Issue2

NEWSLETTER

IEEE lifesciences

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The IEEE Life Sciences Technical Community

Editor's Comment:

Dear Reader,

Life science is sometimes more present in different research areas as you may think. To accurately cover the large scope, the IEEE Life Science Community and the Editorial Team explore new ways of collaboration with other IEEE Societies and Communities. Thus, we hope that the growing collaborations provide the opportunity for an open and wide communication in research.
To kick things of, for this issue the LSTC leadership teamed up with IEEE Standards to bring together a feature on how standards come alive. Standards seek to uniformly generate specifications and procedures. The process of standards often seems to be quite complicated and difficult to start with. Thus, we tried, with our IEEE EMB Standards liaison Carole Carey, to outline the basics of standards and how to get started. Not only this, but we have included two current projects undergoing the process to establish standards, to show the big picture of standards.

Although the Life Sciences Newsletter is a small outlet and at its very beginning, it constitutes an attractive medium to communicate and present research and ideas, simply the contributor's passion, and who doesn't want to talk about their passions?
We are looking to get in contact with you and would like to help and provide the outlet to communicate your scientific passion.

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Tobias Cibis,
Editor in Chief,
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Chair's Comment:

Dear Readers,

Welcome to the second edition of the resurrected newsletter. As an initiative to further establish and develop our LSTC community we have submitted our intent to convert the newsletter to a magazine to IEEE publications. A magazine will allow future content to be peer reviewed and indexed. The feedback we have indicates that there is a strong need for an avenue to publish content that is of interest to people with an interest in the life sciences, as distinct from bio medical engineering.

Reflecting on 2018, the LSTC committee has worked hard and made good progress towards growing interest in an IEEE Life Sciences Technical Community. Currently we have over 5,000 people associated with LSTC! LSTC thus has created more interest than many IEEE Societies. Thus our committee sees the need to make LSTC a more formal operational unit (OU).

In order to make LSTC an independent OU we still have a lot of work to do. The establishment of conferences is an important step. During October 2018 we held a very successful Life Sciences Conference (LSC) in Montreal. I congratulate Professor Sawan and his team for organizing this highly successful event. This newsletter has an article that reports on the Montreal conference.

During 2018 Professor Hase from Japan proposed a new conference, the Life Tech Conference (LTC), which will be held in Osaka, Japan during March 12-14. Unlike the Life Sciences Conference which roams around the world, LTC will remain in Japan. Professor Hase identified a large community in Japan that justifies a conference to serve it. LTC will serve the community in Japan and East Asia. But it is open to the international community as well. About 180 papers have been submitted to the inaugural LTC, and 122 presentations have been accepted. This second event is a very important step in growing LSTC and making it a viable OU.

Having a successful regional conference is a good step in developing local communities, and as we grow it is very feasible for LSTC to establish more local events.

A next step in growing our community is establishing summer schools and one day events. This is something we will develop as we grow.

As a growing entity, we need more hands to get involved and help, especially with conferences and with the news-letter/ magazine. If you want to get involved, please contact me or if you want to help with the newsletter/ magazine contact our Editor in Chief Tobias Cibis.

This year promises to be an exciting year and I look forward to serving the Life Sciences Technical Community!

Stefan Mozar,
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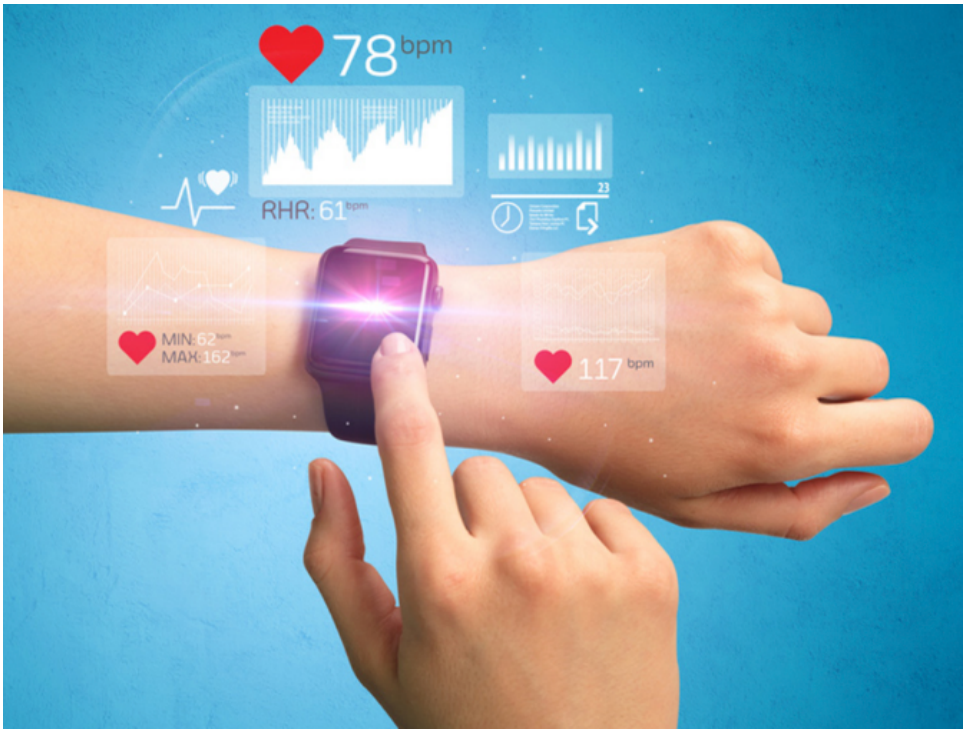
Wearable Medical Devices: Challenges and Self-aware Solutions

by Nima Taherinejad

The number of wearable health-care systems is proliferating exponentially, however, they still face several systematic challenges. Some of these challenges include the battery life-time, the accuracy of these devices, the adversities coming with the movement of the subjects and the vast variations in the environment in which these devices should perform. Design engineers work on these challenges by trying to increase battery life-time, fabricating more accurate sensors, and designing better signal processing algorithms. However, some of these improvements are rather slow (e.g., battery life-time increase) and some of them are in contradictions with one another (e.g., more complex processing algorithms against the battery life-time). This calls for different type of solutions.

The battery life-time of smart watches, for example, ranges from a couple of days to a month. To extract that many hours of operation from the battery, the number of sensors and features on these watches are in many cases reduced to a minimum. Continuous monitoring or full usage of all available features brings the battery life-time towards the lower end of the spectrum. For insulin pumps the battery life-time is between 7-14 days for external batteries and 2-6 years for implants. Defibrillators have a similar life time too, about 7 years. To achieve such life-times, processing, intelligence, and safety are minimized on these devices and security features are practically non-existent. Furthermore, given the cost and difficulties of surgeries required to change implants, any life-time below current life expectancy for the patients is only sub-optimal.

To have a deeper look at the challenges that wearable medical devices face, let us consider smart watches which are very popular and promising in the future of health monitoring. On one hand, due to issues such as cost, power consumption, and space, they all have a very limited number of sensors (often only a Photoplethysmography (PPG) and accelerometer) and even those sensors have limited accuracy and operation modes again due to restrictions on cost and power



consumption. On the other hand, they have to operate under a wide range of environmental changes. The quality of signals captured by their sensors while sitting still or sleeping is quite different compared to those of intense sport activities. The electronic chips – especially those fabricated for such commercial devices- are often designed for room temperature and their performance in hot Hawaiian weather is not the same as in the cold Alpine slopes. A user might be swimming in Mediterranean Sea one day and taking a safari trip in Sahara Desert another day. To make things even more difficult, a number of features such as respiratory rate, sleep pattern, user activity types, and burnt calories are inferred only indirectly from the PPG and acceleration sensors. Despite all these difficulties, it is expected that these device work properly, consistently, and reliably at all times.

To establish and maintain such balanced and delicate operations, these devices need to make many decisions. For example, is the heart rate of 120 beat per minute (BPM) dangerous or not? Should the device notify care givers or health-care personnel? Or at what battery level should the device turn off a certain functionality? Most often the answer to these questions heavily depends on the context. Is 120 BPM a correctly calculated value? Is the sensor and/or inference algorithm functioning properly? Is the user sitting still or in motion? Is turning off a certain functionality going to considerably affect the reliability of the operations of the system and achievement of its goals? Is it expected that the device will be connected to a charger soon? If a wearable healthcare system is going to make all these intricate decisions, it needs to have a good awareness about itself and its environment. Understand the context and its shortcomings, and adjust its operations to compensate for these shortcomings. That motivates research on self-awareness and development of self-aware systems.

Self-awareness of systems refers to the ability of systems to monitor themselves, their resources, their own behavior and that of their environment, and subsequently use this awareness to make decisions which brings them closer to their goals and objectives (which themselves may be changing from time to time). It is important to notice that despite the similarity between self-aware systems and some more traditional systems, the design methodology is different and self-awareness concepts must be considered at design time to achieve good results.

Recently, computational self-awareness methods have been used in some wearable health-care systems and shown a great promise in handling those challenges. In my tutorial at the 2018 IEEE Life Science Conference in Montreal, Canada, I presented the fundamental concepts of self-awareness, with a focus on the elements of observation [1]. Using examples, I showed how each component can help in designing a better system, in particular for wearable health-care. Among examples, we discussed in depth the works I and my colleagues at TU Wien and University of Turku have done on early warning score (currently assessed manually in hospitals and emergency units to predict potential deteriorations in the health of patients) [2-4]. We showed that using concepts such as data reliability, self-aware abstraction, disambiguation, desirability, and attention this score can be assessed using wearables more reliably and accurately, while reducing the power consumption or the need for redundant or very accurate sensors. Using self-aware epileptic seizure detection example [5] of Embedded System Laboratory of EPFL, we discussed how confidence assessment can help to improve the quality of prediction in machine learning algorithms, while reducing its power consumption and required resources.

These examples scratch only the surface of what can be done using computational self-awareness concepts. This leaves a large territory of potentials unexplored, which means considerable opportunities for research and development in this field. To find out what the top researchers in the field of computational self-awareness are doing, I invite you to attend the fourth edition of self-aware cyber-physical systems (SelPhyS) workshop, which this year will be held in Munich, Germany. I am very excited to discover what the future has in store for us, and I hope you are too.

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Innovation Through Standards: See How it is Done and Get Involved!

By Carole C. Carey

Emerging technologies in medicine, biology, life sciences and engineering are focusing more than ever on innovative products in delivering safe effective medical devices, novel therapeutic treatments, and efficiency of health care systems around the world. The aim is for patients to have early access to innovative devices as well as reduction in costs of medical products.

Standards Do Matter

Standards are published formal documents that establish uniform specifications and procedures to ensure quality, compatibility and reliability of materials, products, methods and/or services. They support and facilitate interoperability between devices made by different producers. Standards are often derived from innovative technology and are based on the consensus participation of multidimensional views; manufacturers, researchers, policy makers, interest groups, and users. Effective approaches are required. Standards can help reduce the timelines from scientific research discoveries to clinical practice to product technology commercialization. One proven approach is the recognition and consideration of incorporating the use of standards in every stage of the translation roadmap from 'bench to bedside'. Conformance to high quality standards provides assurance to stakeholders on the quality of products and consistency of processes and production methods.

We are witnessing a rapid increase of innovative products and wearables from emerging technologies in both the consumer and healthcare space, such as artificial intelligence, 3D-based bioprinting, brain computer/machine interface, medical robotics, and blockchain for life sciences among others. Standards are lagging behind. The development of standards needs to catch up with technology innovations. Collaboration among standards developers around the world should expand and intensify.

Regulatory Challenge and Opportunity

Medical devices are highly regulated products. One of the challenges that manufacturers face, particularly multinational firms, is overcoming complex government regulatory review of new devices. A lengthy market approval process can impede innovation and delay the availability of better health and healthcare systems. Regulatory bodies across international jurisdictions recognize that established industry consensus standards help simplify the process of designing, developing, testing and manufacturing new technologies. Regulators support the use of harmonized standards as one of the regulatory tools that augment the supervision and management of medical products. The harmonized process, allows innovative devices to reach patients quicker, is considerably streamlined. Moreover, the cooperation between government and regulated industry greatly reduces the regulatory burdens on both sides.

IEEE Standards Development: Guiding Principles

International standards are generally developed through a voluntary consensus process that brings together volunteers and subject matter experts with an interest in the standards' topics to be considered. One purpose of establishing standards is in response to technical, safety, performance, regulatory, societal and market needs in order to serve the public good. Most standards are generally made available to the public. Through an accredited consensus process, standards setting bodies or standards development organizations (SDOs) like IEEE, IEC, ISO and others manage and facilitate the development of standards. Although the goals of SDOs are essentially the same, each SDO applies its own set of rules, terminology, processes, policies, and guidelines. They help ensure the integrity of the standards development process.

The IEEE organizational unit that oversees the standards development process is the IEEE Standards Association (IEEE-SA). The IEEE-SA Standards Board (IEEE-SASB) and its Committees provide the policies and guidelines for the development of individual and entity-driven standards in order to ensure a fair and equitable process. These Committees include the New Standards Review Committee (NesCom), Standards Review Committee (RevCom), Procedures Committee (ProCom), Audit Committee (AudCom), and Patent Committee (PatCom). IEEE-SA adheres to the Open Stand paradigm and supports the principles and requirements of WTO (*World Trade Organization's Decision on Principles for the Development of International Standards, Guides and Recommendations*). It should be noted that the IEEE-SASB does not develop the standards. Collaborative teams or standards working groups (WGs) are formed to develop standards. IEEE-SA staff provides guidance and operational support.

Participation in WGs is also guided by five basic principles.

1. **Openness**: Participation in IEEE standards development is open to all interested parties, IEEE members or non-IEEE members alike.
2. **Due Process**: Highly visible operating procedures are followed.
3. **Balance**: No one party has an overwhelming influence in the ballot group.
4. **Consensus**: Resolving differences of opinion and a clearly defined percentage of those in a balloting group vote to approve a draft of the standard.
5. **Right of Appeal**: Anyone may appeal a standards development decision at any point, before or after a standard has been approved.

It All Starts with An Idea or Concept

A standardization project usually gets under way when a person or a group of people with similar interest identifies a specific topic in need of standardization. The idea or concept can be broad or very specific. An example is standardization of common terms, definitions, or symbols. Standards projects can be about technical characteristics, performance, and safety requirements associated with devices, equipment, and systems. They can also be about recommendations reflecting current state-of-the-art in the application of engineering principles. There are many more examples.

In IEEE, the term Standards encompasses three types of projects and/or documents: Standards ("shall" contains mandatory requirements), Recommended Practice ("should" outlines preferred procedures), or Guide ("may" offers suggestions for working with a technology). When deciding on starting a standards project, the potential working group should take into consideration the following criteria: (1) Broad market potential, (2) Technical feasibility, (3) Readiness for standardization, (4) Distinct identity or substantial technical merit when compared to other standards, and (5) Adequate participation, enough participants to step forward to develop the standard.

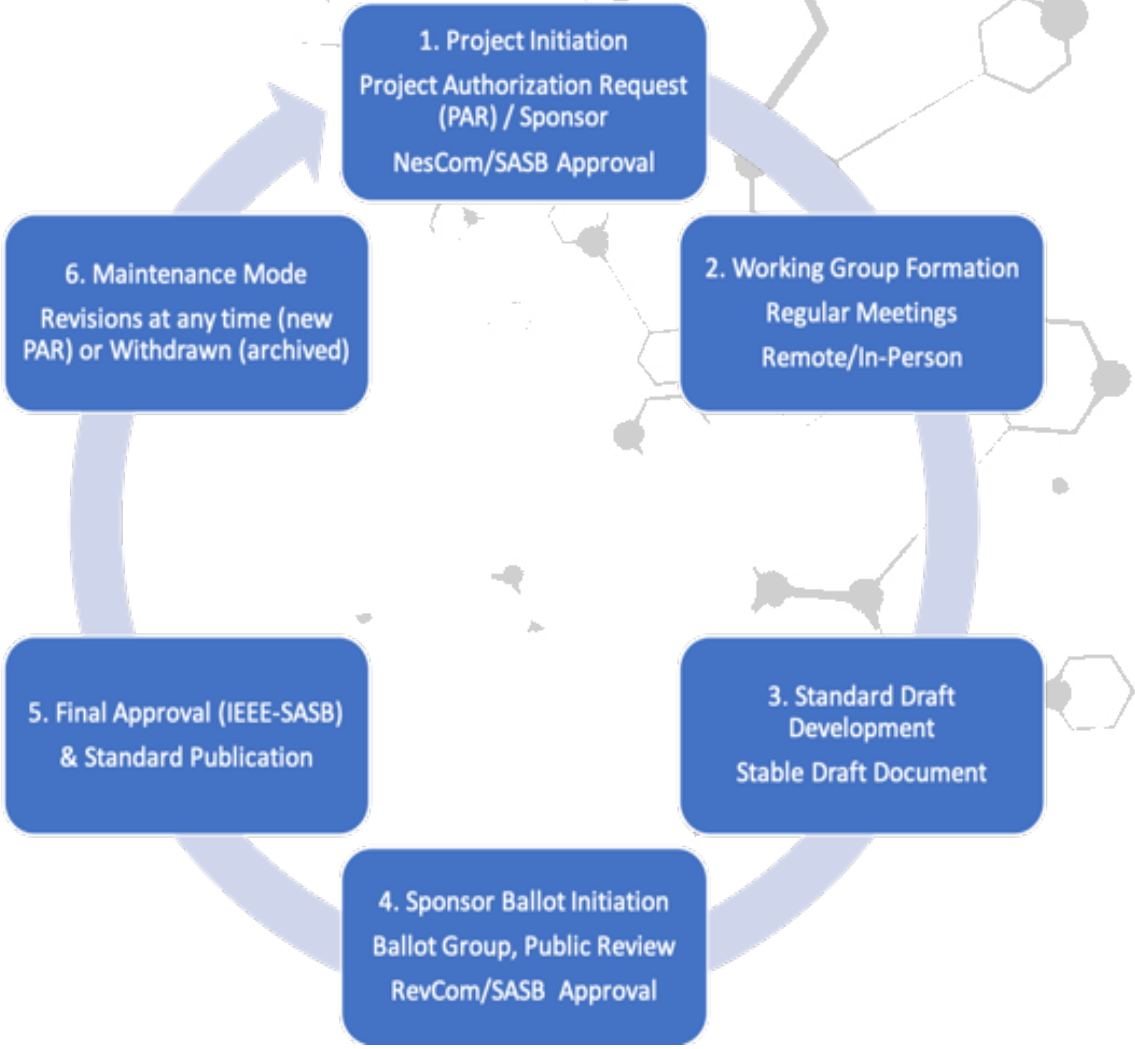

Figure 1. Six stages Standards Development Lifecycle

1. Initiating the Project. Project authorization request (PAR) is a small structured document that defines the scope, purpose and need for a standard. An IEEE standard project also needs a Sponsor, the entity that assumes the responsibility for a particular standards idea. The Sponsor provides technical oversight, including the organization of the standards development team and its activities, from inception to completion. Sponsors are typically from the IEEE technical Societies and Committees. An IEEE-SASB approved PAR marks the official start of the standards project. *This is the time to submit a PAR through myProject (a web-based tool that facilitates the IEEE standards development process)!*

2. Mobilizing the Working Group. "Working Group" is term IEEE uses to refer to the collaborative team that actively develops a standard, recommended practice or guide. Other SDOs may refer to their groups using different terms or may follow slightly different processes. Working Groups are comprised of individuals and/or entities (people, companies, organizations, non-profits, government agencies) who volunteer to support the development of standards. The WG Chair calls for participation. *This is a good time to sign up and join the "Kick-off" meeting and attend future meetings!*

3. Drafting the Standard. Under the leadership and guidance of the WG Chair, who also acts as the point of contact for technical questions, the WG makes technical decisions in the process of developing the standard. The WG's first milestone is completion of the first mature draft in order to move the project for Sponsor approval/ballot and ultimately IEEE-SASB approval. *This is the time to make contributions to the standard draft development and help the WG move forward!*

4. Balloting the Standard. The goal in balloting is to gain the greatest consensus and balance with no dominance by any one group of interest or company. Balloting process starts when the sponsor determines the draft of the full standard is stable. Sponsor will initiate the invitation to form the balloting group (persons interested in the standard). Anyone can contribute comments through the Public Review Process. However, only votes from eligible members of the balloting group count toward approval. *This is the time to enroll and join the ballot pool and participate in the consensus ballot!*

5. Gaining Final Approval. The completed standard and supporting materials are submitted to RevCom to ensure the WG followed all procedures and guiding principles in drafting and balloting the standard. Similar to the PAR, the completed standard will be presented to IEEE-SASB for approval/disapproval. IEEE-SA professional editor reviews multiple drafts during development. After IEEE-SASB approval, the editor prepares the final text for publication. *Your primary task is completed once the standard is approved and published!*

6. Maintaining the Standard. An IEEE standard is valid for 10 years from the date of IEEE-SASB approval. Amendments and Corrigenda (corrections of technical errors) can be developed and balloted within the 10-year validity rule. If the standard becomes outdated, a Revision can be initiated. After 10 years, one of two actions can occur: revision or withdrawal. *It would be beneficial to stay up-to-date on technology developments, new information from research and product field experience.*

Standards help ensure consumer safety and interoperability across devices. Participation in developing global, consensus standards in an open platform encourages innovation, drives competition among product designers and developers, and promotes international trade.
Please, get involved!

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IEEE STANDARDS ASSOCIATION
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Standardization of Three Dimensional (3D) and Four-Dimensional (4D) Based Medical Application

By Young Lae Moon, Dae Ok Kim, Wonbong Lim

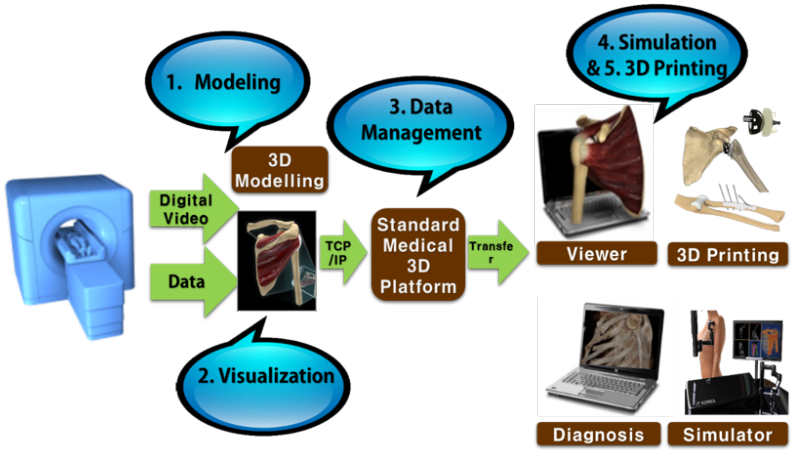
Standardization of medical 3D and 4D Application has not been pioneered.

Additive manufacturing, otherwise known as medical 3D, is driving major innovations in many areas, such as manufacturing, engineering, art, education and medicine. Especially, the medical field is greatly becoming interested in this technology with the ability to create solutions specifically tailored towards the patient. From the creation of 3D models that help surgeons plan operations, to the fabrication of patient-specific titanium implants, 3D printing is already changing the traditional medical industry. In our Working group, sponsored by IEEE Engineering in Medicine and Biology Society (EMBS) as a primary sponsor for 3D Based Medical Application Working Group (EMB/Stds Com/3333.2) with the Computer Society as joint sponsor, practical applications of medical 3D has been suggested the demand for technical standards for clinical educational utilities.

Medical imaging and modeling procedures for solid organ 3D printing

Medical images from hospitals consist of a two-dimensional (2D) dataset and provide human body information as a slice, however the human body has a three-dimensional (3D) morphology. If we reproduce a 3D morphology via simulations, we might be able to obtain more information about the body as well as contribute in the clinical environment to both better treatment and surgical outcomes. The objective for solid organ 3D printing is to generate 3D medical data from 2D images. Although doctors spend a great deal of time and effort in this process, the resultant 3D data are usually different in each institute. A standardized procedure provides standard, simple and accurate 3D data for solid 3D printing.

Figure 1. The Procedure for hard and soft tissue 3D printing



The procedure for hard and soft tissue 3D printing

Standardization in hard and soft tissue printing involves the use of medical scanning devices to acquire physical data models with density and size characteristics which are necessary to develop comparative analysis data. In order to achieve an accurate segmentation, it is necessary to apply certain

segmentation algorithms, including processing step, such as extracting bone features with image enhancement and density selection. The standard for hard and soft tissue 3D printing defines a procedure that increases the precision of 3D printing model output of hard or soft tissues in medical images. In addition, medical imaging and modeling procedures for hard and soft tissue 3D printing will include the following features: 1) Modeling for image enhancement, 2) Visualization in medical image, 3) Data management, 4) Simulation and 5) 3D printing (Fig.1).

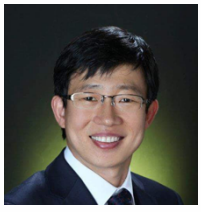
Standardization of personalized artificial joint implant 3D model design

The goal of medical 3D printing in the orthopedic field is to reproduce the normal biomedical functions of missing bones. It is necessary to put and apply the artificial joint replacement as the presently feasible intermediate step. This standard is to apply the output to the operation by individually optimizing the shape of the implants of the lost joint based on the rotation data of the positional rotation of the mirrored motion in the normal joint. The use of CAD based on medical image is essential, and a designing technique that minimizes the modeling error is needed. Therefore, definition of optimal design elements for medical 3D printing and development of technical standards based on the analysis of medical elements of artificial joint output are required for analysis of patient's three-dimensional model data, artificial joint template and other technical factors. In order to maximize the patients and physician's satisfaction with implant surgery, the accuracy of artificial prosthesis placement is important and surgical guide model design techniques are required to minimize errors.

Standard for in vivo evaluation of three-dimensional printed polymeric scaffolds in bone defects

The standard specifies the in vivo experimentation required for the biological assessment of three-dimensional (3D0 bioprinted polymeric scaffolds intended for the use in bone regeneration. 2D bioprinted scaffolds are gaining increasing attention, and animal experiments are fundamental in assessing their performance prior to potential clinical use. This international standard can be applied to the preclinical assessment such as animal experiments to evaluate the in vivo performance of 3D bioprinted porous polymeric scaffolds.

More recently, the 3D medical applications working group (P3333.2 WG) added 5 project authorization requests (PARs). The approved PARs are: "Standard for Soft Tissue Modeling for Medical 3D Printing," "Standard for Hard Tissue Modeling for 3D Printing," "Standard for Surgical Guide Design Modeling for Medical 3D Printing," "Standard for Artificial Joint Implant Design Modeling for Medical 3D Printing," and "Standard for In Vivo Evaluation of 3D Printed Polymeric scaffolds in bone defects." The resulting family of standards under IEEE P3333.2.5 (Standard for Bio-CAD file Format for Medical Three-Dimensional (3D) Printing) will create a substantial basis for improved medical diagnoses, surgical simulations, implant design, tissue engineering and virtual endoscopy, and personalized medical services.



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On Brain-Computer Interface Standards

By Luigi Bianchi

Brain-Computer Interfaces (BCI) allow people to interact with the environment for either communicating or controlling external devices without using the natural pathways of nerves and muscles [1]. By inducing endogenously or exogenously recognizable brain states, a user intention can be deduced by a special machine that can then drive an external peripheral.

Several different protocols have been proposed over the years, and several brain signals have been analyzed such as EEG , MEG, ECoG, fNIRS and fMRI.

BCI constitutes a highly multidisciplinary research field that has gained great interest in the last two decades, in which several research areas are involved such as engineering, computer science, robotics, neurology, neurophysiology, psychology and rehabilitation. Moreover, the experts must interact not only among themselves but also with patients, health professionals and medical doctors to design or tune a system in the most efficient way. This richness of expertise, however, has some drawbacks because different vocabularies and points of view are used to deal with the same model or BCI system element, and this can easily lead to misunderstandings. Since the early days, it was clear that the large variety of BCI systems could generate confusion: for this reason, in 2003, Mason et al [2] proposed a general static (e.g. no timing issues among modules were dealt) functional model, which is illustrated in Fig. 1: the two relevant main components are the Transducer and the Control Interface. The transducer, in short, is responsible of detecting brain states and its output (a logical symbol, LS, which is the classifier output in general has no semantic meaning) constitutes the input for the control interface, which is responsible of encoding sequences of LSs into a Semantic Symbol SS such as a spelling device that converts classifier's outputs into a character of the English alphabet.

However, even if this functional model were widely adopted, how can we measure BCI performances? Typically, computer scientists are more interested at increasing brain states classification accuracy whereas Amyotrophic Lateral Sclerosis (ALS) patients are usually demanding to maximize their communication speed. Even if the two ways of expressing the performances of BCIs seem comparable, they are actually not: in the first case only the identification of brain patterns is involved, that occurs at the output of the transducer, while in the second case also the control interface play a relevant role (e.g. the choice of the used alphabet) that affects the performances of a system. This simple fact could make it difficult, if not impossible, to compare different systems

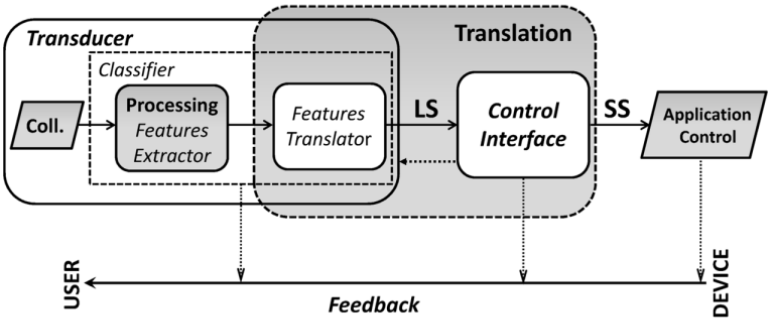

Fig. 1 – Mason's functional model of a Brain- Computer Interface

and is caused by the lack of standardized procedures.

In addition, clear and widely accepted definitions of simple characteristics such as “trial”, “session”, “run”, “real-time”, are missing, which very often differ among research laboratories, manufacturers and the available frameworks, making the description of a system confusing.

In 2008, Quitadamo et al. [3] extended Mason’s model that evolved from static to dynamic, thus dealing with timing issues and synchronization among the various elements, by means of a detailed description made in Unified Modeling Language (UML). In this work she demonstrated that it could be successfully applied to five different commonly used BCI protocols: P300, SSVEP, Motor Imagery, Slow Cortical Potentials and fMRI mental tasks. The great advantage of such implementation was that all the systems shared the same terminology and metrics and that it could be possible to unify their description, making it easy to compare and describe different systems. However, even if several BCI system frameworks were made available over the years, none of them but [4] fully adopted it, making it virtually impossible to share resources among different implementations and very often to compare the performances of the various systems.

As a consequence of all the different visions of what a BCI is, it seems impossible today to imagine converging towards common definitions and methods which allows a painless sharing of resources. The scenery is complex, with different models, methods and frameworks and consequently different file formats that make the cooperation among different laboratories very difficult.

Today the existence of BCI standards is mandatory and their adoption cannot be delayed anymore. This process, however, should be implemented smoothly in order to minimize the effort of making standard compliant to the actually available systems and to maximize the perception adhering to them will provide great advantages to patients, users, manufacturers and the scientific community.

The clear starting point of the standardization process is the definition and adoption of a common BCI functional model that will then open the way to the definition of file formats and tools for designing, describing, optimizing, evaluating, comparing and tuning systems that could be shared among caregivers, health professionals, researchers and engineers. IEEE Standards Association and Brain-Computer Interface Society can clearly play a fundamental role to achieve this goal. Previous experiences demonstrated that it is possible to share a common BCI model and terminology across a wide range of BCIs providing the aforementioned advantages.

A roadmap has been also proposed in [5] showing that relevant benefits can be easily obtained with little effort, even if limited to off-line analysis, systems configuration and in general non real-time BCI behavior. This last, which requires a relevant effort to adapt existing systems to a common dynamic implementation of a BCI, could be however addressed in a successive phase.

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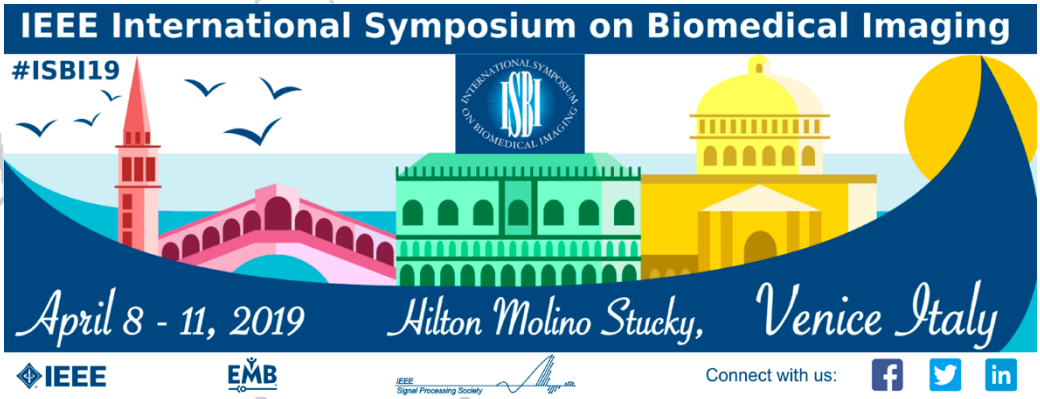
Upcoming Events:



Reports on past IEEE Life Science Events

Life Science Conference'18 Montreal

This year, the IEEE Life Sciences Conference (LSC) was organized by Dr Mohamad Sawan and Dr Carolyn McGregor, General co-chairs, in Montreal, Canada, on October 28 - 30. With more than 150 delegates and authors from all around the world, the conference was a great success! The conference program included 3 keynotes, 8 tutorials, 12 regular lecture and poster sessions, 6 invited lecture sessions and 2 panel sessions on the several innovative topics at the forefront of the discipline, including novel biosensors, smart medical devices, new assistive technologies, bioinformatics, etc. The attendees enjoyed great food and great music at the Conference diner, in the heart of the beautiful city of Montreal. Congratulation to the six Best paper and Best poster awards winners, and warm thanks to all for making this conference a great success, especially to the organizers, the program committee members, the review committee members, the authors and all the delegates!
https://lsc.ieee.org/2018/

Benoit Gosselin, PhD, Ing.
Technical Program Chair
Life Science Conference 2018

LSC'18 Student's Paper Competition Feature

At the IEEE Life Science Conference 2018, held in Montreal, Canada, from 23 to 30 October, Keri McNiel (University of Alberta, Canada), and Gabriel Gagnon-Turcotte (Laval University, Canada), both received best paper awards (1st place and 2nd place, respectively) for their work on the design of smart wireless sensors dedicated to improve and control prosthetic technologies.

Keri McNiel's paper entitled "Development and Verification of a Low-Cost Prosthetic Knee Motion Sensor" presents a wireless sensor for detecting when prosthetic knee is in motion. Indeed, limb amputation affects many individuals across the world, with the majority of amputations occurring in the lower limb. Healthy individuals with intact limbs have biological sensors embedded in their anatomy to interact with the environment and to facilitate stable walking. Lower-limb prosthetic users lose these embedded sensors, leading to decreased balance and an increased risk of falling, abnormal gait, and decreased quality of life. Tactile and kinesthetic sensory feedback techniques are being investigated for upper-limb prosthetic users and may soon translate to lower-limb users. A barrier to implementing these techniques is the lack of adequate instrumentation of lower-limb prostheses. The objective M. McNiel research was to design and develop a low-cost wireless system, using inertial measurement units, which can detect when a single-axis prosthetic knee is in motion. This sensor could be used to communicate the movement of a prosthetic device to actuators responsible for providing feedback to the user. M. McNiel results indicate that the device is capable of tracking the onset and termination of movement at normal walking speeds.

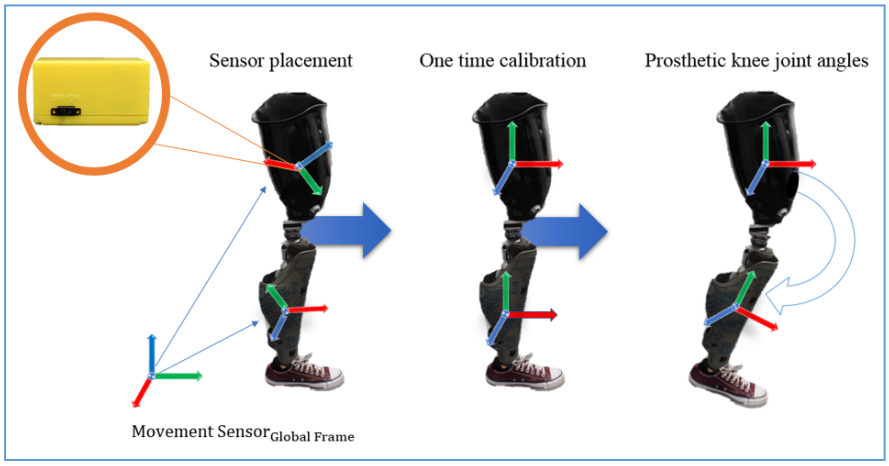


Fig. 1: Concept of the sensor that can detect when a single-axis prosthetic knee is in motion.

M. Keri, A. W. Shehata, Q. A. Boser, A. H. Vette, and J. S. Hebert, "Development and Verification of a Low-Cost Prosthetic Knee Motion Sensor," in 2018 IEEE Life Sciences Conference (LSC), 2018, pp. 283–286.

Gabriel Gagnon-Turcotte's paper entitled "A Multichannel Wireless sEMG Sensor Endowing a 0.13 µm CMOS Mixed-Signal SoC" presents a wireless low-power multichannel surface electromyography (sEMG) sensor featuring a custom 0.13-µm CMOS mixed-signal system-on-chip (SoC) analog frontend circuit for muscle activity discrimination. The proposed sensor includes 10 sEMG recording channels with tunable bandwidth and analog-to-digital converter resolution. The SoC includes 10 low-power & low-noise bioamplifiers, 10 low-power 3rd order ΔΣ MASH 1-1-1 ADC, 10 on-chip 4th order cascaded integrator-comb decimation filter (DF), and a logic module encompassing a serial peripheral interface (SPI) slave module. This SoC provides the sEMG samples data through a SPI bus to a low-power MSP430F5328, Texas Instrument, USA, microcontroller unit (MCU) that then transfers the data to a nRF24L01p, Nordic Semiconductor, Norway, wireless transceiver. M. Gagnon-Turcotte report sEMG waveforms acquired using a custom multichannel electrode module, and a comparison with a commercial grade system. Experimental resultsdemonstrate that the proposed system has better or equivalent characteristics (input-referred noise, bandwidth, power consumption, sampling rate, etc.) than the other available wireless systems, while being smaller and lighter. The sensor has an input-referred noise of 2.5 μV_{rms} (BW of 10-500 Hz), an input-dynamic range of 6 mV_{pp}, a programmable sampling rate of 2 ksps, for sEMG, while consuming only 7.1 µW/Ch for the SoC (1.2-V, w/ ADC & DF) and 21.8 mW of power for the whole sensor fully working (1.9-V, Transceiver, MCU, etc.). The SoC is wirebonded directly on a 1.5 x 2.0 cm^2 printed circuit board, and the whole system weights < 1 g (w/o battery). In future works, M. Gagnon-Turcotte intend to use this sensor for robust muscle activity discrimination for prosthesis control.

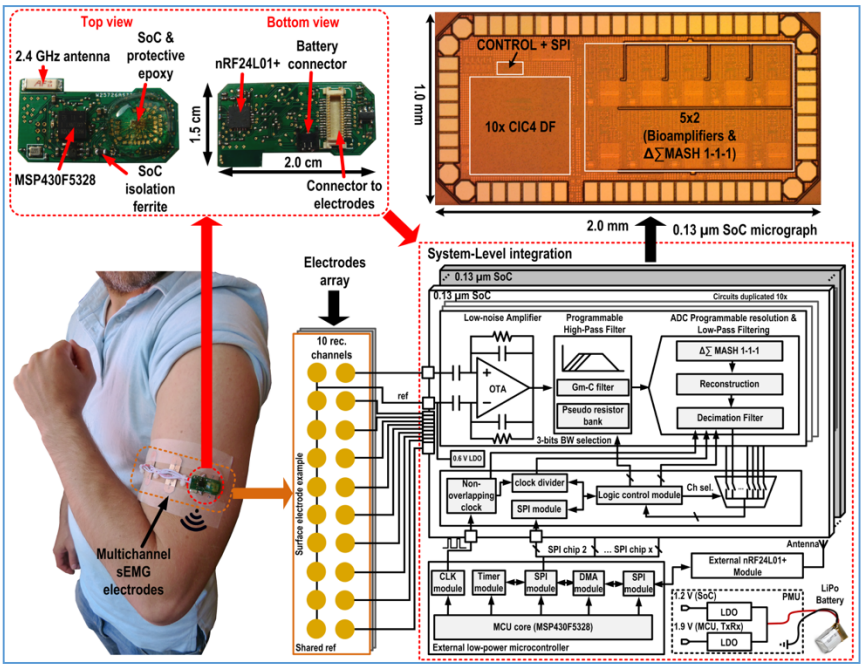


Fig. 2: System-level concept of a wireless multichannel sEMG sensor, which is built around a custom SoC. The 0.13 µm CMOS SoC includes 10 sEMG recording channels, each of which includes a low-noise bio-amplifier, a ΔΣ MASH 1-1-1 ADC and a DF. Each recording channel is differential with one shared electrode, the latter of which is connected to a 0.6-V on-chip LDO output providing the body reference. The SoC is interfaced with an MSP430F5328 low-power MCU through an SPI bus. Hence, multiple SoC can be connected on the same bus to increase the resolution. The SoC micrograph is also shown.

G. Gagnon-Turcotte, C. L. Fall, Q. Mascret, M. Bielmann, L. Bouyer, and B. Gosselin, "A Multichannel Wireless sEMG Sensor Endowing 0.13-µm CMOS Mixed-Signal SoC," in 2018 IEEE Life Sciences Conference (LSC), 2018, pp. 1–4.

Benoit Gosselin, PhD, Ing.
Technical Program Chair
Life Science Conference 2018

Life Science at the IEEE International Symposium on Technology and Society

By Luis Kun

The 2018 IEEE International Symposium on Technology and Society (ISTAS) took place in Washington, D.C., at the George Washington University hosted by the School of Engineering and Applied Science during November 13 and 14, 2018. This is the flagship conference for Technology and Society and the IEEE Society for Social Implications of Technology (SSIT).

ISTAS 2018 - LSTC SESSION- Workshop and Panel Discussion

Health and Public Health Delivery Challenges and Ethics in the Information Age

Background: We live in a planet where two very different realities coexist. One is a world where Internet, cell phones, computers, i-Phones, i-Tunes, i-Pads, i-Pods, High Definition TV, the Global Economy, medications a la carte for: depression, cholesterol, high blood pressure or erectile dysfunction are available. The other reality, however shows that over 71% of the World lives with less than 10 dollars a day. Also according to the United Nations: 884million **people** don't have **access** to **clean water**; 2.5 billion lack proper sanitation facilities; 21.000 persons die every day from malnutrition. In this "other" reality thousands of daily deaths are caused by tuberculosis, AIDS and Malaria (to name a few). Most of these deaths, due to: dirty water, lack of food and medications / vaccines for infectious diseases, are preventable. In the mid-90's a discussion ensued regarding a potential "digital divide" between these two groups. The call for attention was based on the great social inequities that could be produced based on the possibilities between having or not, access to the Internet and communication technologies. Today, 25 years later, new advances, new hurdles and several ethical questions arose. Shifting from a disease centric system to one that focuses on wellness, requires a strategy on prevention. This strategy may require: silencing, activating or editing genes; disactivate cancer cells; correcting genetic defects; neutralizing mosquitos of Malaria, Dengue or Yellow Fever; neutralizing cancer cells; neutralizing infections, virus, HIV, etc. If our goal is to improve the quality of life by avoiding disease while decreasing the associated healthcare costs, many ethical questions will occur regarding Genetically Modified Organisms (GMO)/ humans in particular. While genetic enhancement for a healthier life may be acceptable, what about the following features: stronger, better looking, smarter, or even creating someone as a super human or a super villain? These characteristics could generate errors / horrors, discrimination responsibility toward the future generations, banalization and human dignity challenges to Society. Life expectancy has increased because of advances in science and technology. In the developed world, expenses related to the elderly (non-communicable diseases / chronic conditions) are mounting daily. It is expected for example that the US over 65 population will more than double by 2030. The US already spends 19% of the GDP in health expenses. If we consider that the last

year of life is the most expensive one, then this expense will not only be staggering but unsustainable. In parallel, the world population grew from a 6 to 7.6 billion, from 1995 to 2017. It is expected to reach 8.2 B by 2030, 9.7 B by 2050 and 11.2 billion in 2100, according to a UN report. These population increases will be mainly felt in Africa and Asia, where already 75% of the world population resides. The increases in population density will increase the potential for transmission of communicable (infectious) diseases throughout the world. Advances in computing, information and communications technology provide a unique opportunity to provide mechanisms that may lower the cost of healthcare through prevention while improving the quality of life. Cybercare / homecare through fast access Internet offers such possibilities, however new "digital" challenges such as access to medical information, privacy and security of our information and the interdependence of all of the world's Critical Infrastructures is a new paradigm.

"The Cybercare model shifts health care provision from hospital to home; from specialist to generalist; and from treatment to prevention. Cybercare uses seven "pillars" of technology to provide medical care: genomics; telemedicine; robotics; simulation, including virtual and augmented reality; artificial intelligence (AI), including intelligent agents; the electronic medical record (EMR); and smartphones. All these technologies are evolving and blending. The technologies are integrated functionally because they underlie the Cybercare network, and/or form part of the care for patients using that distributed network. Moving health care provision to a networked, distributed model will save money, improve outcomes, facilitate access, improve security, increase patient and provider satisfaction, and may mitigate the international global burden of disease." From the "Future Delivery of Healthcare"[1]

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[1] C. Koop, Robyn Mosher, Luis Kun, Jim Geiling, Eliot Grigg, Sarah Long, Christian Macedonia, Ronald Merrell, Richard Satava, Joseph Rosen (2008). Future delivery of health care: Cybercare. *IEEE Engineering in Medicine and Biology Magazine*, *27*(6), 29-38. DOI: 10.1109/MEMB.2008.929888 http://www.academia.edu/20121023/Future_delivery_of_health_care_Cybercare

Presenters:

Health and Public Health Delivery Challenges in the Information Age: Prevention a Key

Luis Kun, Ph.D,
Distinguished Professor Emeritus of National Security Affairs
CHDS/NDU -Washington DC

Cybercare / homecare through fast access Internet links patients and primary care providers to tertiary medical providers via telemedicine. This decentralization could reduce costs and as a dual system, better protect a country's resources in an event of biological terror, or natural disasters. A large ransomware cyberattack in May 2017 crippled computer systems at hospitals across Britain with appointments cancelled, phone lines down and patients turned away. Malware infected and locked computers while the attackers demanded a (small) ransom. The ransomware attack however, not only hit 16 National Health System hospitals in the UK but up to 70,000 devices across 74 countries using a leaked exploit first discovered by the NSA and included Banks (China), telephone companies, Federal Express (US), etc. In an interconnected digital world economy, a cyberattack to any industry, anywhere, can have consequences everywhere. Conversely an attack to any other industry can have consequences in the healthcare delivery system. Estonia is the first 100% digital country. In 2007 Russia through a denial of service attack, closed all of this country's critical infrastructures. With the adoption of the Aadhaar system in India (collection of biometrics) 1.4 billion people's privacy and security is at risk. Our (electronic) health records are islands of information not fully accessible, integrated or interoperable. In the US, currently 440.000 people die every year because of preventable medical errors.

Opportunities for applying artificial intelligence in medicine to benefit underserved populations

Sameer Antani, PhD –
National Library of Medicine,
National Institutes of Health, Bethesda, MD

Abstract: Some of the world's deadliest but curable diseases afflict under-resourced and populations of the world. For example, comorbidities of HIV and TB, Malaria, and Uterine cervical cancer are all treatable, or manageable diseases. Yet, these scourges kill millions every year. Recently, the role of artificial intelligence in medicine and other automation and the potential for their introducing cost and labor efficiencies has been extensively discussed in the research literature and popular press. Extending these ideas to under-resourced regions presents an opportunity to apply meaningful research outcomes to serve the afflicted and perhaps even eradicate some of these. At the National Library of Medicine and various other institutes within the National Institutes of Health, computer scientists and biomedical researchers are working toward studying and developing solutions that could make that dream a reality. These solutions are interdisciplinary involving the clinical sciences, computer sciences, and engineering and communication between relevant information systems. This talk will highlight some of the projects led by Dr. Antani that apply image data analytics, machine learning, and AI techniques toward this goal.

Standardization for Life Sciences Technologies: Why do Standards Matter?

Carole Carey, M.S. – IEEE Engineering in Medicine and Biology Society
Private Consulting, Washington DC

Abstract: Life Sciences in the 21st century encompasses industry sectors in many fields, such as biotechnology, biomedical technologies, medical devices, environmental, pharmaceuticals, food processing and so on. Innovation and advances in life sciences technologies have significantly change healthcare and healthcare systems. It is shifting the landscape to more "Personalized Healthcare and Wearables." Whether the use of life science technologies is for clinical application or consumer wearables, the need for standardization is evident in order to produce quality, safe, reliable products at lower costs. This presentation will be a perspective on the value of standards at any stage: research, development, technology transfer or commercialization, of multi-disciplines and inter-disciplines.

Technology is Not Above All. People and Their Needs Are!

Nahum Gershon, Ph.D.,
Senior Principal Scientist MITRE,
Washington D.C. Metro Area

Abstract: Our addiction to mobile devices and the occasional disregard of technology to how people would like to conduct their lives are only two examples of an array of potential ill effects of technology on humans (in addition to its positive effects). Having the slogan of "Advancing technology for the benefit of humanity", it is of utmost importance for IEEE to become knowledgeable and actionable about the disadvantages of technology. The IEEE Life Sciences Community relies on its Life Sciences & technology practitioners to study the positive as well as the negative effects of technology on users and organizations. It thus works to formulate guidelines and methods that will help people & organizations take advantage of the positive aspects of technology use while avoiding its potential pitfalls.