E-Voting Authentication based on Tactile Internet and Blockchain Technology

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ABSTRACT
E-voting requires entrance of large numbers of citizens simultaneously in a relatively small time. This may cause slowness or unavailability of the service in the worst case. Authentication of large-scale e-voting is still an issue that needs more security and privacy. Moreover, there are many developments in the internet culminating to internet-of-things and anticipating reaching to Tactile Internet with fifth generation (5G) mobile networks. However, implementing e-voting according to this new technology imposes many challenges. This paper presents a proposed authentication architecture that assumes the existence of Tactile Internet as a futuristic infrastructure and the blockchain as a solution for maintaining security. The proposed architecture technically provides two modes of operation: mobile phone and virtual reality (VR) lenses. The gained results of e-voting authorization are proved to be applicable with higher accuracy.

General Terms
Blockchain, E-voting

Keywords
Blockchain, E-voting, Tactile Internet

1. INTRODUCTION
Many countries are seeking to achieve transparency by one hundred per cent in electronic voting, in light of the evolution in communication technologies. Securing e-voting is still a big issue that requires more considerations.

The process of e-voting requires entrance of large numbers of citizens in a relatively small time. This may cause slowness or unavailability of the service in the worst case. Denial of service is a nightmare from security point of view.

This paper presents, in section 3, an architecture that blends Tactile Internet with blockchain. Tactile Internet is concerned with communication, while blockchain is concerned with managing voting results. These technologies are overviewed in section 2. Finally, the paper conclusion and future directions are in the last section.

2. LITERATURE OVERVIEW

2.1 Tactile Internet
The fifth generation (5G) mobile networks corroborate the promised Tactile Internet (TI)[1]. TI is guaranteed at data transfer with 1-millisecond latency [2]. This 1 ms latency condition can be attained by changes in the infra-structure such as software defined networking (SDN) [3] that employs a centralized controller with system's global knowledge. TI may be considered as an evolution of Internet-of-Things with a focus on latency of communication [4-5]. TI has many applications and challenges as summarized in Ref. [6]. The key challenge lurks in the fact that physical transmission should have very tiny packets.

2.2 Blockchain
The inception of bitcoin heralds a new era of blockchain [7]. This nascent technology contributes an information revolution [8] with applicability in many areas [9]. Blockchain is a software architecture in which transactions have 3 characteristics [10]:

1. Recorded in a distributed ledger
2. Permanence and non-edit-ability.
3. Verifiability.

Blockchain is used in security for integrity-preserving services. For a couple examples refer to [11-12]. A private blockchain need not to follow standard protocols [13].

3. PROPOSED METHODOLOGY
Figure 1 shows the proposed architecture, in which there are two modes of operation, either with the mobile phone or virtual reality (VR) lenses. Both should be equipped with capturing device to capture fingerprint or iris respectively. Then the e-voting is carried out and stored in blockchain wallet. The rest of this section elaborates on these steps.

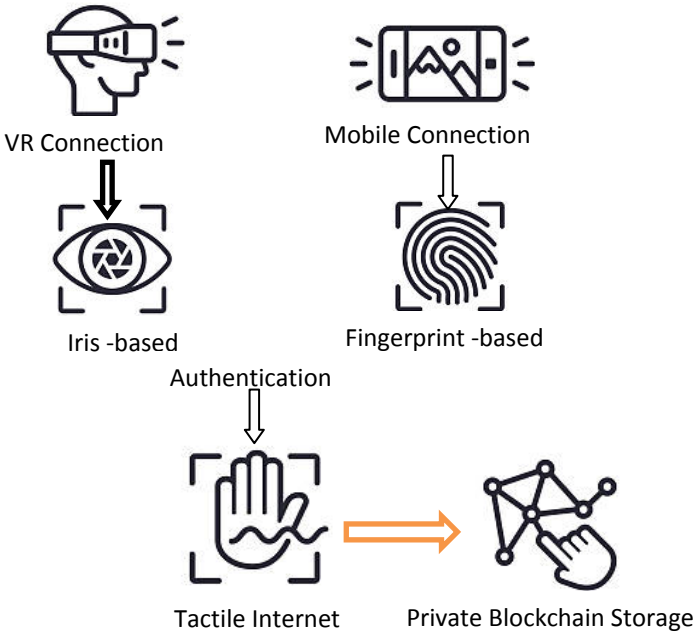

Fig 1: Proposed methodology

3.1 Authentication

Authentication is based on three phases, namely pre-processing, features extraction, and Artificial Neural Network as depicted in Figure 2. First, image is captured. Then it undergoes de-noising based on histogram equalization. Then feature extracted based on Gabor filter. It is mostly used for feature extraction the same as Fourier transform. Finally, classification is carried out using Artificial Neural Network (ANN) which mimics the capability of the human brain learning.

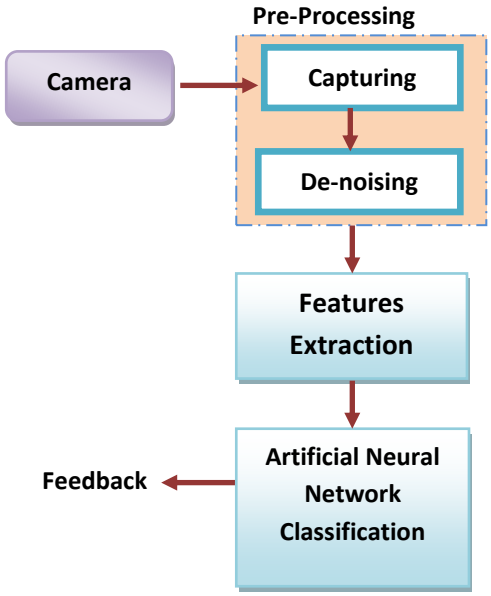

Fig 2: Authentication Process

Firstly, the fingerprint undergoes histogram equalization for sake of contrast enhancement, as shown in Figure 3.

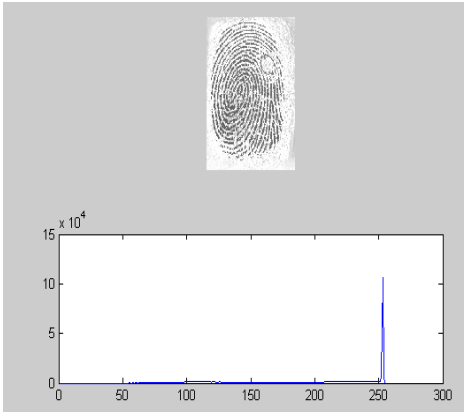

Fig 3: Histogram equalization for contrast enhancement

LearningSecondly, Gabor filter[14] is employed(Figure 4), It is defined as:

$$g(x,y)=\left(\frac{1}{2\pi\sigma_x\sigma_y}\right)\exp\left[-\frac{1}{2}\left(\frac{x^2}{\sigma_x^2}+\frac{y^2}{\sigma_y^2}\right)+2\pi jWx\right] \quad (1)$$

where σ_x and σ_y are the scaling factors of the filter in the (x) and (y) dimensions, and W is central frequency.

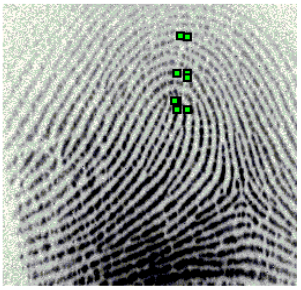

Fig 4:Feature Extraction based on Gabor filter

Thirdly, fingerprint undergoes ANN classification with

topology as in Table 1, and parameters as in Table 2.

Table 1. Artificial Neural network topology

Architecture	feedforward backprobagation
# Input Neurons	900 (30 × 30 core pixel area)
#Hidden Neuron	10 by guesswork
# Output Neurons	number of classes (10 persons)

Table 2. Artificial Neural network Parameters

Training Method	log-sigmoid
Activation Function	gradient decent
Error Rate Measure	sum of squared error

Stopping Criteria can be either that error reaches 0.001; or maximum epochs reach 5000.

3.2 Blockchain Implementation

A good start for blockchain implementation in Matlab, you can access a demo that is publicly available[1]. However, the author of the paper in hand has a tendency to build another prototypical e-voting local blockchain in Microsoft Visual C#.NET based on an online tutorial.

After the voting of a hypothetical user named Ali, the wallet content is shown in Figure 5. The first block of any blockchain is the Genesis Block as shown in Figure 6. The first added block is shown on Figure 7. Hashes are reduced for space limitation of the paper.

Fig 5:Initial Wallet contents

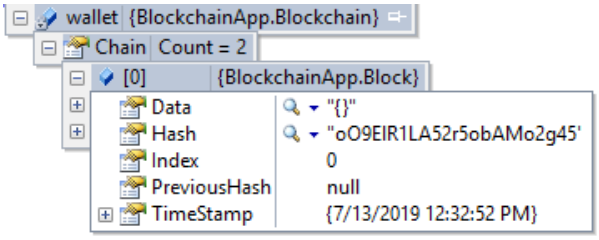

Fig 6:The Genesis block

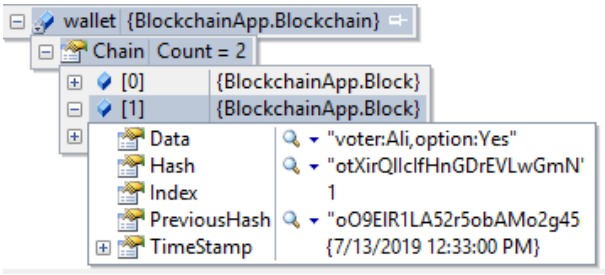

Fig 7:The first added block

If an attempt to check validity of the blockchain, the result of this check corroborates validity.

[1]https://www.mathworks.com/matlabcentral/fileexchange/65419-matlab-blockchain-example

If an attempt to check validity of the blockchain after an update or a delete of a block, the result of this check will destroy validity.

3.3 Experiments

AFor fingerprint-based authentication, a prototype is built in Matlab based on CASIA Fingerprint Image Database . Experiments are carried out on 80 images (10 persons ×8 images each) with Rotation, Scaling, and Translation invariance.

The correct recognition rate is 94.50 % for artificial neural network matching with Gabor feature extraction. Table 3 shows comparison with previous work.

Table 3. Authentication Comparison with Previous Work

Classifier	Accuracy
Support vector machine [15]	76.1
Naive Bayes [15]	87.4
Proposed Authentication Architecture	94.5

Similarly, for iris authentication, experiments are carried out on CASIA Iris dataset, with recognition rate 94 % for artificial neural network.

Everything is the same as fingerprint authentication except of applying Hough transform in preprocessing just before applying the Gabor filter, as in Figure 8, following Daugman algorithm [16]. Hough transform is perfect in detecting circles in the iris image.

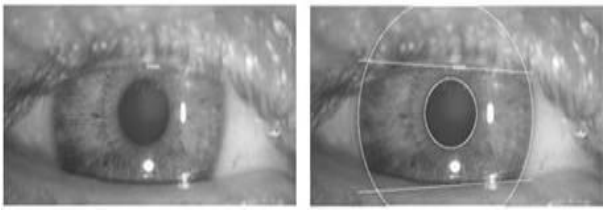

Fig 4:Hough Transform Pre-processing

4. CONCLUSIONS

E-voting authentication is enhanced by using blockchain. Many problems will be solved in the presence of Tactile Internet, and blockchain will play a prominent role. Furthermore, many e-services such as e-government will be positively affected [17].

This paper presented a proof-of-concept that blends Tactile Internet for communication, with blockchain for managing e-voting authentication results.

The Tactile Internet is still ongoing research that needs more interest of researchers. Many e-services are expected to be enhanced after applying Tactile Internet. E-voting is considered as the most beneficiary of this technology, as proved in this paper.

A possible future work is to consider flexibility and autonomy of 5G[18]. Another direction of security and privacy of the blockchain could be considered [11-12].

5. REFERENCES

[1] M. Simsek; A. Aijaz; M. Dohler; J. Sachs; G. Fettweis, "5G-Enabled Tactile Internet," in IEEE Journal on Selected Areas in Communications ,vol.PP, no.99, pp.1-1, to appear

[2] ITU. "ITU-T Technology Watch Report: Tactile Internet", August 2014.

[3] Ateya, AbdelhamiedA. ; Muthanna, Ammar ; Gudkova, Irina ; Abuarqoub, Abdelrahman ; Vybornova, Anastasia ; Koucheryavy, Andrey, "Development of Intelligent Core Network for Tactile Internet and Future Smart Systems, " Journal of Sensor and Actuator Networks, vol 7, no.1, 2018

[4] P. Schulz et al., "Latency Critical IoT Applications in 5G: Perspective on the Design of Radio Interface and Network Architecture" in IEEE Communications Magazine, 55(2): 70-78, 2017.

[5] D. Szabo, A. Gulyas, F. H. P. Fitzek, and D. E. Lucani, "Towards the Tactile Internet: Decreasing Communication Latency with Network Coding and Software Defined Networking," European Wireless 2015; 21th European Wireless Conference; Proceedings of, Budapest, Hungary, 2015, pp. 1-6.

[6] Fettweis, G.P.."The Tactile Internet: Applications and Challenges," Vehicular Technology Magazine, IEEE , vol.9, no.1, pp.64,70, March 2014.

[7] Nakamoto, Satoshi, et al. "Bitcoin: A peer-to-peer electronic cash system". 2008.

[8] Tapscott, Don; Tapscott, Alex. "Blockchain revolution: how the technology behind bitcoin is changing money", business, and the world. Penguin, 2016.

[9] Casey, Michael J.; Vigna, Paul. "The Truth Machine: The Blockchain and the Future of Everything". St. Martin's Press, 2018.

[10] Iansiti, Marco; Lakhani, Karim R. "The truth about blockchain. " Harvard Business Review, 2017, 95.1: 118-127.

[11] El-Dosuky, Mohamed A.; Eladl, Gamal H. DOORchain: Deep Ontology-Based Operation Research to Detect Malicious Smart Contracts. In: World Conference on Information Systems and Technologies. Springer, Cham, 2019. p. 538-545.

[12] El-Dosuky, Mohamed A.; Eladl, Gamal H. SPAINChain: Security, Privacy, and Ambient Intelligence in Negotiation Between IOT and Blockchain. In: World Conference on Information Systems and Technologies. Springer, Cham, 2019. p. 415-425.

[13] Bambara, J. J., Et Al. "Blockchain: A practical guide to developing business, law, and technology solutions", McGraw Hill Education, 2018.

[14] Manjunath, Bangalore S.; MA, Wei-Ying. Texture features for browsing and retrieval of image data. IEEE Transactions on pattern analysis and machine intelligence, 1996, 18.8: 837-842.

[15] MISHRA, Ashish; MAHESHWARY, Preeti. A novel technique for fingerprint classification based on Naïve Bayes classifier and support vector machine. Int. J. Comput. Appl., 2017, 169.7: 58-62.

[16] Daugman, John. How iris recognition works. In: The essential guide to image processing. Academic Press, 2009. p. 715-739.

[17] El-Dosuky, M. A., & El-adl, G. H. "GIZAChain: e-Government Interoperability Zone Alignment, based on blockchain technology". PeerJPrePrints, 7, e27477v1, 2019.

[18] M. Simsek, D. Zhang, D. Öhmann, M. Matthé, G. Fettweis, "On the Flexibility and Autonomy of 5G Wireless Networks" in IEEE Access, 2017.