MDAR

MULTIMEDIA DATA ANALYTICS RESEARCH

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The Bahria Multimedia Data Analytics Research (MDAR) Center brings together researchers across the areas of computer vision, machine learning, natural language processing, medical image analysis, signal analysis, blockchain, and big data analytics. MDAR includes over a dozen PhD researchers and their associated graduate students pursuing research on fundamental advances in the above areas as well as cross-cutting themes including multi-modal deep learning, blockchain data analytics, and connecting machine learning with variety of scientific disciplines including medicine (disease detection/prediction support based on variety of medical imaging and signals), psychological assessment, and the humanities. Researchers at MDAR focus on developing Bahria University's niche research expertise and recognition by applying analytics-oriented methodologies to study critical problems of high national and global value, with an emphasis on solving the local problems. Computer Vision is one of the strengths of the researchers working under MDAR thematic area where they simulate the human visual system with high level understanding of objects and scenes. The goal is to impart human intelligence and instincts to machines exploiting the pattern recognition techniques. From driverless cars to remote sensing, finger print recognition to handwriting/text recognition, and sign language recognition to video surveillance, computer vision enjoys a huge and diverse set of applications. The recent advancements in deep learning have revolutionized the computer vision and pattern recognition research allowing not only the introduction of novel applications but contributing significantly to make these a part of our everyday life. Researchers at MDAR have given prime focus on handling our national language in different domains including but not limited to Natural Language Processing systems, Urdu OCR, detection and recognition of Urdu text in low quality video streams and semantic analysis based on big Urdu data. We also focus on integrating vision and analytics system with other domains including robotics where researchers are working on different projects including Robotic Fruit Harvesting, Underwater Vehicle docking Systems, Home service Robots etc. Researchers working under the thematic research area of MDAR have produced many high-quality impact factor publications and are engaged in various funded research projects with national/international collaborators.

SALIENT FEATURES

- Industrial Cases and Adoption: To design, develop and implement multi-media analytics solutions
- Software Simulations and Solutions: to develop, enhance and deploy intelligent and adaptive platforms and systems with and for industry
- Hardware Prototypes and Solutions: to research and develop hardware enabled solutions, with key focus on multi-modal deep learning, medical imaging and signal analysis, blockchain analytics, and machine learning in inter-disciplinary domains including Medicine and Humanities.

CONSULTING SERVICES

Provide advance research, academic and industrial services to small, medium-sized and large businesses. Core competencies in Multimedia Data Analytics with specializations in:

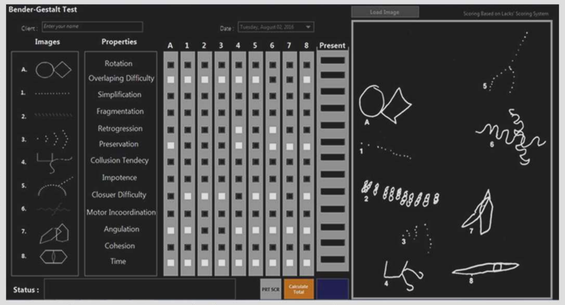
- Multi-modal Deep Learning
- Vision Systems
- Medical Imaging Analysis
- Blockchain Data Analytics
- Machine Learning in Medicine and Humanities
- Natural Language Processing

RESEARCH & SERVICES PORTFOLIO

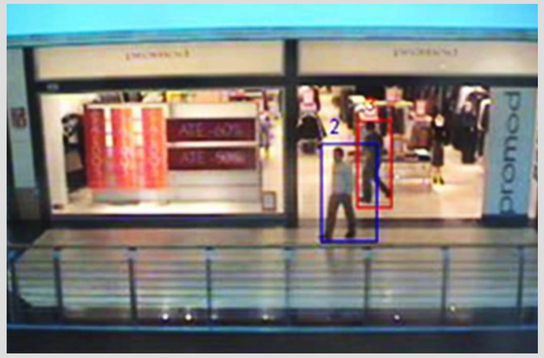
Content-based Video Indexing & Retrieval

Combing through the news or any sort of media in terms of finding a topic of interest has been implemented in countries like China or America. In Pakistan, a relevant system, i.e., applicable both for Urdu and English, is being developed by a team at MDAR. This system has potential application in Regulatory bodies, media houses Intelligence agencies as well as general end users. The caption text appearing in videos is used as the primary index, while the audio content in these videos serves as the secondary index. The textual content appearing in videos in the form of News tickers, anchor names, alerts or any other information is localized and converted into text using a video Optical Character Recognition. The system considers Urdu and English text, but can be extended to other scripts as well. Examples of typical queries include Retrieve all videos where the keyword صدر " has appeared or Retrieve all videos where the keyword "پاکستان " has been spoken, and others.

Automated Detection of Neuropsychological Impairments from Image-Based Visio-constructive Screening Tests

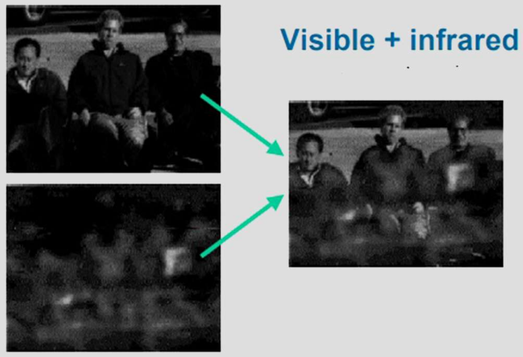


The project investigates the potential of hand-drawn shapes in early prediction of neuro-psychological disorders. Drawing tests have been long used by practitioners and researchers for early detection of psychological and neurological impairments. These tests allow subjects to naturally express themselves as opposed to an interview or a written assessment. Computerized solutions were developed for screening of suspected cases using Bender Gestalt Test (BGT) as a case study. Bender Gestalt Test (BGT) is a well-known and established test designed to detect signs of perceptual distortions. The project was jointly funded by HEC Pakistan under the PERIDOT program and the French Ministry of For=em.



Activity Recognition and Anomaly Detection

CCTV surveillance systems aren't as accurate as needed. We gather extensive information on object's activity based on motion trajectories, e.g., tracking of players and ball in the playing field. To extract motion sequences from video, tracking algorithm is used. This technique classifies new trajectories and anomalies by checking closeness of object trajectories. The system has potential application in CCTV surveillance systems, GPS, SATNAV and phone cameras. A major challenge in modern day surveillance systems is the difficulty in separating primary target from the background. The proposed system uses thermal radiation information to separate the target on the basis of heat signature and detailed texture information from visible images to create a more clarified image.

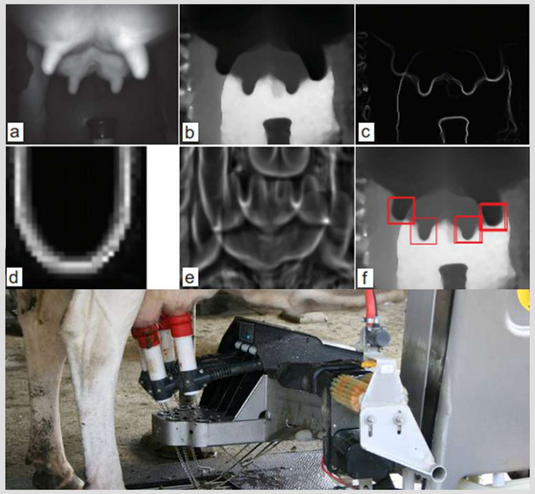


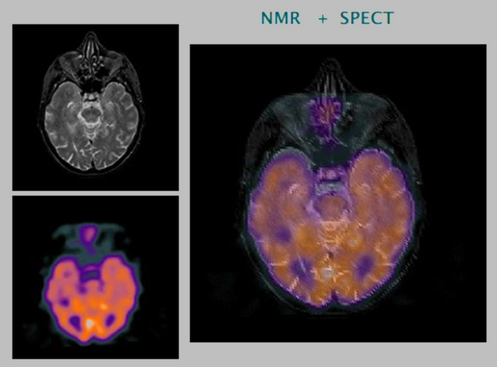
Surveillance Imaging Enhancement Using Thermal texturing

The biggest drawback of modern day surveillance systems is that it's extremely difficult to separate our primary target from the rest of the background. This leads to complications when a possible suspect needs to be identified (from the surveillance footage). What the proposed system does is use thermal radiation information to separate our target on basis of heat signature (using infrared images) and detailed texture information from visible images to create a more clarified image. The basic schemes used for this are compressive sensing principle, noise reduction using dynamic fusion and sharpness scheme.

Automated Cow's Teat Detection for Fast Cupping using Moving Cameras

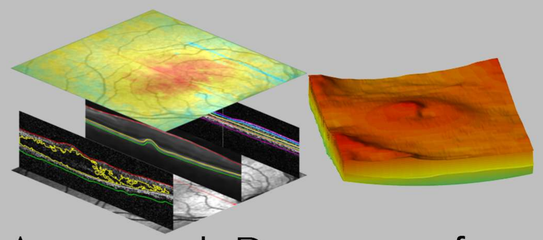
Automated farming is the future and un-manned milking system for cow farms is a step in this direction. The system comprises of a KUKA robotic arm with custom built gadgetry example, gripper for holding 4 of the suction cups at a time, Swiss Ranger ToF camera for 3D sensing of cow and its teats. The system is successfully installed in Rangitata farm in New Zealand and is a consideration in the local Pakistani market.





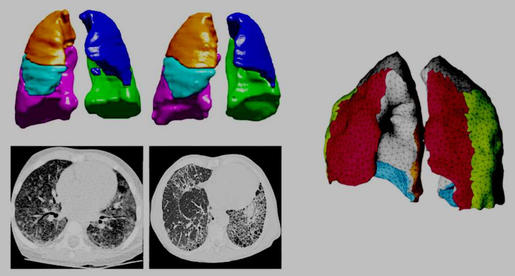
Clinical Diagnostic Imaging

Health of individuals in a society carries prime importance. Most of the time, the diagnostic equipment we use (although they use image fusion quite a lot) fall short of analyzing the abnormality at hand. The system we use rectifies issues such as excessive noise, blurry objects etc. At its core, multi-modality image fusion is used to either merge or overlap different images; We use a combination of schemes to perform the required improvements.



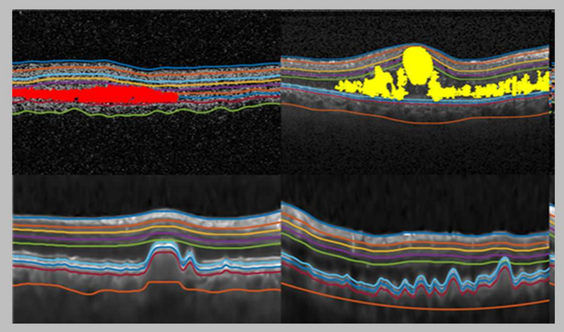
Automated Detection of Macular Edema

Macular edema (ME) is a major indicator of proliferative diabetic retinopathy and it is commonly caused due to diabetes. ME causes retinal swelling due to the accumulation of protein deposits within subretinal layers. OCT imaging provides an early detection of ME by showing the cross-sectional view of macular pathology. This paper proposes a fully automated method for extracting and analyzing subretinal layers from OCT images using coherent tensors. These subretinal layers are then used to predict ME from candidate images using a support vector machine (SVM) classifier. A total of 71 OCT images of 64 patients are collected locally in which 15 persons have ME and 49 persons are healthy. Our proposed system has an overall accuracy of 97.78% in correctly classifying ME patients and healthy persons.



Automated Lungs Segmentation and Tuberculosis Detection

We provide a fully autonomous lungs analysis and diagnosis of tuberculosis. Whenever the volumetric scans are loaded into the system, the lungs are automatically extracted using cutting edge image processing techniques. The system identifies different lungs lobes for more in-depth analysis as the extracted lungs information is then passed on to the trained deep learning models for the automated diagnosis of TB.

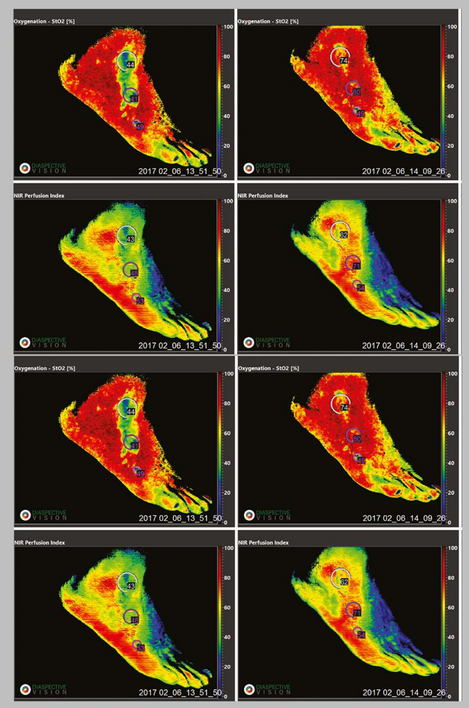


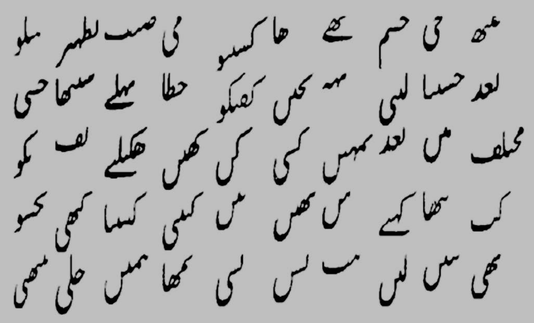
Automated Maculopathy Analysis using TensorGraphs

Maculopathy represents group of retinal diseases which affect macula and can cause severe vision loss if not treated in time. We present a vendor-independent framework for the extraction and characterization of retinal layers and fluid pathology, along with 3-D retinal profiling. The proposed approach works by first extracting nine layers from an optical coherence tomography (OCT) scan; Afterwards, the extracted layers, combined with a deep CNN model, are used to automatically segment cyst and serous pathology. Further, the autonomous 3-D retinal profiling. The system has been validated through thousands of OCT scans acquired through different OCT machinery and has surpassed the performance of its competitors.

WoundCare Vision System: Dermal Imaging

The idea is to incorporate the strengths of computer vision and Artificial intelligence and to develop assistive technology for healthcare department. Woundcare system is designed to assist dermatologists in effective wound management providing AI tools for predictive analysis. The system has been approved to be used in two of the DHB and won the MedCentral award 2015. Woundcare system consists of 4MP RGB camera, laser pattern projector, LED lights, RaspberryPi, and Gooseneck stand with an integrated 3D calibration board. The system works over a few layers, such as camera and laser modules are operated through acquisition layer and the software resides in the RasberryPi. A nurse deploys the acquisition module over the wound or the infected area and scans the region for spectral and 3D morphological features. A mix of vision alogirthms and heuristics generates the contemporary wound model and infection index is predicted based on its comparison with the previous states of the wound. Backend of Woundcare is powered by cloud layer that consists of scalable NodeJS application running on Amazon Webserver and a database instance. Patients' data flows though New Zealand National Database and for that special access privileges have been acquired at various levels.



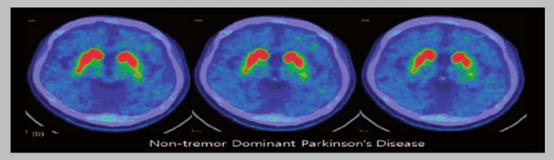


Urdu Stemmer

Urdu is a widely known/ spoken language used by approximately 200 million people worldwide and there is an abundance of raw Urdu text available. To refine and extract useful information, our product: Urdu Stemmer utilizes the data mining techniques such as Stemming. The stem of words (news) خبروں(news)خبریں(newspapers),اخبارات(Newspapers) اخبار is خبر (news). In this project, we have built a stemming system for Urdu text. This system performs stemming on Urdu words as well as words borrowed from other languages such as Arabic, Persian and Turkish. T- The state of the art stemmer has extensively improved search accuracy which is why it is being utilized for translation algorithms for systems at NADRA.

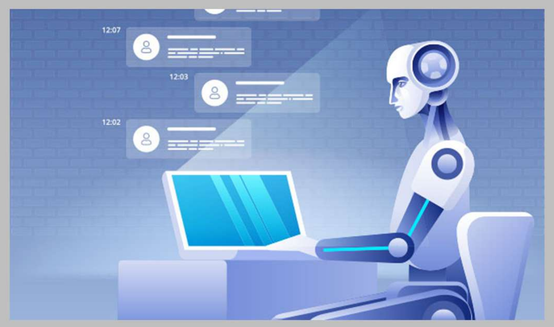
Urdu Optical Character Recognition (OCR)

An Urdu OCR has been developed for Nastaliq font. It is currently in the initial development cycle. It utilizes a technique of separating the main body of ligatures from secondary components. A right-to-left sliding window captures projection, concavity and curvature information. The data from the window is fed to the model for training which has a recognition rate of 98% for the widely used ligatures. The system has direct application in translation softwares.



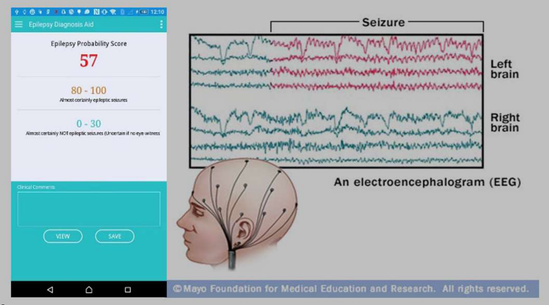
Bio Skeleton

Bio Skeleton is a specialized solution for patients with Parkinson disease, the solution majorly comprises of a wearable tremor controlling device used for minimizing the effect of tremors through bombardment of controlled vibrations. To facilitate paralyzed subjects, a bionic suite can read the EMG signals to move the patient's body parts as desired. We provide a hope to the patients to enjoy their life again to their fullest.



My Virtual Assistant

Personal assistants are very effective in organizing daily routines of a manager. They can monitor, expedite and run routine functions when you are not physically present. Good managers assign repetitive tasks to be looked after by their assistants so that they may use their precious time in doing something innovative. However, affording personal assistants is an out of reach luxury for many managers working in small and medium size organizations. A number of daily tasks can be relegated to your virtual assistant. These virtual assistants are to be taught about you, your preferences and most importantly your business whereas everything else is catered by the intelligent algorithms. These virtual assistants can post updates about your organization, they can reply to queries, send emails on your behalf, reply to emails, read your emails and indicate if there is anything important.



Epilepsy Predictor

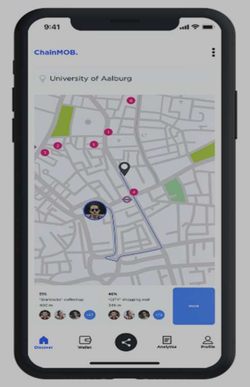
Epliepsy Predictor is an android application that predicts epileptic seizures in patients. Over 2 million people are affected by this in Pakistan and many go untreated due to lack of awareness. The system notifies doctors and caretakers in advance about a possible attack. The system works on EEG signals that are pre-processed and then multiple features are extracted and finally classified to predict the attack. When an attack is detected an alarm is generated to prevent the seizure. As this is a locally developed solution, Epilepsy Predictor can help reduce the health budget and reduce imports and production of expensive medicines.

Motion-based Aircraft Simulators (PAF/USA)

This project simulates a real Aircraft flying experience. Aircraft simulator project has been initiated as a joint venture between Pakistan Air Force and Bravo Zulu International (USA) (Designed for T-37) For realistic flying experience (in T-37), real gauges (with stepper motors and limit switches) are installed in the cockpit. Electronic control modules like Button Control, Instrument Control and Axis Control are designed using microcontrollers. Each module sends its data to the simulation system over RS485. The system controls sound effects, emergency stimulation, air modelling and navigation. It receives pilot's inputs/responses and incorporates them into the simulation system and ensures every single aspect of flight training.

Mobility Analytics on Blockchain

Smart devices have dominated the 21st century with almost everyone using some type of smart gadget on a daily basis. Importantly, all kinds of smart devices store user's data which can potentially risk the user's privacy; as such with the increasing number of data breaches occurring with technological advancements of these devices, there is an element of lack of trust for data security. This imposes a major security concern for the users. To address such data security concerns, risks and issues, Blockchain technology offers reliable data management where the data is the property of the user. This can be highly applicable for IoT integration of Smart Cities. Blockchain with IoT data in smart cities for large data processing and predictive analytics is undoubtedly the way to the future and one of the key interest areas of MDAR group.



Sentiment Search Engine

Insights obtained from Social media platforms now provide a more comprehensive overview of brands' outreach performance, likability, sales conversion and potential competitive advantages; thus, helping brands and businesses to grow and formulate their business and marketing strategies in real time. Keeping track of the growing need and lack of custom-built optimization tools for your businesses, the proposed model search engine can keep track of all the social media activity, relevant posts and potential business prospects. The model also reports parameters such as bad reviews generated and optimization and possible lead generation; SSE also produces a summary of information with insights and dashboards for making the process of decision-making more efficient and effective for the relevant stakeholders.

Town Planning using Big Data Analytics

The system of Vehicular Ad-hoc Networks (VANETs) is used for path planning. The most prominent feature for doing so is through the collection of real time data. The data on traffic congestion is used to calculate the quickest and shortest path of travel. An interesting application of this project is the inclusion possibility in China Pakistan Economic Corridor CPEC. The possibilities include vehicle to vehicle communication and traffic control. The project in parts has been implemented in South Korea.

Targeting Social Influencers and Optimizing Niche

Social media influencers and opinion makers are individuals who based on their content generation and following, influence masses and impact their way of perceiving a specific brand. A shared belief of a strong influencer is that of having massive social active followers and quality content generated. Though tools and algorithms can be used to classify or categorize huge quantity of unstructured data, such tools do not cater to identifying, correlating and to market relevant factual data or influencers based on categories such as the originators expertise and the niche it caters/targets. Categories such as their level of engagement with the target audience/niche and said expertise on the topic in hand should be amongst the evaluation criteria for the influencer, in order to maximize outreach gained and insights attained via linking to relevant influencers and opinion makers.

KEY RESEARCHERS

Prof. Dr. Shehzad Khalid

Dr. Shehzad Khalid is the Director of Research innovation, Commercialization and Development (ORIC), and the Director of Pakistan China Study and Research Center (PCSRC) at Bahria University. Dr. Shehzad received his Doctorate degree in Computer Vision and Machine Learning from the University of Manchester, UK. He has contributed to domains including Computer vision, Machine Learning, Medical Image Analysis, Signal Analysis, Biometrics, Natural Language Processing with specialization, Short and Long multi-lingual text mining, Urdu stemming and OCR, and Sentiment Analysis using Big Data. He is frequently invited to present his work at renowned international forums. His research work has been published by reputed international peer-reviewed journals. His contributions to the field have also been recognized at the national level, as he is a receiver of Best University Faculty Award and Best Researcher Award from Higher Education Commission, Pakistan, and Bahria University, respectively. Dr. Shehzad has successfully completed several R&D projects as PI or Co-PI. His international collaborations are in USA, UK, Europe, Korea, China, and Middle East. Recently, he has been a lead mentor at Business Incubation Center and is responsible for successfully commercializing sustainable SME and Businesses.

Prof. Dr. Imran Siddiqi

Imran Siddiqi is working as Professor of Computer Science at Bahria University Islamabad. Dr. Siddiqi received his PhD degree from Paris Descartes University, France in 2009 and specializes in image analysis and pattern classification techniques. He has been an active researcher with more than 100 research publications at reputed conferences and journals. He has also won several funded projects from National as well as International funding bodies. His recent research interests include application of deep learning techniques to computerized analysis of online as well as offline handwriting, biometric and forensic applications, prediction of neurological disorders using non-invasive modalities and content-based image and video retrieval. Dr. Siddiqi is also a key member of the Pakistan Pattern Recognition Society (PPRS), the Pakistan chapter of the International Association of Pattern Recognition (IAPR).

Dr. Muhammad Muzammal

Dr. Muzammal is an Associate Professor and HoD of CS Department BUIC. Dr. Muzammal received his PhD degree from University of Leicester and specializes in Data Science and Decentralized Systems. He has been an active researcher with more than 40 research publications at reputed conferences and journals. He has won funded projects from Prestigious Visiting Fellow, Chinese Academy of Sciences. His recent research interests include application of data mining techniques to automated big data analysis of online as well as offline data, and application of decentralized techniques to emerging blockchain sys-

Dr. Amina Jameel

Dr. Amina Jameel is serving as a senior Associate Professor in CE Deparment, BUIC. Dr. Amina received her Doctorate in Electrical Engienering from NUST, Pakistan. She has contributed to various domains including Computer vision, Machine Learning, Medical Image Analysis, Signal Analysis, and Image fusion. She has been an active researcher with publications at reputed International conferences and in peer-reviewed journals She has frequently presented her work at international conferences. She has also been awarded Best Researcher Award from Higher Education Commission, Pakistan. She has over 12 years of industrial and teaching experience.

Dr. Shujjaat Khan

Dr. Shujjaat Khan has been associated with international robotics industry since 2006. After completing his PhD from Massey University, New Zealand, he became an integrated part of various innovative ventures in New Zealand, Australia, USA, China and Malaysia. During the span of his international exposure, Dr. Shujaat has contributed to state of the art projects for many organizations like Callaghan Innovation, Scott Technology New Zealand, Veritaxa, E-Byte New Zealand, General Electric USA, Fisher & Paykel, Bravo Zulu International, Pakistan Air Force, Silver Fern Farm NZ and RobotWorks USA. His major projects include Milking robots, Meat Processing robots, Aircraft simulators, Robot soccer and Dermal Imaging. Dr. Khan is an active member of many professional organizations like IEEE, IET, ICRC & ICSFE; currently working on the promotion of Robotics & Artificial Intelligence among all tiers of our society.

Dr. Taimur Hassan

Dr. Taimur is one of the top young researchers and academicians of Pakistan who is actively involved in cutting edge research in the areas of medical image analysis, biomedical signal processing, artificial intelligence, embedded computing and Internet of Things. He recieved his Ph.D. form NUST with his dissertation is in the field of Ophthalmic Image Processing. Mr. Taimur Hassan has 6 years of industrial and teaching experience. Currently, he is working as a Lecturer in the EE Department, BUIC. He has been a part of many local and foreign research projects. Currently, he is leading one project as a Principal Investigator. He is a recipient of various national and international awards. He is also serving as a reviewer in IEEE Journal of Biomedical Health Informatics [Quartile Score: Q1, Impact Factor: 3.85], IEEE Access [Quartile Score: Q1, Impact Factor: 3.557] and Springer Journal of Digital Imaging [Quartile Score: Q2, Impact Factor: 1.536]. His Ph.D. research won Gold Award in Research & Development category at (P@SHA) 2016 and Asia Pacific ICT Alliance (APICTA) 2016. Recently, he and his team won Gold Award in the Artificial Intelligence category at P@SHA 2018. Mr. Taimur Hassan has 30+ research publications in last the 3 years having 100+ research citations with the cumulative impact factor of 24.399.

Dr. Awais Ahmed

Dr. Awais Ahmad received his Ph.D. in Computer Science and Engineering from Kyungpook National University, Korea. He is currently working as an Assistant Professor in CS Deparment, BUIC. He is also working as a Senior Research Scientist at University degli Studi di Milano, Italy. He has served as AP in the Department of Information and Communication Engineering, Yeungnam University and a visiting researcher in INTEL-NTU-. He has published more than 110 International Journals (cumulative Impact Factor: 150+). Dr. Awais is also serving as Guest editor in various Elsevier and Springer Journals, including Future Generation Computer Systems (Elsevier), Sustainable City and Societies (Elsevier), and Computational Intelligence and Complexity (Springer), Multimedia Tools and Applications (Springer), IEEE Access, and Real-Time Image Processing Journal (Springer). Dr. Ahmad was the recipient of four prestigious awards: (1) IEEE Best Research Paper Award: International Workshop on Ubiquitous Sensor Systems (UWSS 2015), in conjunction with the Smart World Congress (SWC 2015), Beijing, China, August, (2) Research Award from President of Bahria University Islamabad, Pakistan in 2011, (3) best Paper Nomination Award in WCECS 2011 at UCLA, USA, and (4) best Paper Award in 1st Symposium on CS&E, Moju Resort, South Korea, in 2013. He was also awarded as Best Outgoing Researcher of CCMP labs. His research interests include Deep Learning, Machine Learning, Artificial Intelligence, Denoising and Demosacking, Big Data Analytics, Sensor and Adhoc Network, Internet of Things.