18 batches rolled out in HKBKCE), Software testing, etc.

His special areas of interest are - Control systems, DSP, AI, ML, DL, Swarm Intelligence, Research Methodology, Cognitive Sciences, IP, PE, Robotics, Signals & systems, Smart Intelligent Structures, Basic Electrical Engg., Basic Electronics, Network Analysis, Vibration control, Communication Theory, Instrumentation, IoT, Power Electronics, WSNs, Circuits & Networks, Matlab, etc...