Editorial: Information Security Solutions for Telemedicine Applications
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Implementing telemedicine solutions has recently become a trend among various research teams at an international level. Telemedicine refers to the use of modern information and communication technologies to meet the needs of citizens, patients, healthcare professionals, and healthcare providers, as well as policy makers. Telemedicine applications are very promising and have great potential; they can play a very important role in service provision by improving access, equity and quality through connecting healthcare facilities and healthcare professionals, and diminishing geographical and physical barriers. However, the transmission and access technologies of medical information raise critical issues that urgently need to be addressed, especially those related to security. Further, medical identity theft is a growing and dangerous crime. Stolen personal information can have a negative financial impact, but stolen medical information cuts to the very core of personal privacy. Medical identity theft already costs billions of dollars each year, and altered medical information can put a person’s health at risk through misdiagnosis, delayed treatment or incorrect prescriptions. Yet, the use of hand devices to store, access, and transmit medical information is outpacing the privacy and security protection on those devices. Therefore, the authenticity of the information and related medical images is of prime concern as they form the basis of inference for diagnostic purposes. In such applications, tamper proofing and guaranteed originality of medical data/information is achieved by embedding some kind of watermark(s) which must be secure and robust against malicious attacks. Robustness and security of medical data/information against attacks is an interesting, challenging area for researchers. Potential researchers are using watermarking and cryptography to disseminate security to the medical data. Further, noted researchers are using watermarking techniques in the field of healthcare to address health data management issues, including source and data authentication, efficient image archiving and retrieval, optimizing bandwidth required to transmit the data, and highlighting diagnostically significant regions.

The objective of this Special Section in IEEE ACCESS is to present a snapshot of the state-of-the-art security techniques in the field of telemedicine.

Our Call for Papers received an enthusiastic response with 49 high-quality submissions. Per IEEE policy, it was ensured that handling editors did not have any potential conflict of interest with authors of submitted articles. All articles were reviewed by at least two independent potential referees. The articles were evaluated for their rigor and quality, and also for their relevance to the theme of our Special Section. After a rigorous review process, we accepted 15 articles to form the Special Section. The brief summary about each paper is presented as follows.

1) The invited article “SBPG: secure better portable graphics for trustworthy media communications in the IoT,” by Saraju P. Mohanty et al., first introduced some major challenges faced in the Internet of Things (IoT) infrastructure, specifically secure communication and user authentication in the context of automated analysis of biomedical images and communication of the analysis results and related metadata in a smart healthcare framework. Further, authors proposed hardware architecture for a secure digital camera integrated with the secure better portable graphics (SBPG) compression algorithm, which is very useful for image communications in IoT. The performance of proposed BPG method with respect to compression quality and size of the compressed file is found superior than traditional JPEG method.

2) In the article “Nucleosome positioning with fractal entropy increment of diversity in telemedicine”, by Mengye Lu et al. proposed a fractal entropy increment of diversity-based nucleosome positioning technique. Core DNA of human, worm, fly and yeast were recognized by their sequences. The authors evaluate the model’s quality, and different nucleosome positioning methods were compared with the same existing benchmark datasets. Extensive experimental results showed that the provided model was an effective nucleosome positioning method. Further, the authors analyzed the importance of all factors which were thought to play roles in nucleosome structure.

3) The article “Prediction of lung motion from four-dimensional computer tomography (4DCT) images
using Bayesian registration and trajectory modeling. “
by Min Li et al., presented an approach for modeling
lung motion based on Bayesian registration and traject-
ory simulations. In the registration process, the neigh-
borhood information is combined with a similarity
metric such that an initial displacement field is gener-
ated, which is smoothed and refined via the displace-
ment regularization. The dense displacement fields are
then used to describe the lung motion. The experi-
mental results indicated that any point in the lungs at
any given time is accurately predicted, which provides
another method of determining the lung and tumor
motions for radiation therapy. In addition, the exper-
iments provided promising results compared to some
similar state-of-the-art image registration methods.

4) In the article “A dynamic and cross-domain authentica-
tion asymmetric group key agreement in telemedicine
application,” Qikun Zhang et al. proposed a dynamic
and cross-domain authenticated asymmetric group key
agreement for telemedicine. The method uses the
group keys also has been implemented efficiently in
cryptographic systems to provide confidential and
privacy. It supports that the members leave one
group or join another group frequently. Extensive anal-
ysis of the method makes it suitable for security group
communication in telemedicine applications.

5) In the article “Hybrid predictor based four-phase
adaptive reversible watermarking,” Muhammad Ish-
tiaq et al. presented a prediction error expansion based
reversible watermarking technique. The method uses
four phases for embedding a watermark to provide
authentication of both an image and source of origin.
Further, the authors have compared the performance of
the proposed method with three interesting state-of-the-
art techniques and found very promising results.

6) The article “Secure and robust digital image water-
marking using coefficient differencing and chaotic
encryption,” authored by Nazir A. Loan et al. proposed
a DCT based watermarking scheme, which is secure
and blind in nature. The method uses Arnold transform
and chaotic encryption to add dual level security to
the watermark. The proposed embedding technique is
based on the difference between the coefficients of
adjacent blocks. The performance of various variants
of the method was tested for many attacks. Further,
the comparison results depict that the proposed scheme
outperforms many state-of-the-art schemes. Authors
believe that the proposed method will be beneficial for
secure telemedicine.

7) The article “A short linearly homomorphic proxy sig-
nature scheme,” authored by Qun Lin et al., introduced
a concept and security model of linearly homor-
phic proxy signature (LHPS) method, and designed a
novel LHPS method from bilinear pairings. Further,
the authors prove that the method is secure under
consideration. Due to the short length of signature,
the method is suitable for any low-bandwidth commu-
nication environments.

8) In the article “Eye recognition with mixed convolu-
tional and residual network (MiCoRe-Net),”
Zi Wang et al. proposed a deep learning based Eye
Recognition system to improve the accuracy of other
similar deep learning based methods. The method uses
deep learning architecture called mixed convolutional
and residual network (MiCoRe-Net), which inserts a
plain convolutional layer between every two residual
layers. The MiCoRe-Net takes advantage of fast learn-
ing from convolutional neural network, and nonsatura-
tion features from residual network. The performance
of the proposed method is tested for different datasets
and results show the superiority in accuracy to previ-
ously published research.

9) The article “Whole brain fMRI pattern analysis based
on tensor neural network,” authored by Xiaowen
Xu et al., proposed a framework to more efficiently and
accurately extract features and improve the per-
formance of functional magnetic resonance imaging
(fMRI) classification. The method uses tensor neu-
ral network (TensorNet) to extract the essential and
discriminative features from the whole-brain fMRI
data. Authors confirmed that the proposed method
performed better than SVM classifier based similar
method for multi-class fMRI data.

10) The article “Secure medical data transmission model
for IoT-based healthcare systems,” authored by Mohamed Elhoseny et al., proposed a method to pro-
vide secure transmission of patient data through the
combination of watermarking and cryptography in an
IoT environment. The method uses hybrid encryption
(AES and RSA) to encrypt the secret information and
then hides the results in the cover gray/color images
through DWT. The authors presented a detailed eval-
uation and demonstrated superior performance of the
proposed method.

11) The article “Efficient quantum information hiding for
remote medical image sharing,” authored by Ahmed A.
Abd El-Latif et al. proposed two quantum information
hiding approaches based on least and most significant
qubits for healthcare applications. The first method
uses controlled-NOT gate to encrypt quantum images
and hide encrypted results into quantum cover image.
However, the second method uses Arnold’s cat map
to scramble the secret quantum watermark image. The
authors hide the scrambled result into the quantum
cover image. The authors presented a detailed evalua-
tion and demonstrated the method has excellent visual
quality and high embedding capacity.

12) The article “Secure delegation-based authentication
for telecare medicine information systems,” authored by Zuowen Tan, proposed a secure delegation-based
authentication protocol for wireless roaming ser-
tice using identity based-cryptography. Experimental
security analysis under Random Oracle model and Burrows-Abadi-Needham (BAN) logic shows that the proposed technique provides communication confidentiality at low computational cost.

13) The article “Anonymous data sharing scheme in public cloud and its application in e-Health record,” authored by Huaqun Wang, developed a data sharing scheme for the security of the outsourced cloud information. The method uses symmetric encryption, searchable encryption and attribute-based encryption techniques to provide confidentiality in public clouds. The security and efficiency analysis demonstrate that the designed scheme is feasible and efficient. The author further discussed the suitability of the scheme for secure e-health records.

14) In the article “A practical public key encryption scheme based on learning parity with noise,” Zhimin Yu et al. proposed a single-bit public key encryption method based on a variant of learning parity with noise (LPN) and extended it to a multi-bit public key encryption technique. Experimental demonstration efficiently proved the correctness and chosen plaintext attack security of the proposed method. Further, the method solved encoding error rate issues of the previous LPN based public key technique, while the encoding error rate in the proposed is negligible.

15) Finally, the article entitled “Privacy-preserving protocol for sink node location in telemedicine networks,” authored by Ting Li et al., presented a privacy-preserving protocol for sink node location for telemedicine networks. The method uses fake sink nodes and data packets to make it difficult to determine the location of the real sink node at low delivery time. The extensive experimental results show the significant improvement in safe time of the sink node and reduction in the data delivery time.

To conclude, we would like to sincerely thank all the authors for submitting their high quality articles to this Special Section, and the large number of reviewers who have participated in the review process, and provided helpful comments and suggestions to the authors to improve their article. We especially thank the IEEE ACCESS Editor-in-Chief, Professor Michael Pecht, and other staff members of IEEE ACCESS for their continuous support and great guidance. We believe that our Special Section will be helpful to the senior undergraduate and graduate students, researchers, industry professionals, healthcare professionals and providers working in the area of telemedicine as well as other emerging applications demanding state-of-the-art information security solutions.

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