ITUKALEIDOSCOPE
ATLANTA 2019

S1.1 5G-enabled health systems: Solutions, challenging issues and future research trends
Di Zhang, Zhengzhou University, China

S1.2 Access technologies for medical IoT systems
Junaid Ahmed Siddiquee, Ericsson, India (remote presentation)

S1.3 Community healthcare mesh network engineering in white space frequencies
Antoine Bagula, University of the Western Cape, South Africa

S1.4 Exploration of the non-intrusive optical intervention therapy based on the indoor smart lighting facility
Jian Song, Tsinghua University, China

Session 1, ICT infrastructure for healthcare
Session Chair: Mostafa Hashem Sherif, Kaleidoscope Technical Programme Committee Chair

4-6 December
Atlanta, Georgia, USA

Highlights from Paper 1

"The 5G-Enabled Health Systems: Solutions, Challenging Issues and Future Research Trends"

- 5G-technology can improve access to health care in remote areas, thus reducing the disparity of access between cities and rural areas
  - However, the effects of human exposure to 5G radiation may not have been fully evaluated
- Demonstration system from Zhengzhou University, Henan Province
  - Uplink reached 200 Mb/s
  - Latency 2 ms
  - Recently, connected to Aksu, Xijian distance of about 3,7000 km)
  - Public funds were used (i.e. ROI was not the top criterion)
- Applications:
  - Remote diagnostic and treatment
  - Remote and robotic surgery enhanced with virtual reality
  - 5G-enabled ambulances
  - Smart monitoring (in hospital wards and in homes)

Highlights from Paper 2

"Access Technologies for Medical IOT Systems"

- This paper was presented remotely because the author was unable to attend
- Various IOT connectivity standards (5G and Wi-Fi) and proprietary protocols are used for e-Health and m-Health were presented
- The paper lists requirements and challenges and gives an overview of the factors impacting IOT deployment
- A model for the deployment medical IOT systems was proposed.
- The model can be used to classify various Medical IOT systems

Highlights from Paper 3

"Community healthcare mesh network engineering in white space frequencies"

- "White space frequencies" are considered in South Africa and the DRC (aka Congo-Kinshasa) to address telehealth in remote areas.
- Two main issues
  - A common control channel for all nodes is difficult to find
  - Dense network topologies lead to many packet collision.
- The paper presents:
  - A link-based algorithm to reduce the dense mesh network topology in white space frequencies
  - An optimization function to produce a hierarchical back bone.
- The design was evaluated with a simulation on the public safety mesh network for police stations in Cape Town, South Africa.
- The frequencies are unlicensed so the effect of their use in medical systems needs to be evaluate.

Highlights from Paper 4

"Exploration of the non-intrusive optical intervention therapy based on the indoor smart lighting facility"

- LED illumination can affect moods and could be used to enhance well-being or treat diseases such as Alzheimer's disease.
- A preliminary experiment on mice has shown that the hippocampus (responsible for learning and memory) responds to visible light modulation (sine waves at 40 Hz).
- Other factors to be evaluated: type and frequency of modulation, intensity, color temperature.
- This is a first step in a long-term evaluation.

Conclusions/Recommendations

- 5G-enabled health systems can offer solutions to remote diagnosis and treatment, remote surgery and smart monitory.

- There is a need for regulations/certifications for 5G-enabled health systems.

- Since there are plans to use visible light in 6G communications, effects of light modulation on health and well-being must be further investigated.

- Emerging technologies (AI, 6G, Big Data processed identifications such as face recognition, etc.), are permeating daily and the traditional parameters for evaluating ICT capabilities (quality, security, reliability, etc.) may not be adequate in assessing the opportunities/threats of emerging ICT.

- Possible new parameters are safety and trustworthiness.

Highlights from Paper 1

"Module structure for foot prosthetic and interface standardization"

- Motivation: Developing a low price and modular foot prosthetic

- Analyzed the differences in walking gait (i.e. acceleration, angle velocity, angle) of healthy people and people with walking disability with a wearable device

- Developed a prototype shoe with a coil and leaf spring at the heel to increase kicking power to help people with walking disabilities

- Proposed a modular structure for foot prosthetic
  – Composed of socket, ankle joint, foot, instep push/pull, heel-up spring, toe, battery, control board, heel sensor, central terminal

- Defined physical and communication interfaces among the modules
  – Enables third-party manufacturers to produce components of foot prosthetics at a lower cost

Highlights from Paper 2

"Development of hearing technology with personalized safe listening features"

- Motivation: Reduce Noise Induced Hearing Loss (NIHL)

- The proposed safe listening app for both civilian and military population
    - Tracks daily sound exposure: the ambient noise level and the audio that the user is listening
    - Compares the sound exposure to WHO-ITU and US safe listening standards
    - Provides real time alerts and recommendations

- The app is commercialized through a start-up company

- Privacy and security measures are taken according to standards

- The data collected from users with and without hearing disability can help extend Recommendation ITU-T H.870

Conclusions/Recommendations

- The proposed foot prosthetics is not commercialized yet.
  - There should be active participation from organizations to ITU to establish standards so that these types of products can be on the market sooner.

- Security and privacy of medical ICT are major concerns.

- An important question is how these medical ICT devices will be placed in 5G/6G architecture?

SESSION 3

S3.1 Facilitating healthcare IoT standardization with open source: A case study on OCF and IoTivity
Hongki Cha, Electronics and Telecommunications Research Institute, Korea (Rep. of)

S3.2 Empirical study of medical IoT for patients with intractable diseases at home
Kentaro Yoshikawa, Shinshu University and Nagano Prefectural Kiso Hospital, Japan

Session 3, Medical IoT
Session Chair: Antoine Bagula, University of the Western Cape, South Africa

Highlights from Paper 1

"Facilitating healthcare IoT standardization with open source: A case study on OCF and IoTivity"

❖ **Content:** The paper was right on spot in terms of standards and fits very well with the conference theme as the OCF standard can be applied to medical IoT devices.

❖ **Recommendations:** The IoTivity paper raised a debate/controversy where the author recommended/suggested that ITU should do more in adopting the OCF standard. The debate was cleared out by the TSB Director, Chaesub Lee, who recommended that the OCF contributors should put more effort in raising adoption from the other ITU state members since the OCF standard included only 20 members.

Highlights from Paper 1

"Facilitating healthcare IoT standardization with open source: A case study on OCF and IoTivity"

- ❖ **Summary of new trends** (including technical, regulatory, and social aspects), their impacts on standardization and the involvement of academia, and recommended actions. It is my opinion that, though being right on spot, the work done by the presenter is still in infancy stage and **needs much more contribution in terms of features and protocols used** (as raised above) and the **standard itself needs more adoption** by ITU state members as recommended by TSB Director Chaesub Lee.

Highlights from Paper 2

"Empirical study of medical IoT for patients with intractable diseases at home"

❖ **Content:** The paper was right on spot in terms of standards and fits very well with the conference theme. Furthermore, this was a testbed experimentation which is close to a real product compared to simulation which can sometimes be far from the reality.

❖ **Recommendations:** There was no recommendation coming from the audience.

Highlights from Paper 2

"Empirical study of medical IoT for patients with intractable diseases at home"

❖ **Summary of new trends** (including technical, regulatory, and social aspects), their impacts on standardization and the involvement of academia, and recommended actions. It is my opinion that, there are technical and social value to the work. But the future of that work will depend on the direction taken by the authors and the avenues they follow for future work.

SESSION 4

S4.1 Invited paper - Towards international standards for the evaluation of artificial intelligence for health
Markus A. Wenzel, Fraunhofer Heinrich Hertz Institute, Germany

S4.2 Redesigning a basic laboratory information system for the global south
Jung Wook Park, Georgia Institute of Technology, United States

S4.3 #RingingTheAlarm: Chronic "Pilotitis" stunts digital health in Nepal
Ichhya Pant, George Washington University School of Public Health, United States

S4.4 Designing national health stack for public health: Role of ICT-based knowledge management system
Charru Malhotra, Indian Institute of Public Administration, India

Session 4, Digital health strategies
Session Chair: Duncan Sparrell, sFractal Consulting, United States

Highlights from Paper 1

"Towards international standards for the evaluation of artificial intelligence for health"

- Standards for reliable, robust, trustworthy AI/ML are a novel, important subject & highly relevant for health AI

- Standardized benchmarking is a good approach to evaluate and ensure the trustworthiness of AI models

- ITU/WHO Focus Group on "AI for Health" explores best practices and standardization opportunities: Agree on benchmarking criteria, procedures, metrics, test data

Highlights from Paper 2

"Redesigning a basic laboratory information system for the global south"

- Redesigned a laboratory information system (C4G BLIS) to meet the emerging demands of the global south

- Evaluated the improvement with 51 actual users in three African countries

- Confirmed that they were able to improve the usability (speed) **by 30%** using a responsive, simple UI framework. It should not be a challenging task.

- Encouraged international standards organizations dealing with health informatics to pay attention to usability standards for information systems.

Highlights from Paper 3

"#RingingTheAlarm: Chronic "Pilotitis" stunts digital health in Nepal"

- The momentum for digital health projects in Nepal is sporadic but continuous.

- Overall, digital health solutions in Nepal are limited in scope, focus areas, target audiences and sustainability potential.

- At the national level, implementation of digital health projects is frayed, issue and organization-centric, and primarily driven by donor or non-governmental organizations.

- Engaging the private sector, especially telecommunications companies, is an underutilized strategy to move beyond "pilotitis".

Highlights from Paper 4

"Designing national health stack for public health: Role of ICT-based knowledge management system"

- Study proposes to enable the transformation of the health system from one narrowly focused on curing diseases to an integrated KMS focused on all aspects impacting human health

- Recommended model proposes a National Health Stack (NHS) for Public Health (PH) based on principles of Knowledge Management (KMS) consisting of four layers-
  - Data providers (Multi-sectoral); Integrated KM Platform; Inputs for policies/decision making flowing to relevant stakeholders; and spreading awareness about unified approach

- Bidirectional feedback loop amongst all the layers

- Stages in implementation of the model:
  - Identifying building blocks of national health ecosystem; defining ICT benchmarks for KPIs
  - Mapping PH stakeholders/data sources etc. and data collection
  - Data analytics
  - Evidence based decision making
  - Awareness, sensitization and training

Conclusions/Recommendations

- Standards for reliable, robust, trustworthy AI/ML are a novel, important subject & highly relevant for health AI

- Since usability has a strong relationship with productivity and error rate in clinical settings, we should pay attention to usability issues when enacting medical IT standards.

- Engage in strategic collaborative partnerships with the private sector or incentivize independent commercial health technology ventures.

- Inform stakeholders, including the Ministry of Health and ICT in Nepal, of Paper 3 findings

- **Technical** (Standardization, Interoperability, Enabling Infrastructure), **Legal** (Data protection, Data Privacy, Data security, confidentiality) and **Socio-economic** (Availability of Resources, Citizen confidence) challenges need to be addressed

- Synchronized Multi-stakeholder, Multi-discipline collaboration across various disciplines like food safety, environmental pollution, agricultural practices facilitated by ICT & KMS

- New models of data driven interpretation, forecasting & decision making can go a long way in establishing evidence based holistic health systems

- Increased level of citizens' confidence in PH systems leading to improvement in the the quality of life (QoL) and achieve "Good Health and well being" for All.

SESSION 5

S5.1 Elderly health monitoring system with fall detection using multi-feature based person tracking
Dhananjay Kumar and Vivekanandan Dharmalingham, Anna University, India

S5.2 A healthcare cost calculator for older patients over the first year after renal transplantation
Rui Fu, University of Toronto, Canada

S5.3 Automatic plan generating system for geriatric care based on mapping similarity and global optimization
Daidi Zhong, Chongqing University, China

Session 5, Smart technologies for caregivers
Session Chair: Jian Song, Tsinghua University, China

4-6 December
Atlanta, Georgia, USA

Highlights from Paper 1

"Elderly health monitoring system with fall detection using multi-feature based person tracking"

- Real-time data analysis using machine learning and cloud computing is proposed for a better and accurate health-care solution of the non-invasive, hassle-free elderly location monitoring and fall detection aiming at in timely treatment, avoiding severe effects.

- The proposed system achieved 94.67% precision in tracking and 98.01% accuracy in fall detection.

- The fall detection module is relevant to the activities of ITU-T Study Group 16 (the proposed scheme is planned to submit to this SG) and Focus Group on Artificial Intelligence for Health (FG-AI4H).

Highlights from Paper 2

"A healthcare cost calculator for older patients over the first year after renal transplantation"

- Patient cohort and data methods are used to develop and validate a machine learning-based health care cost calculator for the recipients with age 60+ of a deceased-donor, kidney-only transplantation over the first year following transplantation.

- Results show that previous health care use strongly predicts upcoming use
  - Consistent pattern of use among older, chronically ill patients
  - Continuous monitoring of health care use -> continuous cost prediction

- It is recommended to also consider racial and other social underlining factors for a deep and better understanding and estimation of this issue.

Highlights from Paper 3

"Automatic plan generating system for geriatric care based on mapping similarity and global optimization"

- An automatic plan generating system to generate the sensing devices selection plan for the effective and efficient geriatric care is proposed, based on Smart-desire mapping method and Self-repairing artificial fish swarm algorithm.

- This method is verified and validated by the experiments on those elderly people suffering from hypertension, diabetes, and heart diseases.

- In future, standards in the field of geriatric care and smart services will be considered to standardize the design of the smart home.

- The energy consumption should be included into the evaluation metrics.

Conclusions/Recommendations

- ICT has been playing and will play a very important role in every aspect of the health-related areas.

- ITU has a much broader standard coverage which provides a good opportunity for academia to make their ideas, inventions, even prototypes shared with the industry and also standardized.
  - Publish in the ITU conference and academic journal
  - Join the existing FGs or SGs and submit contributions
  - Together establish new FGs or SGs for new emerging areas

SESSION 6

S6.1 Invited paper - Preparing for the AI era under the digital health framework
Shan Xu, China Academy of Information and Communication Technology (CAICT), China

S6.2 Operationalizing data justice in health informatics
Mamello Thinyane, United Nations University, Macao SAR, China

Session 6, Data and artificial intelligence era
Session Chair: Yoshitoshi Murata, Iwate Prefectural University, Japan

Highlights from Paper 1
"Preparing for the AI era under the digital health framework"

- A framework of the digital health industry has been proposed in this paper.

- Factors from the health industry and the ICT part are extracted to study the interaction between two groups of component factors.

- The interaction between ICT and health can be traced through the development history.

- Standardization and regulation have been proposed for the sustainable development of digital health in the AI era.

Highlights from Paper 2
"Operationalizing data justice in health informatics"

- This paper explores the notion of data justice in the context of health informatics and outlines the key considerations for data collection, processing, use, sharing and exchange towards health outcomes and impact.

- In this paper, the human-data interaction framework has been adopted to frame the discussion on the outworking of data justice in health informatics systems.

- The paper expands on the imperatives of legibility, agency and negotiability to identify specific considerations and requirements to inform the design of health informatics systems.

- He proposed the architecture, Personal Health Information eXchange that is based on the multi-agent systems paradigm.

Conclusions/Recommendation

- Ms. Shan Xu's paper is useful to understand the influence of ICT technology on health and the strengths, weaknesses and limitations of AI for health.

- Architecture proposed by Mr. Mamello Thinyane, PHIX, puts the individuals at the center of personal health data flows, and in full control of their data.

- These both papers gave us useful concept and architecture to achieve the Sustainable Development Goals in Health.

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SESSION 7

S7.1 Thought-based authenticated key exchange
Phillip H. Griffin, Griffin Information Security, United States

S7.2 Cyber-safety in healthcare IoT
Duncan Sparrell, sFractal Consulting, United States

Session 7, Safety and security in healthcare
Session Chair: Dhananjay Kumar, Anna University, India

4-6 December
Atlanta, Georgia, USA

Highlights from Paper 1
"Thought-based authenticated key exchange"

- Password to operate *Password Authenticated Key Exchange* (**PAKE**)

  – Keyboards, biometric sensor data, and modeling results collected from non-biometric device

- Extension of **ITU-T Rec. X.1035** for PAKE

  – To support **multi-factor** authentication by adding **biometric** & **possession** factors to the encrypted server challenge

- **Biometric sensor** data based on **two authentication** factors to support the goals of universal access

  – *something-you-know* and *something-you-are*

- Model results of **simple gesture** inputs can be mapped to complex passwords

- PAKE can provide a **low cost**, **certificateless** substitute for the TLS handshake

Highlights from Paper 2
"Cyber-safety in healthcare IoT"

- **Threats** to healthcare IoT threaten patient **safety**

- **Cybersecurity** standards being developed today will enable future healthcare systems to **automatically adapt** to cybersecurity threats in real time

- Use **quantitative** risk analysis such as **loss exceedance** curves and FAIRTM

- Require **Software Bill of Materials** (SBoM)

- **Automation** will be driven by **standards** such as SBoM, STIXTM, TAXIITM, OpenC2, and CACAO

Conclusions/Recommendations

- **ITU-T Rec. X.1035 PAKE** can be extended to support multi-factor authentication by adding **biometric** & **possession** factors to the encrypted server challenge

- PAKE can provide a **low cost**, **certificateless** substitute for the Transport Layer Security (**TLS**) handshake

- **Software bill of materials** (SBOM) approach helps in **cyber-safety** implementation of health care

- **Automation** can be driven by standards such as SBoM, STIXTM, TAXIITM, OpenC2, and CACAO

Highlights from Paper 1

"Technical and legal challenges for healthcare blockchains and smart contracts "

– Blockchain has wide and diverse applications, though the most famous is in finance (cryptocurrency) – more useful applications include healthcare (e.g., integrity of drug supply chains).

– Blockchain presents tangible solutions for improving security, but it's ability to be a game changer for privacy is not yet as clear

– Blockchain technology remains in an early technological stage of development (software will have bugs that need to be worked through)

– Blockchain presents pros and cons with respect to trust

– Many legal issues are presented by blockchain (private law, public law, etc). These will likely impede the growth of blockchain unless resolved.

Highlights from Paper 2

"Design of a credible blockchain-based e-health records (CB-EHRs) platform "

– Goal of designing and creating a credible blockchain e-health record platform

– Platform's focus aimed to both protect privacy and enable more efficient flow of health data as appropriate

– Platform was designed with separate layers for a user interface, business administration, and data access.

– Data demonstrated new insights into effective design of e-health record platforms using blockchain.

Highlights from Paper 3

"The GDPR transfer regime and modern technologies"

– In examining the GDPR's allowances for data transfers and modern technologies, purpose of paper and research was to examine the pros and cons of aspects including how health data is processed outside of the medical context (recognizing that data flows everywhere)

– Examined how health data is protected elsewhere using a step counter use case, and quickly realized that health data is very difficult to track

– Overall, the GDPR appears to have infeasible characteristics that do not account for realistic data flows, and much further technical research is needed to inform the GDPR's effectiveness in practice.