

EDITORIAL**IEEE ACCESS SPECIAL SECTION EDITORIAL:
MOBILE MULTIMEDIA FOR HEALTHCARE**

With the availability of easy access to the Internet, and the proliferation of various mobile devices, people can get access to mobile multimedia ubiquitously in order to have a desktop experience. Mobile multimedia refers to different types of multimedia content (e.g., text, images, audios, and videos), which are accessed via heterogeneous mobile devices, such as mobile phones, portable devices, and smartphones. Mobile multimedia services and applications have tremendous potential in the healthcare sector. Currently, as the healthcare sector is increasingly dependent on mobile multimedia services and applications, many challenges remain unsolved for the successful deployment of mobile multimedia services in order to have a balance between power-limited mobile devices and resource hungry medical multimedia content. This Special Section aims to theme innovative research achievements in the field of related techniques, applications, services, and systems for mobile multimedia healthcare.

The articles in this Special Section bring together academic and industrial researchers to identify and discuss technical challenges and recent results related to mobile multimedia for healthcare. As an application area, mobile multimedia is one of the most active and successful fields of use in the domain of the healthcare industry. The Special Section focuses on particular aspects of mobile multimedia for healthcare, such as comprehensive data sensing, assistive sensory media, and sharing mobile-healthcare big data. After a rigorous review process, we accepted the following articles to form the Special Section.

In the article titled, “DEEP-SEE FACE: A mobile face recognition system dedicated to visually impaired people,” by Mocanu *et al.*, the authors introduce a novel assistive device designed to improve cognition, interaction, and communication of visually impaired (VI) people in social encounters. The proposed approach jointly exploits computer vision algorithms and deep convolutional neural networks in order to detect, track, and recognize, in real time, various people’s existence in video streams. The major contribution of the article concerns a global, fixed-size face representation that takes into account various video frames while remaining independent of the length of the image sequence. For this purpose, the authors introduce an effective weight adaptation scheme that can determine the relevance assigned to each face instance, depending on the frame degree of motion/camera blur, scale variation, and compression artifacts.

The experimental results carried out on a large-scale data set validate the proposed methodology with an average accuracy and recognition rates superior to 92%. When tested in real-life indoor/outdoor scenarios, the proposed framework proves to be effective and easy to use, allowing the VI people to access visual information during social events.

In the article, “Voice disorder identification by using machine learning techniques,” by Verde *et al.*, the authors introduce an exhaustive comparison between the most used machine learning algorithms existing in the literature. The aim of this study is to identify the techniques capable of discriminating between pathological and healthy voices with more accuracy. This is fundamental to realizing a valid and precise mobile health system and a promising solution for people who desire the detection, monitoring, and treatment of their health conditions anywhere and at any time. All analyses are performed on a dataset of voices selected from the freely available Saarbrücken Voice Database. They show that the best accuracy in voice disease detection is achieved by the support vector machine algorithm or the decision tree one, depending on the features evaluated by using opportune feature selection methods.

The article “Performance analysis of personal cloud storage services for mobile multimedia health record management,” by Akter *et al.*, focuses on performance analysis of personal cloud storage services for mobile multimedia personal health record (PHR) management. In particular, the authors investigated using qualitative and quantitative analyses of the strengths and weaknesses of personal cloud storage services for PHR management scenarios. The qualitative analysis includes chunking, bundling, deduplication, delta-encoding, and data compression features. The quantitative analysis includes control data overhead, application data exchanged, and impact of data size on number of packets, as well as transmission rate, synchronization initialization time, and protocol overhead. Experimental results on various benchmark cloud storage datasets showed satisfactory outcomes.

Wearable technology and personal health devices (PHDs) play a critical role in shaping the future of healthcare. The International Organization for Standardization (ISO) realized the role of personal health systems and proposed the 11 073 family of standards. To this end, the article “ISO/IEEE 11 073 personal health device (X73-PHD) standards

compliant systems: A systematic literature review,” by Badawi *et al.*, presents a systematic literature review for the existing literature on ISO/IEEE 11 073 Personal Health Device (X73-PHD) Standards using three databases: Scopus, Pub Med, and Web of Science. The authors classified personal health systems based on the location in which they are used, the technology used to develop them, and the purpose which is determined by the targeted users. They also presented the adaptation techniques and found that the pulse oximeter is the most used device in such systems. In addition, the authors discuss the role of (X73-PHD) standards in IoT and tele-healthcare systems with the challenges in this regard. They also discuss converting the non-standardized devices into standardized. Finally, the authors propose a list of requirements for personal health systems based on their review of the literature.

The obesity and overweight trends are alarming and can cause serious health conditions. One of the major causes of this is the sedentary lifestyle of modern societies. When addressing this problem, a considerable challenge faced is long hours of TV watching every day. With the above objectives, in the article, “Multimedia for social good: Green energy donation for healthier societies,” by Laamarti and El Saddik, the authors propose a multimedia for social good system that tackles this issue and motivates the individuals leading a sedentary lifestyle to get physically active. The proposed system allows green energy generation by collaborating individuals and competitive teams and donates it to poor countries of choice. This proposed green energy donation system makes use of the time already spent watching TV daily and leverages people’s drive for social good to get them physically active. The authors conducted an experiment which showed very promising results, where 75% of participants exceeded the physical activity recommendation.

Smart healthcare monitoring, as well as human action, is very important in the healthcare domain to remotely monitor the status of patients or elderly people. In this context, the article “An annotation technique for in-home smart monitoring environments,” by Al Zamil *et al.*, introduces an efficient technique for annotating activities in smart home environments. The article “Human action monitoring for healthcare based on deep learning,” by Gao *et al.*, proposes a novel deep learning architecture named recurrent 3-D convolutional neural network (R3D) to extract effective and discriminative spatial-temporal features to be used for human action recognition for intelligent healthcare. In the article, “Monitoring system for patients using multimedia for smart healthcare,” by Alamri, the author proposes a user satisfaction detection system as part of a smart healthcare framework, where multimedia-based techniques are used to capture speech and image signals from the users.

The article “Energy-efficient architecture for wireless sensor networks in healthcare applications,” by Saleh *et al.*, proposes a technique to resolve the problems of limited energy sources for wireless sensor networks used in mobile healthcare applications. Muhammad *et al.* proposed an

electroencephalogram (EEG)-based seizure detection system in the article titled “Automatic seizure detection in a mobile multimedia framework.” The EEG signal was divided into five band-limited signals, which were fed into five parallel convolutional neural network (CNN) models. These models were fused using an autoencoder. The proposed system outperformed all the existing related systems on a public dataset

Security of medical media is important for patient safety and confidentiality. In the article titled “Robust encryption of quantum medical images,” by Abd El-Latif *et al.*, the authors propose a framework for the chaos-based quantum encryption of healthcare images. In the framework, healthcare staff in one location send secured images to the cloud. In the article, “Blockchain-based mobile edge computing framework for secure therapy applications,” by Rahman *et al.*, the authors present an in-home therapy environment that leverages blockchain and off-chain solutions to secure therapeutic data. The work presented also leverages the advancements of mobile edge computing to support high-speed health IoT data sharing with the outside world. Based on the experimental results, the authors conclude that the framework achieves acceptable mean processing time while handling therapeutic data in decentralized databases.

In the article, “Spatial blockchain-based secure mass screening framework for children with dyslexia,” by Rahman *et al.*, the authors introduce a novel dyslexia symptom management system, which leverages multimedia IoT devices and blockchain. The framework introduces secure dyslexia tests for different age groups, shares the test payload in an off-chain decentralized database, auto-grades the multimedia test payload, and shares the test results with one’s community of interest via blockchain data. The implementation and test results show that the framework can be scaled and adapted to different languages and populations.

With the rapid development of the Internet and with the rise of Web2.0, digital social network websites have caused more individuals to participate in online social networking, and communication between users is no longer blocked by time or space barriers. Dynamic interactions between users can better reflect the intimacy of relationships between users in the online social network. In the article, “Tibetan Weibo user group division based on user behaviors for analyzing health problems,” Qiu *et al.* propose a group division method based on the analysis of interactive behaviors among users and construct a single-dimensional network structure between users based on behaviors of connecting, commenting, forwarding, and liking.

Today, deep learning or machine learning gets lots of attention in the healthcare community. To this end, the article “A greedy deep learning method for medical disease analysis,” by Wu *et al.*, introduces a new deep learning method, the greedy deep weighted dictionary learning for mobile multimedia for medical diseases analysis. Based on the traditional dictionary learning method, which neglects the relationship between the sample and the dictionary atom, the authors propose a weighted mechanism to connect the

sample with the dictionary atom. In the article, “Cognitive privacy middleware for deep learning mashup in environmental IoT,” Elmisery *et al.* discuss building a cognitive -based middleware for private data mashup (CMPM) to serve centralized IoT-enabled environmental monitoring services. An anomaly detection solution was also presented in detail, which achieves promising results in terms of performance. The article “A framework to estimate the nutritional value of food in real time using deep learning techniques,” by Yunus *et al.*, presents a system that exploits the extensive use of mobile devices to provide health information about the intake of our food. It proposes a novel system to automatically estimate food attributes such as ingredients and nutritional value by classifying the input image of food based on employing different deep learning models for accurate food identification. The mobile-based app also takes the image of the meal and presents approximate ingredients and nutritional values in food.

A voice pathology detection system in a mobile framework was proposed in the article “Voice pathology detection using deep learning on mobile healthcare framework,” by Alhussein and Muhammad. Several deep learning models were evaluated in a cross-database platform. The system achieved excellent performance to detect voice pathology. In the article, “Automatic voice pathology monitoring using parallel deep models for smart healthcare,” Alhussein and Muhammad proposed a parallel CNN model to exploit the temporal aspect of a voice. The input to the model was a spectrogram of the voice. Therefore, the proposed system extracted spectro-temporal deep features to detect voice pathology. The system was then deployed in a smart healthcare framework.

Mobile multimedia applications transfer multimedia data and generate a huge amount of data. Due to the high data rate, the heat generated from sensor devices is considerably high and results in thermal dissipation. This heat generated from nodes may result in sensitive tissue damage. Hence, to avoid any damage to body organs, there is a need to analyze SAR. For this reason, the article “Rigorous analysis and evaluation of specific absorption rate (SAR) for mobile multimedia healthcare,” by Ahmed *et al.*, analyzes the specific absorption rate (SAR) impact on the human body.

With the continuous development and progress in the healthcare monitoring system, medical diagnosis as well as correct uniform doses for human health play a critical role which can help doctors make correct choices and effective treatment plans. The techniques in the article “An effective

dictionary learning algorithm based on fMRI data for mobile medical disease analysis,” by Xu *et al.*, can be applied to classify medical diseases through the use of mobile multimedia technology. With regard to identifying equivalent uniform dose as medication, in the article, “A novel definition of equivalent uniform dose based on volume dose curve,” by Lan *et al.*, the authors propose a method to identify proper medication dose for realizing visualized radiotherapy, as uniform medication dosage is important for healthcare. The definition of equivalent uniform dose is based on the volume dose curve. Different weight curves are used to represent the biological effects of different organs. Through this project, the dose volume histogram is used to describe the dose distribution of different tissues in the target and non-target regions.

We would like to thank all the authors for their contributions and the reviewers for their efforts in respecting deadlines. Without their voluntary time, effort, and dedication, this Special Section would never come to be. We would also like to thank the Editor-in-Chief and other staff members of IEEE ACCESS for their continuous support and guidance. We hope that the articles from this Special Section will contribute to the roadmap for the emerging use of mobile multimedia for healthcare.

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Dr. Hossain is a Senior Member of the ACM. He was a recipient of a number of awards, including the Best Conference Paper Award, the 2016 *ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM)* Nicolas D. Georganas Best Paper Award, the 2019 King Saud University Scientific Excellence Award (Research Quality), and the Research in Excellence Award from the College of Computer and Information Sciences (CCIS), King Saud University (three times in a row). He has served as the Co-Chair, the General Chair, the Workshop Chair, the Publication Chair, and TPC for over 12 IEEE and ACM conferences and workshops. Currently, he serves as the Co-Chair for the 3rd IEEE ICME Workshop on Multimedia Services and Tools for Smart-Health (MUST-SH 2020) and the 1st IEEE GLOBECOM 2019 Workshop on The Advances of the Internet of Things and Cloud for Smart Connected Living (AIoTCSCSL 2019). He is on the Editorial Board of several SCI/ISI-indexed journals/transactions, including the IEEE TRANSACTIONS ON MULTIMEDIA, the IEEE MULTIMEDIA, the IEEE NETWORK, the IEEE WIRELESS COMMUNICATIONS, IEEE ACCESS, the *Journal of Network and Computer Applications* (Elsevier), the *International Journal of Multimedia Tools and Applications* (Springer), and the *Human-centric Computing and Information Sciences* (Springer). Previously, he served as a Guest Editor for *IEEE Communications Magazine*, the IEEE NETWORK, IEEE ACCESS, the IEEE TRANSACTIONS ON INFORMATION TECHNOLOGY IN BIOMEDICINE (currently JBHI), the IEEE TRANSACTIONS ON CLOUD COMPUTING, the *International Journal of Multimedia Tools and Applications* (Springer), *Cluster Computing* (Springer), *Future Generation Computing Systems* (Elsevier), *Computers and Electrical Engineering* (Elsevier), *Sensors* (MDPI), and the *International Journal of Distributed Sensor Networks*.



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Prof. Xu received the Best Paper Awards of the ACM Multimedia 2016, the 2016 ACM Transactions on Multimedia Computing, Communications and Applications, and the 2017 IEEE Multimedia. He has served as the Program Chair of ACM Multimedia 2009. He has served as an Associate Editor, a Guest Editor, the General Chair, the Program Chair, the Area/Track Chair, the Special Session Organizer, the Session Chair, and a TPC member for over 20 IEEE and ACM prestigious multimedia journals, conferences, and workshops. He is the Editor-in-Chief of the journal *Multimedia Systems* and serves/served as an Associate Editor of the IEEE TRANSACTIONS ON MULTIMEDIA and the *ACM Transactions on Multimedia Computing, Communications and*

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than 50 international conferences, symposia, and workshops on collaborative haptic-audio-visual environments, multimedia communications, and instrumentation and measurement. He was the General Co-Chair for the ACM MM 2008. He is a Senior Associate Editor of the *ACM Transactions on Multimedia Computing, Communications and Applications (ACM TOMM)*, an Associate Editor of the IEEE TRANSACTIONS ON MULTIMEDIA (IEEE TMM), *Multimedia Tools and Applications (MTAP)* (Springer), the *Journal of Emerging Technologies in Web Intelligence (JETWI)*, the *International Journal on Smart Sensing and Intelligent Systems (S2IS)*, and the *Journal of Multimedia (JMM)*, and a Guest Editor for several IEEE TRANSACTIONS and Springer and Elsevier journals.

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