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**UGANDA
COMMUNICATIONS
COMMISSION**

The 7th National Conference on Communications (NCC 2022)

21ST – 22ND JUNE 2022

Inclusive Digital Transformation Through Innovation

NCC
The National
Conference on
Communications

Dr. Edwin Mugume

Chairman Organising Committee, NCC 2022

I am pleased to welcome you to Makerere University to participate in the Seventh National Conference on Communications (NCC 2022). Established by the Uganda Communications Commission (UCC) in October 2010, NCC is a forum that aims to strengthen ICT-based research and innovation, particularly of locally relevant solutions. It is an opportunity for players from academia, industry, and government to come together and discuss the most pressing sector-specific issues. It is also aimed at facilitating networking between junior and senior researchers and practitioners as well as students at different levels of study.

Once again, the College of Engineering, Design, Art and Technology (CEDAT) is proud to organize this conference from the 20th – 23rd June 2022. It is expected that this blended conference will be attended by over 700 people, with 350 delegates in physical attendance (at the Central Teaching Facility (CTF) 2, Makerere University) and the rest attending remotely via Zoom Webinar. This is the second time, after NCC 2021, that the NCC is being held in hybrid mode to virtually reach a wider audience in Uganda and across the region. We have taken all necessary measures to give remote attendees a wonderful experience.

For NCC 2022, we formulated the theme "Inclusive Digital Transformation Through Innovation" to enable participants discuss challenges of affordability and inclusion of access, why digital transformation is important to unlock Uganda's development potential, and the role that the innovation ecosystem can play in this transformation. Our choices of the two keynote speakers, two panel topics and the ten panelists were influenced by this theme. We have also invited two experts to speak on topical issues in our sector. I extend special thanks and gratitude to all the speakers for finding time out of their busy schedules to share their knowledge and experiences with the conference delegates. I am certain that the delegates will benefit greatly from these discussions and talks.

For the first time, we have included industry visits mainly targeted at university students as part of the NCC programme. Industry visits by students and some faculty members will be held on the 20th and 23rd of June 2022.

I take this opportunity to thank our industry partners, Uganda Broadcasting Corporation (UBC), Kiira Motors Corporation (KMC) and Luwero Industries Limited, for accepting to host the students. I would also like to encourage future hosts of NCC to include such opportunities for the students to gain more experience and plan their future careers better. In addition, I also thank our other industry partners, Huawei Technologies Uganda Co. Ltd and the Research and Education Network for Uganda (RENU) for their generous sponsorship towards some activities. For instance, RENU has installed a separate network at the venue to enable all delegates to access high quality Internet during the conference.

In another first, NCC 2022 is featuring an innovations competition focusing on the work that ICT Clubs in Secondary Schools in Uganda are doing. Dubbed the "School ICT Clubs Innovations Competition", the preliminary stage included regional competitions in the Western, Central, Northern and Eastern regions. Regional winners automatically entered the final national competition that will be held on Day 2 of this conference. In addition to the regional winners, the judges selected the best two runners-ups to join the final competition. I have personally been amazed by the innovative ideas and technical competences that these young people have and I encourage all conference delegates to pick interest in the final session. I would like to thank the school administrators as well as club patrons for giving us access to the students to work with them. I also recognize the important mentorship work of the mentors that we allocated to these schools during their ideation and implementation of projects. I also recognize the immense support of KAWA Agency in helping us to reach many schools across the country and further supporting us during the regional competition events.

In yet another first, we held the "National Student Challenge in Cybersecurity" in collaboration with the CyLab of Carnegie Mellon University Africa. Targeted at High School and University students, the aim of the competition was to introduce students to cybersecurity at an early stage and to encourage them to take it up as a career option given that Africa needs more cybersecurity professionals. Although the competition was Africa-wide, teams from Uganda were ranked on a Uganda-only leaderboard to find the best performing teams to be awarded at NCC 2022. I congratulate the winning teams as well as winners of the Best Paper Awards and the School ICT Clubs Innovations Competition and encourage others to improve and win next time. In particular, I encourage junior researchers to take advantage of the Publishing Masterclass workshops that we hold as part of the NCC to improve their research results and writing skills.

I thank UCC for their continued generous financial support which makes NCC possible. This includes the generous financial packages that are given to winners to enable them to continue their work. In addition, UCUSAF supports some ICT Clubs in Secondary Schools, some of which are here. UCC and UCUSAF are creating positive change in the sector and I encourage practitioners, researchers and students to take advantage of these opportunities.

I also wish to thank the Makerere University Administration for supporting this collaboration with UCC in making NCC a reality. Having now hosted five NCCs, the organizers have always received positive support from the administration. I extend special thanks to the Principal of CEDAT, also the Ag. Deputy Vice Chancellor for Finance and Administration, Prof. Henry Alinaitwe, and the Dean of the School of Engineering, Dr. Dorothy K. Okello, for their leadership, advice and support during the organization of this conference. Last but not least, I am grateful for the support of members of the Organizing Committee, from the various Chairs and Co-Chairs, through to our support staff, research staff and some of our students. Without a collective effort, we would not have succeeded in hosting this very huge event.

I wish you all fruitful deliberations and a successful NCC 2022.

AGENDA

Day 0: Monday, 20 June 2022		
14:00 - 17:00	Student Activity	Industry Visit to Uganda Broadcasting Corporation (UBC)
Day 1: Tuesday, 21 June 2022		
08:00 – 09:00	Arrival and Registration of Participants	
09:00 – 10:00	Opening Addresses	1. Prof. Henry Alinaitwe, Principal, CEDAT and DVC F&A 2. Prof. Barnabas Nawangwe, VC, Makerere University 3. Eng. Irene Kaggwa Sewankambo, Executive Director, UCC 4. Hon. Godfrey Baluku Kabyanga, Minister of State for National Guidance
10:00 – 10:20	Group Photo	
10:20 – 10:50	*Tea Break*	
10:50 – 11:30	Keynote Speech 1	Dr. Aminah Zawedde, PS MoICT&NG
11:30 – 11:50	Innovation Demos	Short Profile Videos
11:50 – 13:00	Panel Discussion 1: *Inclusive Digital Transformation in Uganda: Opportunities and Challenges*	*1. Mr. Geoffrey Ssengendo, UCC [Moderator]* *2. Hon. Nyombi Tembo, Director UCUSAF, UCC* *3. Ms. Stella Alibateese, Director PDPO, NITA-U* *4. Mr. Nicholas Mbonimpa, CEO RENU* *5. Dr. Bello Moussa, Huawei Southern Africa*
13:00 – 14:00	*Lunch*	
14:00 – 14:30	Invited Talk	Mr. Cosmas Zavazava, ITU
14:30 – 15:30	Presentation of Technical Papers	Mr. Mayur Chhipa, ISBAT University
15:30 – 17:00	Posters and Demos	
18:00 – 21:00	Cocktail Reception	(Invitation Only)
Day 2: Wednesday, 22 June 2022		
08:00 – 09:00	Arrival and Registration of Participants	
09:00 – 09:40	Keynote Speech 2	Dr. Assane Gueye, CMU-Africa
09:40 – 10:10	Invited Talk: Mr. Tony Li, Huawei Ug.	*5G Is Coming: How to Build Secure and Resilient 5G Networks*
10:10 – 10:50	*Tea Break*	
10:50 – 13:00	School ICT Clubs Innovations Pitch	St. Mary's College Kisubi, Tororo Girls School, St. Gracious Secondary School, Iganga (Girls) Secondary School, Ntare School, St. Henry's College Kitovu
13:00 – 14:00	*Lunch*	
14:00 – 15:10	Panel Discussion 2: *Harnessing Uganda's Innovation Potential to Achieve Digital Transformation*	*1. Dr. Cosmas Mwikirize, Office of the President [Moderator]* *2. Ms. Peace Oliver Amuge, ED WOUGNET* *3. Mr. Richard Zulu, Lead at Outbox* *4. Mr. Kwame Rugunda, Chief Executive CryptoSavannah* *5. Dr. Roseline N. Akol, CEDAT Makerere University*
15:10 – 15:40	Award Ceremony	1. Winners, ICT Clubs Competition 2. Winners, Cybersecurity Competition 3. Best Papers
15:40 – 16:10	Closing Remarks	Dr. Dorothy K. Okello, CEDAT
16:10 – 16:30	Final Remarks	1. General Chair, NCC 2022 2. Executive Director, UCC
16:30 – 18:00	Departure at Leisure	
Day 3: Thursday, 23 June 2022		
09:00 – 15:00	Student Activity	Industry Visit to Luweero Industries Ltd and Kiira Motors Corporation (KMC)

SPEAKERS

Keynote Speakers

Dr. Aminah Zawedde

Permanent Secretary of the Ministry of ICT and National Guidance.

Dr. Aminah Zawedde is an experienced IT professional passionate about embracing digital transformation to improve business models, service delivery and transform people's lives. She provides strategic and technical guidance on how various sectors can leverage innovation and digital solutions to solve their problems while creating employment opportunities for the youths. To this end, she has played a big role in strengthening the linkages between government, the private sector, academia and development partners. Dr. Zawedde is a Rotarian and also serves on the boards of DFCU Limited, NITA-U and MustardSeed Junior School.

Dr. Assane Gueye

Professor, Carnegie Mellon University Africa

Dr. Assane Gueye is an Assistant Teaching Professor at Carnegie Mellon University Africa since August 2020. He is the co-Director of the CyLab-Africa initiative and Director of the Upanzi Digital Public Goods Network. Dr. Gueye also holds a Guest Researcher position with the National Institute for Standards and Technology, Gaithersburg, USA. He previously was a faculty member at the ICT Department at the University Alioune Diop of Bambey, Senegal, where he also led the research group "Technologies de l'Information et de la Communication pour le Développement" (TIC4Dev). Assane completed his PhD in Electrical Engineering and Computer Sciences from UC Berkeley in March 2011. He previously received a master's degree

in communication systems engineering from Ecole Polytechnique Fédérale de Lausanne, Switzerland. His research interest focuses in two main areas: performance evaluation and security of large-scale communication systems, and information and communication technologies for development (ICT4D). Assane is a Fellow of the Next Einstein Forum (Class of 2016). In 2019 he was nominated as a member of the European Alliance for Innovation (EAI) inaugural Fellow Class.

Title: On the Need of Tailored Cybersecurity Research and Education for Africa

As Africa is embarking into the Fourth Industrial Revolution by leveraging digital technology, it has become an urgency to develop cybersecurity solutions that will enable a resilient and trustworthy digital environment in the continent, as well as the skilled workforce necessary to implement and support these solutions. Unfortunately, according to the Global Cybersecurity index published by the ITU, cybersecurity maturity assessments done by Oxford University's Global Cybersecurity Capacity Building Center and interviews with over 70 experts across 66 organizations - it was established that Africa was lagging behind in cybersecurity capacity across multiple dimensions spanning technology, policy, legal, educational and infrastructure. For instance, only 12 countries (out of 55 members of the African Union) had a national cyber strategy and only 13 countries had a national computer emergency response team (CERT) as of May 2020. There is a significant "visibility gap" in seeing, understanding and responding to cyber threats because of a lack of incentive (risks becoming an open target), infrastructure (e.g. national/sectoral CERTs), institutions (well-coordinated and connected information clearing houses) and enforcement capabilities. While cybersecurity continues to be an issue for each single part of the world, Africa has a unique and fragile cyber environment that deserves tailored research and education efforts.

In this talk, I will first argue for the need of tailored cybersecurity research and education in Africa. Then, I will talk about some of the projects we are currently carrying at CyLab-Africa with a focus on the opportunities and the challenges we are facing, as well as some of our early results.

PANELISTS

Hon. George William Nyombi Thembo

Hon. George William Nyombi Thembo is the Director for the Uganda Communications Universal Services Access Fund (UCUSAF) at the Uganda Communications Commission (UCC). He assumed that office in January 2017. He holds a Bachelor of Arts degree from Makerere University and a Master of Science in Development Economics from Uganda Martyrs University (UMU). He also holds a diploma in project planning and management (Bradford University, UK) and a post-graduate diploma in financial management (UMU).

Among others, Hon. Nyombi worked as an analyst, planning officer and senior planning officer for the then Uganda Railways Corporation during the 1990s and as a Project Manager for Transport Rehabilitation Project (Railway Component), at Kampala City Council (1995-2001), when he joined politics. Hon. Nyombi was elected to the Ugandan Parliament in 2001, representing his home constituency of Kassanda County South in Mubende District for over a decade (2001-2015). He has also held a number of posts in the Ugandan Cabinet: State Minister for Primary Education in the Ministry of Education and Sports (2001-2009), State Minister for Luweero Triangle in the Office of the Prime Minister (2009-2011) and State Minister for Information and Communications Technology (2011-15).

Geoffrey Sengendo

Mr. Geoffrey Ssengendo is a multi-skilled ICT professional with 22 years working experience with the Uganda Communications Commission, the regulator for the ICT sector in Uganda. He possesses vast knowledge and interest in the International Policy & Regulatory aspects of the ICT sector.

He possesses a BSc in Electrical Engineering from Makerere University and an MSc in Operational Communications, and is a British Chevening Scholar. He has held a number of roles at UCC over the years, and has gained significant experience in spectrum management, technical services, international relations and leadership. He is currently the Head of Research and Service Development at UCC.

Stella Alibateese

National Personal Data Protection Director in the Personal Data Protection Office.

Ms. Stella Alibateese is the National Personal Data Protection Director in the Personal Data Protection Office. The Personal Data Protection office is an independent office set up under National Information Technology Authority, Uganda (NITA-U) to be responsible for personal data protection in Uganda.

She is responsible for the management and operationalisation of the Personal Data Protection Office and is the national focal point for monitoring and assurance of matters related to the implementation of the Data Protection and Privacy Act, 2019.

She is a practising advocate with 25 years' experience with the bulk of it being on policy and regulatory matters in the Public Sector. 10 years of this experience has been in the ICT sector where she has made tremendous

contribution to regulation of the ICT sector.

Prior to this appointment, she worked as the Director, Regulation and Legal Services at the National Information Technology Authority, Uganda (NITA-U) where she led teams in the development of Laws (including the Data Protection and Privacy Act 2019) and Legal Instruments for regulation of the ICT sector with a focus on the development of Electronic Government in Uganda. She has also over the years provided excellent in house legal counsel services with a proactive approach.

Stella also worked with the National Social Security Fund (NSSF) for 10 years where she rose to the position of Deputy Corporation Secretary/Ag. Corporation Secretary, at Messrs Hunter and Greig Advocates and Tropical Bank Limited.

She holds a Master of Laws (University of London UK), Post graduate Diploma in Project Planning and Management (Uganda Management Institute), Post Graduate Diploma in Legal Practice (Law Development Centre, Kampala) and a Bachelor of Laws (Hons) (Makerere University).

She is a GIAC Certified Professional: Law of Data Security and Investigations (GLEG), and an IAPP Certified Information Privacy Manager. She is an advocate and Commissioner for Oaths and a member of various professional associations.

Stella is passionate about issues affecting youth and women and believes that through ICT, they can be empowered to develop and harness their talents to overcome the various challenges they face. She is a mentor and a Rotarian.

Dr. Bello Moussa

Head of Innovation and ICT Strategies Huawei Southern Africa

Mr. Bello Moussa is responsible for design and implementation of new solutions and new technologies aimed at supporting developing countries in unleashing digital opportunities for inclusive development. These include solutions relating to broadband infrastructure, wireless telecom protocols, wireless product portfolio management & development, solution strategy for IoT, 5G &5.5G.

He has 20 years' experience in Telecommunication Industry forward focus on ensuring Regional and National ICT policies and regulations are aligned and inclusive of future ICT technological developments and implementation solutions to the benefit of the Region economies and Social Welfare.

Nicholas Mbonimpa

Chief Executive Officer of the Research and Education Network for Uganda (RENU).

Mr. Nicholas Mbonimpa has over 10 years of experience in data network planning and design. He previously worked as the Chief Technical Officer (CTO) for RENU, from 2014 to 2018. Before that, he worked as a Data Network Planning Engineer for MTN Uganda, and as a Satellite Systems Engineer for iWayAfrica (U) Limited.

Dr. Cosmas Mwikirize

Dr. Cosmas Mwikirize is the Superintendent-Industrial Value Chains Development at the Science, Technology and Innovation Secretariat, Office of the President." In this role, he is responsible for coordinating the implementation of strategic research, technology development and innovation to facilitate development of Uganda's priority industrial value chains (Pathogen Economy, Mobility, Industry 4.0+, Aeronautics and Space, Infrastructure Innovations, Productivity Acceleration, Import Substitution and Export Promotion). He is on secondment from Makerere University where he is a Lecturer in the Department of Electrical and Computer Engineering. He holds a PhD in Biomedical Engineering from Rutgers University-USA, Master's degrees in Biomedical Engineering and Electrical Engineering from Rutgers and Makerere University + Massachusetts Institute of Technology, and a Bachelor's degree in Electrical Engineering from Makerere University. He has previously undertaken industrial residency at Philips Research North America in the Ultrasound Imaging and Interventions group.

His research body of work focuses on biomedical instrumentation, applications of machine learning in medical image computing and computer-assisted interventions, and IoT device development. He is a renowned scholar, with over 20 peer reviewed articles, 5 USPTO & WIPO patent publications, and numerous international awards. He is also a project manager and Board Member at Innovex Uganda Limited, a manufacturer of IoT solutions for remote monitoring and control of renewable energy technologies. Since 2013, Cosmas has been a mentor and judge for BigIdeas@Berkeley, a competition that sponsors student-led moonshot innovations toward solving salient global challenges.

Dr. Roseline N. Akol

Dr. Roseline N. Akol, holds BSc. Engineering (Electrical) degree from Makerere University, MSc. & PhD degrees in Electronic Engineering both from the University of KwaZulu-Natal. Dr. Akol has been teaching in institutions of higher learning for over 25 years. During this time, she has taught, researched, supervised and mentored students at different levels. Dr.

Akol has been in the business of human capital development of Electrical, Computer & Telecommunications Engineers in Uganda for many years. Her current research interest is in wireless technologies, Internet of Things (IoT), smart grids and smart technologies. Dr. Akol is passionate about harnessing and growing resources.

Peace Oliver Amuge

Executive Director of Women of Uganda Network (WOUGNET)

Peace Oliver Amuge is a Communications Specialist, Gender Digital Rights Activist and a Writer, she's currently the Executive Director of Women of Uganda Network (WOUGNET). WOUGNET is an organisation that promotes

the use of technology by women and women's rights organisations. She is a member of the UN Multistakholder Advisory Group (MAG) with the Internet Governance Forum (IGF). She has authored a couple of online publications on topics related to gender and technology. Peace is a mentor for the Open Internet for Democracy Leaders Program and Board member of the Centre for Multilateral Affairs (CfMA).

Kwame Rugunda

Chief Executive at CryptoSavannah technology arm

CryptoSavannah has led the adoption of blockchain technology in Uganda and is an African industry thought leader. They also set up Binusu - Uganda's first crypto exchange, Tuzanye - a leading African blockchain gaming guild, and REDEX – which is using blockchain technology to fractionalize real estate in Uganda.

Kwame Rugunda is the Chairman of the Blockchain Association of Uganda, was the co-founder of Binance Uganda, is a member of the World Economic Forum Council on Cryptocurrencies and sits on Uganda's National Taskforce

Richard Zulu

Richard Zulu is the founder and lead at Outbox, an innovation and entrepreneurship support organisation that brings together the capital, knowledge, infrastructure and people necessary to help small and growing businesses to succeed.
He is also the chairperson of Startup Uganda, an association of 28 innovation and entrepreneurship support organisations working together to improve collective capacities, influence, and impact, and to create a more enabling environment for innovators and entrepreneurs.
He is a member of the innovation and BPO Council under the Ministry of ICT and National Guidance.
He has over twelve years of experience in building support systems for startups, software developer communities and small and growing businesses in Uganda.
Through his work, he has supported in the design and management of innovation challenge initiatives with various partners some of whom include Google, NSSF, UNFPA, UNICEF, MTN Uganda, to mention but a few. He is currently supporting a portfolio of over 100 businesses per year to become

more competitive and investment ready through the various enterprise development initiatives at Outbox. He is passionate about leveraging human centred design approaches for product design and development.

He is an East African Acumen Fellow 2014 and a US International Visitors Leadership Program Alumni.

Invited Speakers

Mr. Tony Li

Huawei Uganda Vice President

Mr. Tony Li is the Huawei Uganda Vice President. He holds a Bachelors Degree in Computer Science and Technology. He possesses over 15 years ICT experience and is an expert of ICT technology like Microwave, DWDM, RAN and Core Network, etc.

He also possesses over 10 years comprehensive Cybersecurity experience, with a deep understanding of Cybersecurity with end-to-end solution design, infrastructure planning and implementation. In addition, he has over 11 years work experience in Africa, supporting more than 10 Africa countries to build advanced ICT network infrastructure.
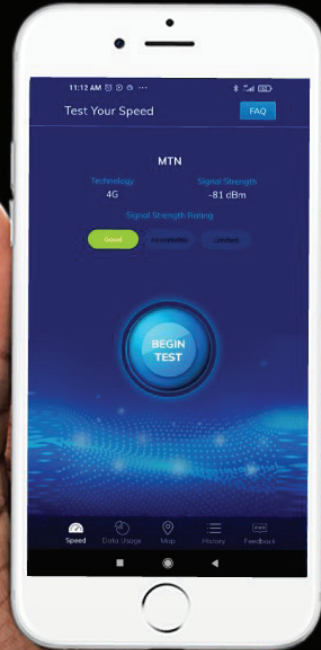
Publishing Masterclass Workshops

The task of writing publishable research papers remains a key challenge to many young researchers. They are often not aware of what information to include and how it should be organized to form an acceptable research paper. However, most science research papers have a standard format (structure) that should be followed. The standard format typically contains an introduction section that briefly states the problem, reviews existing literature of the research area, and gives a general outline of the paper, a methodology section that details how the research was undertake, a separate or combined results, discussion and application sections, and a final conclusions section that highlights the key lessons derived from the research.

As part of the pre-conference activities and lessons learnt from previous NCCs, one-day Publishing Masterclass workshops were held at a number of Universities in Uganda during February 2022. These Universities included Kyambogo University, Ndejje University, Mbarara University of Science and Technology, Kampala International University, Busitema University and Makerere University. The key objective of these workshops was to improve the quality of written research papers submitted to NCC 2022. The workshops were facilitated by Dr. Abubaker Matovu Waswa, Dr. Abel Kamagara, Dr. Andrew Katumba and Mr. Tonny Ssettumba.

The participants in these workshops acquired skills and best practices followed in writing high quality research papers, which are acceptable for publication in both local and international conferences / journals. The workshops emphasized the structural format of research papers and the available tools used to generate such papers.

Publishing Masterclass Facilitators

Dr. Abubaker MATOVU Wasswa

Lecturer, Department of Electrical and Computer Engineering – Makerere University Chair, Technical Program Committee – NCC 2022

He lectures computer and telecommunications engineering courses in the Department of Electrical and Computer Engineering. He previously served as an experienced solution architect at Ericsson where he was responsible for telecommunications network designs and project management of network deployments. He also held network planning engineer positions within Uganda's network operators – MTN Uganda and Uganda Telecom.

He has publications in international conferences/journals with his research interests being in the engineering of telecommunication systems, currently focusing on device-to-device (D2D) communication, internet of things (IoT) and smart networking. He is enthusiastic about applying/adapting the various innovations and/or telecommunications technologies to the evolving needs and challenges of society.

Dr. Abel Kamagara

Dr. Abel Kamagara is an academician and engineer with fifteen years of experience in the field of electrical communications, and electronics engineering. Prior to a brief postdoctoral position at The University of Memphis, Memphis, Tennessee, U.S.A., in Herff College of Engineering in the department of electrical and computer engineering, he completed a Ph.D. in Optical Engineering from The University of Chinese Academy of Sciences, in Beijing, and SIOM-Chinese

Academy of Sciences in Shanghai, China. This is complimented by a Master of Engineering (MEng.) in Analytic Instruments, Measurement and Sensor Technology, from Coburg University of Applied Sciences and Arts, Coburg, Germany, he also obtained Bachelor of Science in Electrical Engineering from Makerere University, Uganda.

Dr. Andrew Katumba

Dr. Andrew Katumba is a Lecturer at Makerere University in the Department of Electrical and Computer Engineering where he also serves as the Lead for the Marconi MachineLearning Lab. He holds a PhD in Photonics Engineering with a focus on applying artificial intelligence to revolutionize the field of high-speed optical communications.

Andrew has published over 60 peer-reviewed publications that have been cited over 500 times and holds 2 patents.

Tonny Ssettumba

Tonny Ssettumba received a Bachelor of Science degree in Telecommunications Engineering from Makerere University Kampala, Uganda. He obtained his MSc. degree in Electronics and Communications Engineering from Egypt Japan University of Science and Technology (EJUST) New Borg-El Arab City, Egypt. He is currently a PhD Candidate in Electrical Engineering (Signal Processing, Automation and Robotics) at Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Rio de Janeiro, Brazil. He is an Assistant Lecturer at the Department Electronics and Computer Engineering at Soroti University (SUN). His current research interests include but not limited to: Iterative detection and decoding for multiple antenna systems, Physical Layer security, Stochastic geometry modeling of communication systems, Green radio and energy-harvesting communications, and electronic waste management.

PROJECT DEMOS

Project Title: A Smart Portable Ultrasound System for Guidance of Minimally Invasive Procedures

Names of Researchers: Paul Okwija Mugume, Alvin Bagetuuma Kimbowa, Sylvia Imanirakiza, Joanitta Nabacwa, Dr. Andrew Katumba, and Dr. Cosmas Mwikirize

Affiliations of Researchers: Makerere University

Non-communicable diseases such as cancer, cardiovascular disease and diabetes contribute to about one third of the total annual deaths in Uganda. Minimally invasive procedures such as biopsies, regional anesthesia and fluid aspiration are crucial in the diagnosis and treatment of these diseases. These procedures involve percutaneous needle insertion and 2D ultrasound imaging is widely used to improve needle placement accuracy. However, ultrasound has a narrow field of view and needle visibility is negatively impacted by steep insertion angles and small needle sizes. This often leads to loss of visibility and could reduce the efficacy of procedures, or cause injury and postprocedural complications. Machine learning algorithms have been proposed to solve this challenge, however, they have not been deployed in ultrasound systems for real time use.

The project addresses the gap between ultrasound systems and machine learning algorithms developed to improve needle visibility and guide minimally invasive procedures. This, consequently, addresses the problem of poor needle visibility during minimally invasive procedures and ultimately the diagnosis of non-communicable diseases in Uganda.

We present robust and accurate machine learning models for both needle localization and segmentation in 2D ultrasound images. Our main contribution is the domain specific model development and evaluation, as well as integration of the models in a low-cost portable 2D ultrasound system, the Clarius L7. The proposed system can provide radiologists with real-time guidance, improving the target detection rate, reducing procedure time, and improving success rate

of clinical procedures. We developed two machine learning models, a YoloR model for needle localization and a Unet inspired model for pixelwise segmentation. We integrated these models into the image processing pipeline of the Clarius L7 portable 2D ultrasound system using the Clarius Cast API. The Clarius Cast API allows for streaming and manipulation of ultrasound images from the probe on multiple laptops or computers . The models receive the 2D ultrasound images from the probe, detect the needle shaft and tip, then feed the output back into the pipeline of the system for display on a graphical user interface.

Project Title: Remot

Names of Researchers: Douglas K. Baguma, David Tusuubira

Affiliations of Researchers: Innovex Uganda

Roughly 567 million of Africa's 1.3 billion population live in urban areas. While urban-dwelling continues to grow, the majority of people still live in rural areas with limited or no access to electricity. In Uganda, 80% of the population lives in rural areas, and less than 10% have access to electricity.

Since connecting the country's entire population to grid electricity is a slow and costly process, alternative sources of power like solar are growing popular. And services like pay-as-you-go (PAYG), are making solar affordable as homeowners can make lease payments for a specified amount of time.

While PAYG solved the payment component of reaching "last-mile" communities, it doesn't address operational challenges like remote monitoring. To address this need, Uganda-based startup Innovex developed Remot, a cloud-based IoT solution enabling solar companies, EPC, and distributors to remotely monitor and manage their energy systems.

By providing better after sales support, Remot is transforming how

solar companies do business by reducing overall downtime and improving the accessibility of solar systems and equipment.

To date, 'Remot' has been used by over 30 companies and researchers in Uganda, and Kenya, DRC, Tanzania, and Ethiopia, as well as research students at Oxford University in the UK and HEC in Paris.

Our Remote Management System delivers digital solutions for off-grid Photovoltaic (PV) installations of different types, use cases, and sizes, in solar home systems and solar-for-productive use settings.

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LIST OF
ABSTRACTS

A Review of Green Communication Techniques Applied in the International Space Station

Mary Patience Namugwanya and Abubaker Matovu Waswa

Abstract: This paper presents the use of green communications in International Space Stations (ISS). There are many other space stations that we have had in the earth's lower orbit, but for this paper, we shall focus on the ISS. A pair of starboard photovoltaic arrays is located at one end of the ISS and a pair of port photovoltaic arrays on the other end. It is made up of seventeen pressurized modules: six Russian modules, eight US modules, two Japanese modules and one European module. These modules are found in the centre of the football pitch sized ISS and need to stay in constant communication with each other. Green communication is essential in such a network, to maximise the network's availability.

This survey paper presents the techniques used to implement green communication on the ISS, which are; Device-to-Device Communication, Multiple Input Multiple Output systems, Heterogeneous Networks and Green Internet of Things. These techniques are already in practice and are evolving in the space communication network. They are defined, their use explained and their applicability on the ISS is shown in this paper per technique. The space communication network contributes to several activities carried out on the ISS. These activities affect human life as well as experiments and general activities on the ISS. This implies that the greener the network, the better.

Design and implementation of a hybrid blind spot detection and monitoring system for public transport

Shibah Lateefa Tusuubira, Stephen Augustine Tipa, Simon Peter Miyingo, Maximus Baguma Byamukama, Amara Agatha Turyagyenda

Abstract: Changing lanes or negotiating a turn in a congested area without proper knowledge of objects in the blind spot areas can be dangerous. Drivers of long/large vehicles have an especially difficult time seeing everything around them, but the implications of missing an impediment could be disastrous. As buses travel on increasingly congested roads, drivers require assistance in eliminating blind spots and identifying potential collisions before they occur.

This paper presents the proposed architecture and design for a hybrid Blindspot Detection System for public transport. The motivation of this project was the need for localization of the value chain in the Ugandan automotive industry. In the system implementation, the Raspberry Pi gathers input parameters from the two types of sensors (ultrasonic sensors for range detection, and an accelerometer for motion detection). Additionally, the feed obtained from the Raspbian camera is fed to an object detection model for object identification.

The system has two basic alert features, auditory feedback, and visual alert. A graphical user interface was also implemented to provide detailed information about the object. With the above setup, a hybrid blind spot detection system was feasible. In-vehicle tests were however not conducted, all tests were alpha tests performed on the bench. The project findings have shown that the HC-SR04 ultrasonic sensors and the Raspbian cameras were not suitable for deployment. For a complete deployable system, there was a need for identifying superior sensors and microcontrollers that can easily be integrated with the Controller Area Network communication protocol.

Design of a Face Recognition system for Public Transport fare Payment

Blaise Marvin Rusoke, Denis Musinguzi, Simon Peter Miyingo, and Andrew Katumba

Abstract: Face Recognition technology is chiefly concerned with accurately re-identifying individuals through the use of mathematical face representations. It presents a window of opportunity for the introduction of a fast, automated, seamless and easy to deploy form of biometric technology. In this research we design a fast, easy to use, and privacy oriented contactless payment system for public transportation that chiefly makes use of face recognition and internet of things technologies.

We demonstrate a one-shot face recognition model and also prepare and test it for real-time inference on the edge. Our system makes use of a Siamese Model built on top of the Inception-Resnet V1 architecture with accuracy, precision and recall values of 93.81%, 90.91% and 97.35% on our validation set. The model was deployed on a Raspberry Pi 4 Model B with an Intel Neural Compute Stick 2. Inference was performed through the inference engine API of the OpenVINO toolkit on the Neural Compute Stick plugged into the Raspberry Pi. The system is composed of three other subsystems, i.e. the edge device, cloud database and user interface subsystems which work together to ensure that payment is complete in under 2 seconds.

A smart Portable Ultrasound for Guidance of Minimally Invasive Procedures

Sylvia Imanirakiza, Joanitta Nabacwa, Paul Okwija Mugume, Alvin Bagetuuma Kimbowa, Dr.Andrew Katumba, and Cosmas Mwikirize

Abstract: Minimally invasive procedures such as biopsies, regional anesthesia and fluid aspiration are crucial in the diagnosis and treatment of non-communicable diseases. These procedures involve percutaneous needle insertion and 2D ultrasound imaging is widely used to improve needle placement accuracy. However, ultrasound has a narrow field of view and needle visibility is negatively impacted by steep insertion angles and small needle sizes.

This often leads to loss of visibility and could reduce the efficacy of procedures, or cause injury and postprocedural complications. Recently, machine learning algorithms have been proposed to solve this challenge, however, they have not been deployed for real time use. This excludes radiologists from the benefits brought about by artificial intelligence. To address this gap, we have developed robust and accurate machine learning algorithms and integrated them in a portable ultrasound system, the Clarius L7, for real-time needle localization and segmentation.

The models are based on YoloR and modified Unet architectures and were trained on 562 human and 874 ex-vivo ultrasound images and evaluated on 381 ex-vivo images. The localization model achieved an mAP@0.5 of 0.702 with an overall processing time of 6 frames per second (fps) on an NVidia GTX 1050 GPU with 4GB VRAM. The segmentation model achieved an IoU of 0.539 with an overall processing time of 14 fps on the same machine. Future work will focus on clinically validating this system. Our work is a step forward toward developing a smart system for real-time localization and segmentation of needles under ultrasound guidance.

TECHNICAL SESSIONS

Chair: MAYUR KUMAR CHHIPA

Paper Presentations

	Authors	Paper Title
1	Mary Patience Namugwanya, Abubaker Matovu Wasswa	A Review of Green Communication Techniques Applied in the International Space Station
2	Lateefa Shibah Tusuubira, Stephen Tipa Augustine, Simon Peter Miyingo, Maximus Byamukama Baguma, Amara Agatha Turyagyenda,	Design and implementation of a hybrid blind spot detection and monitoring system for public transport
3	Blaise Marvin Rusoke, Denis Musinguzi, Simon Peter Miyingo, Andrew Katumba	Design of a Face Recognition system for Public Transport fare Payment
4	Paul Okwija Mugume, Alvin Bagetuuma Kimbowa, Sylvia Imanirakiza, Joanitta Nabacwa, Andrew Katumba, Cosmas Mwikirize	A smart Portable Ultrasound for Guidance of Minimally Invasive Procedures

Poster Presentations

No.	Authors	Title
1	Timothy Mukhooli, Claire Nyaketcho and Duncan Sebampitako	Improving Uganda's Electricity Reliability by Integrating Renewable Energy to the National Grid
2	Abbey Mugisha	Interactive presentation and authoring for real time ideation
3	Ogwal Emmanuel, Joseph Ebosetale Okhaifoh, Ebenezer Esenogho, Malik Mohamed Umar	Investigation of Optimum Beamforming in Millimeter Wave Wireless Sensor Network for Remote Monitoring in Outdoor Environments

National Student Challenge in Cybersecurity

This competition was carried out in collaboration with the CyLab of Carnegie Mellon University Africa. For more details on this competition, read the General Chair's Message on Page 3.

Position	Name of the team	Participants
1	Mak_Team	Orian Ssemambya
		Simon Masombo
		Tracy Adeke
		Patricia Nakiganda
		Henry Poni
2	Reconaicense_red_team	Ouma Syden
		Muhumuza Gilbert
		Joram Matovu
3	#UICT256	Tumwesigire Rodney Michael
		Namugabo Florence Wangi
		Nabulime Florence Angel

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5. Scroll to CA certificate and choose 'do not validate'
6. Enter your email ID and Password
7. Click "Connect", and you are now connected to eduroam

💻 On Windows

1. Open control panel and choose network and Internet
2. Under network and sharing centre, click connect to a network
3. A pop up will open on the right hand side of the computer
4. Click on eduroam network and enter your email and password
5. Click "Ok" and click "Connect"
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NCC Secretariat Liaison Officer	Mr. Alyosious Muheki Wasago	UCC

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Mr. Simon Masombo	netLabs!UG, Makerere University
Ms. Winfried Namuyanja	MarconiLab@Mak, Makerere University
Ms. Diana Akori	netLabs!UG, Makerere University
Mr. David Kateeba	CEDAT, Makerere University
Mr. Jaggen Marvin	CEDAT, Makerere University
Ms. Slyvia Imanirakiza	CEDAT, Makerere University
Ms. Moreen Tumwekwatse	CEDAT, Makerere University

Technical Program Committee

| Name	Affiliation
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Dr. Abel Kamagara (Co-Chair)	Faculty of Engineering, Kyambogo University
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Dr. Jonathan Serugunda	CEDAT, Makerere University
Dr. Roseline Akol	CEDAT, Makerere University
Dr. Hanifa Nabuuma	CEDAT, Makerere University
Mr. Tonny Ssettumba	Pontifical Catholic University of Rio de Janeiro, Brazil
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Ms. Berna Namulyowa	netLabs!UG, Makerere University

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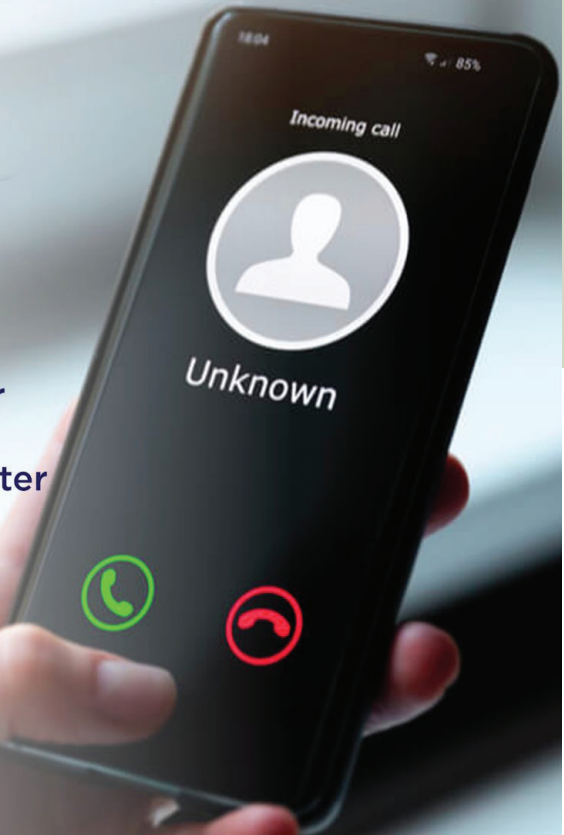
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ICT Clubs Competition

Region	Participants
Central	*St. Mary's College Kisubi* **(Winner)**
	St. Henry's College Kitovu
	Trinity College Nabbingo
	Namilyango College
	Kalinabiri Secondary School
	Kansanga Seed Secondary School
West	*Ntare School* **(Winner)**
	Mbarara High School
	Bubangizi Secondary School
East	*Tororo Girls Secondary School* **(Winner)**
	Iganga (Girls) Secondary School
	Busoga College, Mwiri
	Kongunga High School
North	*St. Gracious Secondary School* **(Winner)**
	Masindi Secondary School
	Arua Secondary School
	Dr. Obote College, Boroboro

JUDGES OF REGIONAL COMPETITIONS

Judge	Affiliation
Dr. Andrew Katumba	Makerere University
Dr. Edwin Mugume	Makerere University
Dr. Angella Atukunda	Resilient Africa Network
Dr. Abel Kamagara	Kyambogo University
Ms. Irene Magara	Mbarara University of Science and Technology
Mr. Frank Ssemakula	netLabs!UG, Makerere University

Project Details

In the regional School ICT innovations competitions, four schools emerged as champions and would compete in the national competition. However, due to the strong potential of their concepts, two additional schools have been selected to participate in the competition; St. Henry's College Kitovu and Iganga (Girls) Secondary school.

Title: SMART GREEN FARMING

Students: Emmanuel Nicholas Opio, Agatha Marrion Kicarwot , Elvis Okoo , Linda Akello, Joshua Emmanuel Owel

Teacher: Jacob Otim

Affiliations: St. Gracious Secondary School, Lira

Overview: The president of the republic of Uganda launched and emphasized the use of irrigation scheme in Uganda. This in his wisdom thought would handle the issue of long dry spelt that in turn results into poor yield. However, the scheme/ irrigation method seems manual because it involves turning on and off of tunnels, pumps and so on.

This innovation aimed at reducing the hunger rate by embracing irrigation, handling labor shortage resulting from the manual irrigation method, solving the problem of inaccurate data seen by most farmers and agricultural institutions and modernization of agriculture (i.e. movement from subsistence type of farming to commercial)

Using the automatic irrigation system to solve the problem of water shortage during dry season, the system focuses on the use of sensors to monitor and automatically open the water channels unlike the manual method which involves the farmer turning on the pump, valves and even the directing water.

This will be possible through the moisture and humidity sensors. In this case, the system will automatically sense the amount of moisture in the soil, amount of humidity in the atmosphere and according turns on or off the system. The system can also dispense fertilizers and other farm managements such as monitoring plants health among others depending on the farmers requirements at any time.

In conclusion, the system collects on data using sensors that provide information to the farmer through transmission from the automated system built.

Title: SCHOOL EYE

Students: Nicholas Mutumba, Brighton Egeru , Julian Ssonko , Gabriel B Kimera

Teacher: Joram Bwambale

Affiliations: St Henrys College Kitovu

Overview: Poor/ inefficient supervision of syllabus coverage in schools on a countrywide scale as well as co-curricular activities such as clubs, games projects. However, through development of the Project, other problems that are solved include; Inefficient system to assess students' capabilities on an individual basis. Tedious registration of students both by UNEB and NIRA. High rates of dropouts. Poor co-ordination among schools. The major problem relates to the Sustainable Development Goal Four (SDG4) Quality Education which states; Ensure inclusive and equitable quality education and promote lifelong opportunities for all. The effect of this problem is that schools are not efficiently monitored as they offer education to the students.

The project entailed the design of an interface that contains an integrated syllabus for all classes where all schools shall be required to update the Ministry of Education and Sports on the coverage of curriculum, co-curricular such as games, clubs, practical skills and projects to be done by students. Inefficient teaching and poor-quality education is also tackled. The same interface connects financially

needy students to sponsors from governments or Non- government Organizations thus lowering dropouts. Lastly, this interface integrates schools together in that schools shall connect to ministry easily for resource materials and possibly good co-ordination between the schools as they share materials. Thus, education will be more of learning rather than competing. In terms of the innovative nature of this project, aptitude tests are done virtually by the best students of the school in order to assess the extent of syllabus coverage by the school and a measure that counteracts wrong data input in the system by the school is built in the system. Also basing on data from aptitude tests, a student's future performance can be visualized as an estimate of in the final exams. Using of Machine learning, the Artificial Intelligence (AI) can base on these estimations to suggest viable options for further studies.

Title: TOWER TV UG

Students: Pero Sumayiya, Lakisa Grace Okot, Patience Asio, Joan Serra, Miriam Amoit Eboot

Teacher: Emmanuel Namudala

Affiliation: Tororo Girls School

Overview: There is a serious problem of a communication gap between the youth and the community. This has caused ignorance to them about their society. We are strengthening the means of communication and revitalizing the global partnership for sustainable development of technology. We are also solving the problem of poverty which has led to reduced economic development. This is done by creating and disseminating powerful content. This drives and grows industry engagement to convene the encouraged networks of industry leaders and innovators to champion the SDGs. Hence forth raising awareness and lead action in support of SDGs.
Ignorance, gender inequality and poverty are being solved by improving the efficiency and effectiveness of news and more sustainable ways of development through providing information. We take advantage of the

readily and commonly available internet that is on a high use. This is based on the fact that 6 in every 10 people use the internet and modern technologies.

Poverty is being solved through sharing different ideas for example agribusiness talks where students show case how to practice agriculture activities like piggery, crop planting that the rest of the community could learn. Therefore aiding in food production thus reducing the rate of world hunger.

Title: UP FARM

Students: Oscar Jordan Ahumuza, Rodney Ngabirano, Alvin Aaron Arinda, Arvin Nuwe, Joshua Asiimwe, Duncan Agaba

Teacher: Justus Mubangizi

Affiliations: Ntare School

Overview: Agriculture being the backbone of Uganda's economy is a song that has been sung for years; What other way to end hunger and poverty. However, land; a primary resource for agriculture is becoming scares day by day and more expensive as well. The Residential Property Price Index (RPPI) for GKMA registered a 9.7 percent increase for calendar year 2020 from 1.2 percent recorded during calendar year 2019. The maximization of the small land that people possess and the extra resources that come along with is what Ntare School's ICT club looked at as far as Sustainable Development Goals: 1(No Poverty), 2(Zero Hunger), 7(Affordable and clean energy), 9(Industry, innovation and infrastructure), and 15(Life on land) are concerned.

The **UPFARM** comes in; as the concept of "up living" in skyscrapers was adapted for people, Ntare ICT club therefore presents the same concept for Agriculture. A model was to be designed to illustrate how possible, efficient and economic friendly this concept is. It aimed at maximizing the limited land and resources like Solar energy. Solar energy is the source of energy but adjusted to make it mobile relative to the suns motion using trackers.

The **UPFARM** structures operates as a multipurpose system at different levels accounting for different practices for example the ground level could have light livestock (small scale), light poultry on the first floor partitioned to even include rabbits, non-light dependent crops like Mushrooms, and beansprouts among others. The layout is flexible hence is capable of being modified on preference basis. The structure is SMART providing; 24/7 monitoring of moisture levels, heat levels linked to your mobile phone– all maintaining effective production and minimizing risks. A sliding roof to cater for some light dependent crops/vegetables that maybe added.

Title: LYTA MOBILE APP; e-market

Students: Proscovia Nakhumitsa, amma Cynthia Nalumansi, Alice Tusubira, Britah Isiiko, Shebah Ahlam Namukose, Praise Tagonza Kintu

Teacher: Paul Mufumba

Affiliations: Iganga Girls Secondary School

Overview: Students face hard time during reporting back to school because they are burdened with carrying a lot of luggage with them like metallic cases, mattresses, dozens of books, etc. in the name of school requirements. Education is particularly greatly affected because some students take long to report to school because they have to look for favorable means of transport to carry them and their luggage. Since it's hard to get some items so that one avoids having a lot of luggage, students tend to forget important school requirements thus The Industry, innovation and infrastructure sector has failed to innovate an easier channel to solve this great challenge. The costs of transport incurred by the students is high since they have to pay for their extra luggage. Students' property is misplaced and damaged especially those who travel long distances. Strain on both the parents and students since they put in a lot of time in preparation, shopping and transportation of school requirements.

LYTA being a mobile app that enables online shopping and mitigates the challenge of heavy travel to school through enabling students to shop variety of school requirements ranging from personal utilities like Vaseline to scholastic materials like books and pens online from various suppliers to be found at school hence solving not only one problem, but also other related problems that come with reporting back to school.

In the regional School ICT innovations competitions, four schools emerged as champions and would compete in the national competition. However, due to the strong potential of their concepts, two additional schools have been selected to participate in the competition; St. Mary's College Kitovu and Iganga (Girls) Secondary school.

Title: VIMBOSCHOLAR

Students: Kevin Turyasingura, Evans Niwamanya, Augustine Katende, Allan Kisembo, Joseph Juuko

Teacher: Vian Turinawe

Affiliations: St. Henry's College, Kitovu

Overview: School going students face challenges in shopping and transport of items to school at the beginning of the term. Due to these challenges, they end up failing to buy some of the items in the shops. There is also damage and loss of property during transportation especially for those who use public means to travel to school. More so, students who buy many items find it tiring to carry the bulky items to school. For those that use public means, they are subjected to an unfair policy of luggage carried at owner's risk and some have suffered the consequences.

The above problem is the reason as to why vimboscholar is existing. Vimboscholar therefore;
- Helps to buy items online using just an internet enabled device like a computer or a smart phone. By doing this, it saves both time and

resources parents would have used to do physical shopping.

- On top of this, one can also sell as a vendor hence creating employment opportunities to the school communities e.g., teachers and parents as delivery personnel and distributors of the items.

All in all, in line with shopping and transportation challenges, parents/students will make shopping lists of items they need from our shopping system. The items can be scholastic materials or personal requirements plus food stuffs. On placing an order and actual payment, the items are procured and transported by our staff to the respective schools (the school whose address was entered).

All that the parent/student has to do is present a receipt processed from our system at the reception to get his/her package. The receipt shall be used as a verification of the (requirements) items.

JUDGES OF THE NATIONAL SECONDARY SCHOOL ICT CLUBS COMPETITION

Allan Lule

Allan Lule is a startup manager at Makerere Innovation and Incubation Centre (MIIC) with a software engineering background. Allan supports startups and entrepreneurs that are developing digital solutions and technology enabled solutions to access business development mentorship, access to software and technology development

talent, access to capital and markets for their solutions. Allan is a software developer and also manages developer teams working on software solutions developer programs of dfcu bank. He is as well a member of the Executive Committee of Startup Uganda Leading of the Investment Subcommittee.

Andrew Tugume

Andrew Tugume is a digital skills trainer and mentor currently working at Outbox hub as learning and development specialist. Andrew works at outbox as a full stack web development learning facilitator in the outbox EDU program and also an E-business curriculum developer in the outbox NSSF hi-innovator business academy. Prior to Outbox,

Andrew worked with Kafeero Foundation, Ujama Tribe, Yonja mobile solutions, Starthub Africa and Greenbridge school of open technologies. Andrew also volunteered as an ambassador for a number of international companies including Techstars, Africa code week, Andela Learning Community and currently data science network.

Andrew studied software engineering at MUK but is also currently pursuing a long-distance degree in artificial intelligence and machine learning at ISBAT

university. Andrew is a self-taught digital technology specialist with a lot of online awards, achievements and certifications in product management, career development and various digital, design and data skills. In his free time, he is engaged in the arts especially making music and visual art exhibitions

Dr. Andrew Katumba [Page 22]
Ms. Harriet Adong

Partners