Biometric System Design Competition

The AI Vision, Health, Biometrics, and Applied Computing (AVHBAC) lab and Biomedical Signal Analysis Lab (Biosal) of Clarkson University are jointly organizing a Biometric system design competition this fall.

This competition is limited to only Clarkson Undergraduate and graduate students. Student teams (a team can be of the highest two members) need to submit a 1-page project proposal (due 31st August 2023), a full project description (due 15th October 2023), a video demonstration (due 20th October 2023), and a live demonstration (21st October 2023) of the working prototype.

The top projects will be invited to CITeR Fall Meeting to be held at Clarkson University (24-25 October 2023). CITeR is an NSF IUCRC researching the rapidly growing areas of identity science and biometric recognition through the interdisciplinary group of faculty, researchers, students, and industry personnel.

The competition winners will be announced on 25th October 2023. The top student projects will be awarded a 300$ Amazon gift card (each project).

One outstanding project will receive a **500$** Amazon gift card.

The developed system should be made open-source, and the project files be shared through a Public Github repository.

The timeline of the competition:

1. 1-page project proposal and competition registration (due 31st August 2023–NO worries if you miss the deadline, just turn in your project),
2. 4-page (max) project description and GitHub repository link for the project files (due 15th October 2023).
3. A 3-minute (max) video demonstration (due 20th October 2023),
4. A live demonstration of the prototype (21st October 2023).
5. Participation of Top Projects in the CITeR Fall Meeting (24-25th October 2023).
6. Winner Announcement (25th October 2023).

For any detailed information, please contact Prof Masudul Imtiaz at mimtiaz@clarkson.edu

1-Page Project Proposal:

Send a 1-page project proposal to Prof Imtiaz at mimtiaz@clarkson.edu by 31st August 2023. The proposal should have a project name, project personnel-maximum of two student members, an abstract of the project, the name of the hardware components and software to be used, the testing procedure, and the possible applications of the system.

A few sample project concepts are provided below. The students can choose one of those projects or can propose a different project related to biometric systems.

- **Concept 1. Development of a Low-Cost Biometric Foveal-Vision Camera**

  Description: Foveal-vision cameras can be used to both track and capture, from a distance, the face/Iris of stationary or on-motion individuals. Recently, there has been technological advancement in the domain of camera technology and computation hardware, such as mobile GPU: Intel Arc A730M 12 GB. It is now feasible to embed multiple cameras with a mobile processor and have onboard deep-learning models for real-time processing. Students will work on the development of a Foveal-vision camera from commercially available components and customized object tracking models. This system can have either a 12MP IMX477 or 64MP Pan Tilt Zoom (PTZ) module, adjustable-resolution stereo/single camera, IR modules, etc. The embedded processor could be a Raspberry PI or a Jetson or Google Coral board. Low-range iris detection would be the target domain for this project, which can be adapted to other biometric applications. The deliverable of this project is a Foveal-vision camera system that can focus on the Iris portion of an eye and capture and store high-resolution images. Real-time image quality assessment could be optionally added; however not mandatory.

- **Concept 2. Development of a camera-based Infant fingerprint capture system**

  Description: There has been published work regarding 'Infant-Prints,' an 8MP camera interfaced with Raspberry PI Zero W for real-time acquisition of infant finger/palm print and quality checking before enrollment. An infant's finger/palm is placed on the glass prism of this system and pressed to transfer the image to a mobile phone via Bluetooth. This system is required to be redesigned with a firmware update. Google Coral boards can be employed for this purpose or a redesign from scratch.

- **Concept 3. Implementation of fingerprint identification to medical wearables**

  Description: A fingerprint-matching model to be hosted on the embedded processor of medical wearables or Wearable IoT, WIoT (e.g., electronic skin patches, ECG/glucose monitor, etc.). For the prototype development, a commercially available small area fingerprint sensor (HF-108, 8mmx8 mm, ~500dpi) is to be interfaced with a tiny BLE module EFR32BG24, which features a 32-bit ARM Cortex M4 processor. The proposed development includes the customization of deep neural networks for a mobile processor, implementing quantization, and utilizing techniques for partial model loading. Prof Imtiaz's group previously successfully ported a deep neural network, modified Mobilenet, to a Cortex M7 processor. Current research also shows that a similar network, after customization, might also be implementable to Cortex M4 processors, which requires an optimal trade-off between accuracy, computational cost, and memory footprint.

- **Concept 4. 3D Printed Iris Spoofs**

  Description: Spoofing the Iris biometric system is often done through cosmetic contact lenses by a person who is on a watchlist to evade detection. It is also conceivable that an attacker wanting to impersonate a particular person could have cosmetic contact lenses made to give them the target person's iris texture. There is not much research on this kind of spoofing. This project will introduce a variety of Iris spoofs, both by developing 3D printed Iris (by light printing-based 3D resin printer) and printing textures on the clear commercially available Iris. First, the texture information will be extracted (using the GLCM method) from the previously captured Iris image. Prof Imtiaz's group will purchase the no-color contact lens, and the student group will grate the texture on the commercial lens. They also will 3D print the eye with these textures. The students will analyze the spoof quality by presenting these physical spoofs to fool the iris scanner. Optionally, the students can test the quality of off-the-shelf spoof detection models with these spoofs.

- **Concept 5. Ultra-low power biometric Sensor Design**

  Description: Sensors (for example, a commercially available small area fingerprint sensor: HF-108, 8mmx8 mm, ~500dpi) is to be interfaced with a low-power FPGA so that the acquired fingerprints will be processed by the FPGA. A biometric recognition or verification model is to be hosted on the FPGA for person authentication. The primary development can be done on an FPGA development board. However, the deliverables should have the complete hardware design on a PCB.

- **Concept 7. Infant Iris Scanner**
  Capturing iris biometric data from infants using existing iris scanners can be a tedious and challenging task since these scanners are not specifically designed for infants. In this project, students will undertake the task of designing an infant iris scanner by utilizing commercially available NIR cameras and illumination. The choice of embedded processors ranges from Raspberry PI to Jetson or Google Coral boards. With a primary focus on low-range iris detection, the ultimate objective is to develop a scanner tailored to infants' unique needs, capable of capturing and storing high-resolution iris images. For added functionality, the inclusion of real-time image quality assessment is an optional consideration but not a mandatory requirement for the project's success.