**Paper 8044-1 - Ground jammer localization with two satellites based on the fusion of multiple parameters**

Monday 8:40 AM - 9:00 AM  
Author(s): Zhonghai Wang, Michigan Technological Univ. (United States); Khanh D. Pham, Erik P. Blasch, Air Force Research Lab. (United States); Genshe Chen, DCM Research Resources, LLC (United States)

**Abstract:** GPS receivers, radar receivers and communication systems are subject to long-range (150 - 200 km) jamming and require anti-jam techniques for successful operation. A jammer emitter transmits signals falling in the target receiver's working bandwidth with a power much larger than the target receiver's desired signal, and floods the target receiver's desired signal. In this paper, we present a localization method based on the fusion of time-difference-of-arrival (TDOA), frequency and direction of arrival (DOA) using an extended Kalman Filter (EKF). In the proposed technique, the jammer's DOA's with respect to the two satellites are first fused to provide a coarse estimation of the jammer position, and then the coarse position is used as the initial value for the fusion of DOA's and TDOA for refining the jammer position. Simulations show that the proposed method can provide high localization accuracy for anti-jamming.

**Quote from Chair Khanh Pham:** The use of satellite technology for positioning is commonplace in everyday life; however new results demonstrate that satellite technology can be used to detect and locate jamming devices that inhibit signal transmissions through measurement data fusion. The two stage methods first fuses direction of arrival (DOA) measurements to eliminate the ambiguity and then fuses time difference of arrival (TDOA) and frequency information to guarantee the localization accuracy and track convergence and maintenance. Detecting active jamming devices enables secure, reliable, and robust communications.

**Potential or future applications of research:** The method or its modifications can be applied to detect, locate, and monitor equipment that seeks to jam, interfere, disrupt, or inhibit secure and reliable communications. Future applications include embedding the technology in a communications system that provides a secure quality of service connection through active signal modification to background interference or a command and control system that provides information on signals intelligence.

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**Paper 8044-2 - Track splitting for improved tracking performance in a cluttered environment using PDAF**

Monday 9:00 AM - 9:20 AM  
Author(s): Xin Tian, Yaakov Bar-Shalom, Univ. of Connecticut (United States); Erik P. Blasch, Khanh D. Pham, Air Force Research Lab. (United States); Genshe Chen, DCM Research Resources LLC (United States)
Abstract: For tracking a target in a heavily cluttered environment, the Probabilistic Data Association Filter (PDAF) is very efficient and can significantly reduce track losses. However, the uncertainty in the measurements' origin may cause significant degradation in the tracking accuracy of the PDAF, and the PDAF will diverge when the clutter density is above a certain threshold [1]. In this paper we explore the technique of splitting the track of the target into sub-tracks running in parallel. Each sub-track occupies a portion of the uncertainty region of the original track. As a result, the sub-tracks maintained using PDAF will be more selective over the incoming measurements (including detection and false alarms), and have less loss in tracking accuracy. The splitting of the track will incur a significant amount of additional computation cost. The problem of how to do this most effectively to improve the tracking performance will be addressed. Due to the simplicity of the PDA algorithm and the hugely improved parallel processing capability of computer systems, the proposed algorithm is very promising in practical tracking applications.


Quote from Chair Khanh Pham: For defense and security applications, it is necessary to track all non-cooperative (potentially hostile) targets using measurements from sensors, e.g., radar and infrared. The surveillance measurement-to-track association problem becomes very challenging when the tracking is done in a cluttered environment, where sensor reports include not only target originated measurements but also false alarms form the clutter. Over the years, various tracking filters have been proposed in the tracking community to address the problem including the Probabilistic Data Association Filter (PDAF), Joint PDAF (JPDAF), Joint-belief PDAF (JBDAF), Multiple Hypothesis Tracker (MHT), Probability Hypothesis Density Filter (PHDF), and the Probabilistic Multi-Hypothesis Tracker (PMHT). Among these filters, the PDAF proposed by Dr. Yaakov Bar-Shalom has low complexity and was shown to work effectively in a heavily cluttered environment. However, the PDAF will experience difficulties when the target track has low accuracy. To solve the low-accuracy limitation of the PDAF, a track splitting systematic method is proposed to divide a less accurate track in a high dimensional state space into a set of sub-tracks to improve the PDAF robustness. The proposed track splitting PDAF (TS-PDAF) technique can be useful for Ballistic Missile Defense (BMD) to track a target that splits into multiple sub-targets in the middle of its trajectory.

Potential or future applications of research: The results of the TS-PDAF have wide applications to not only surveillance, ballistic missile defense, and space situation awareness; but also air, land, and sea target tracking in which a coordinated group of closely spaced targets separate into multiple trajectories such as a plane releasing UAVs, a truck transporting mobile robots, or a ship carrying torpedoes; respectively.

Paper 8032-9 - Advances in QCL for security and crime fighting
Monday - 1:20 PM - 1:40 PM
Author(s): Simon A. Nicholson, Cascade Technologies Ltd. (United Kingdom)
Abstract: The threat of terrorism via the use of explosives is not new. Internationally, the terrorist threat continues to develop and expand both in terms of the target type and materials used.
New forms of terrorist activity include:
• Multiple and co-ordinated well planned attacks.
• Novel methods and materials (Home made and improvised).
• Mass casualties.
• Use of hostile reconnaissance in advance of attack.
• Non-traditional targets.
• No warning (in many cases).
Crowded open places favoured.

Bombs and illegal use of firearms still preferred modes of attack.

Quote from Chair Mark Druy: The array of technologies that have grown up to combat both person and vehicle borne (PBIED and VBIEDS) are wide ranging. QCL lasers are finding their way into applications that have potential commercial applications for security, law enforcement, and infrastructure safety.

Potential or future applications of research - small, highly sensitive and specific gas sensors, bright sources for high resolution infrared imaging of biological tissue


Monday 1:30 PM - 2:00 PM

Author(s): Paul R. Havig, Air Force Research Lab. (United States)

Abstract: Keeping up with current technology is a never ending process. In this paper current and future display types are investigated as to their viability as well as how they may "fit" Air Force applications. Further discussion will be on current and future needs of displays with an emphasis on applications areas.

Quote from Chair Dan Desjardins: A representative from Army Research Lab, Air Force Research Lab and Naval Air Warfare Center will speak on their respective Service roadmaps for future displays.

Paper 8044-11 - Pursuit-evasion orbital game for satellite interception and collision avoidance

Monday 2:00 PM - 2:20 PM

Author(s): Dan Shen, DCM Research Resources, LLC (United States); Khanh D. Pham, Air Force Research Lab. (United States); Genshe Chen, DCM Research Resources, LLC (United States); Erik P. Blasch, Air Force Research Lab. (United States)

Abstract: This paper develops and evaluates a pursuit-evasion orbital game approach for satellite interception and collision avoidance. Using a coupled zero-sum differential pursuit-evasion game, the pursuer minimizes the satellite interception time and evader tries to maximize interception time for collision avoidance. For the satellite interception problem we design an algorithm for pursuer and one for collision avoidance, where the game solution controls the evader satellite. The interception-avoidance (IA) game approach provides a worst-case solution, which is the robust lower-bound performance case.

Quote from Chair Khanh Pham: With the increasing debris from space parts, congestion of widely used orbits, and non-functional satellites, there is a need for satellite collision avoidance capabilities. This paper develops and evaluates a pursuit-evasion orbital game approach for satellite interception and collision avoidance. Using a coupled zero-sum differential pursuit-evasion game, the pursuer minimizes the satellite interception time and evader tries to maximize interception time for collision avoidance. For the satellite interception problem an algorithm for the pursuer and one for collision evader is designed, wherein the game solution controls the satellite avoidance. The interception-avoidance (IA) game approach provides a worst-case solution, which is the robust lower-bound performance. The IA algorithm is divided into two parts: first, the pursuer will rotate its orbit to the same plane of the evader, and second, the two spacecrafts will play a zero-sum pursuit-evasion (PE) game. A two-step approach saves energy during the PE game because rotating a pursuer orbit requires more energy than maneuvering within the orbit plane. To rotate the pursuer orbit plane, a series of small Delta-V’s less than a given requirement is utilized, where Delta-V is the difference in velocity. For the PE orbital game, an optimum open-loop feedback saddle-point equilibrium solution is calculated between the pursuer and
evader control structures. Using the open-loop feedback control strategy, both pursuer and evader will estimate their distributed control track states.

**Potential or future applications of research**: Using the novel game-theoretic pursuit-evasion collision avoidance solution, future unmanned space systems will possess an autonomous capability of sense and avoid for threat deterrence. Moreover, space autonomy can directly benefit from this autonomy technology for autonomously generating counter-responses and measures against persistent and adaptive threats that the conventional responses cannot because the restrictions from viewing, tempo, and obscuration are too great. A capstone technology concept anticipated herein will allow future autonomous systems with creativity, flexibility and agility attributes that will potentially better deal with self-directed tasks requiring responsive pursuit evasion, safe searching, and securing non-cooperative objects.

**Paper 8024-16 - Remote air lasing for trace detection**
Monday 3:20 PM - 3:40 PM
Author(s): Arthur Dogariu, James Michael, Richard B. Miles, Princeton Univ. (United States)
**Abstract**: We report high gain infrared lasing in atmospheric pressure air from the focal region of an ultraviolet laser. The process involves resonant two-photon dissociation of molecular oxygen and simultaneous resonant two-photon pumping of an atomic oxygen fragment. We achieve exceptionally high gain lasing from the atomic oxygen, producing well collimated beams in both the forward and backward directions relative to the pumping UV laser. This is the first demonstration of a practical air laser. This provides a new approach to remote detection using nonlinear interactions such as stimulated Raman scattering with the backward propagating beam.

**Paper 8032-14 - Rapid and field-deployable biological and chemical Raman-based identification**
Monday - 3:30 PM - 3:50 PM
Author(s): Edita Botonjic-Sehic, Marie Lesaicherre, Hacene Boudries, Morpho Detection (United States)
**Abstract**: Using Raman spectroscopy, the StreetLab Mobile delivers quick, accurate and user-friendly 2-in-1 chemical and biological identification capabilities. Assays developed for the identification of E.coli and Bacillus Anthracis have been developed and integrated onto a portable Raman device to allow for rapid & field deployable biological pathogen identification. Results from third party validation of the E.coli and Bacillus Anthracis assays will be presented. Assays conditions were optimized for improved assay performances and recent optimization studies will also be discussed. Finally, results of assays developed for the identification of additional pathogens will also be presented.

**Quote from Chair Mark Druy**: Field deployable Raman spectroscopic instrumentation is one of the fastest growing market segments in molecular spectroscopy. New developments in this field will lead to additional applications for detection of biological warfare agents and trace amounts of explosives.

**Potential or future applications of research** - highly sensitive portable spectroscopic instrumentation for medical diagnostics

**Tuesday**

**Tuesday 10:00 AM - 10:30 AM**
Author(s): C. Edward Dixon, Univ. of Pittsburgh (United States)

**Abstract:** Traumatic brain injury (TBI) produced by repeated exposure to mild blasts is the "signature injury" of current wars. Mild TBI produces subtle cognitive deficits that are difficult to detect and quantify. Biomarkers offer a new approach to rapid and simple TBI diagnostics, prognostics and therapeutic monitoring. Advancement of the field will require 1) new biomarker candidates, 2) clinical validation, 3) more sensitive, portable detectors, 4) new statistical approach to evaluate multiple biomarkers, and 5) commercialization. Animal models were developed to screen novel therapies and conduct proteomic, genomic, and lipodomic studies to mine for new biomarkers of blast TBI.

**Paper 8060-12 - Reconfigurable chip-scale optical router**
Tuesday 4:20 PM - 4:40 PM
Author(s): Ahmed S. Sharkawy, Lumilant, Inc. (United States); Mathew J. Zablocki, Dennis W. Prather, Univ. of Delaware (United States)

**Abstract:** A chip-scale reconfigurable optical router is demonstrated numerically and experimentally by engineering the slow-light properties in coupled photonic crystal waveguides to attain optical signal routing compatible with DoD SWaP requirements. In this talk we focus on a critical building block of the optical router namely Wavelength switching, to switch specific wavelengths from an incoming fiber to multiple outgoing fibers (multiplexing/demultiplexing).

**Quote from Chair Eric Kelmelis:** There is a move to all optical data connections because they are smaller, lighter, and can transmit more data. This paper presents a device developed by a small company in conjunction with the Air Force and the Navy to meet the needs of next generation data communication, particularly on military platforms.

**Potential or future applications of research:** Data routing networks. One of the primary initial applications is replacing the communication infrastructure of military aircraft. This will allow greater connectivity between the various electronic components on the aircraft while also reducing size, weight, and power (SWaP) of the communication infrastructure. Could also be applied to other military and commercial communication networks.

**Paper 8060-13 - Advances in computational fluid dynamics solvers for the GPU**
Tuesday: 4:40 PM - 5:00 PM
Author(s): John R. Humphrey, Jr., Dan Hertenstein, Eric J. Kelmelis, EM Photonics, Inc. (United States)

**Abstract:** EM Photonics has been investigating the application of massively multicore processors to a key problem area: computational fluid dynamics (CFD). The CPU is not a high performance device for scientific computing. An emerging technology in HPC is the graphics processing unit (GPU). There are many well-known codes in the CFD space that can benefit from this technology, such as FUN3D, AVUS, and TetrUSS. We will describe our results in parallelizing these well-known codes on the hybrid manycore GPU platform. The result is a many fold improvement in performance, granting better resolution results in less time without sacrificing accuracy.

**Quote from Chair Eric Kelmelis:** Computational fluid dynamics (CFD) modeling is used in the design of vehicles from cars to ships to airplanes. Due to its complexity, however, it is extremely computationally intense taxing even large supercomputers. This project shows the ability to apply the next-generation hardware, namely graphics processing units (GPUs), to significantly reduce these run times. This paper presents work done for the Navy to help them model the the interaction of airplanes, helicopters, and unmanned aerial vehicles (UAVs) landing on moving ships.
Potential or future applications of research: Current Navy simulations can more than 150,000 CPU hours to run 30 seconds of flight data. These simulations must then be dozens to hundreds of times to account for different weather conditions, angles of approach, etc. as well as the various ship and aircraft pairings. Reducing this time is critical to designing next generation vehicles, effectively developing con ops, and training pilots. The same tools developed here can also be used by groups such as NASA for rocket design and Boeing for commercial aircraft.

Wednesday

Wednesday: 10:00 AM - 10:30 AM
Author(s): Richard Crout, National Oceanic and Atmospheric Administration (United States)
Abstract: The explosion of the Deepwater Horizon (MC-252) drilling platform on 20 April 2010 began a long, unprecedented response from BP and the federal government. Previous responses to oil spills were limited in time due to the amount of oil spilled and were generally confined to the surface. Some of the oil from the Deepwater Horizon wellhead in 1500 meters of water broke into smaller droplets, whose density caused much of the oil to stay within a zone from 1000 to 1300 meters depth. The remainder of the oil rose to the surface. The two primary locations of oil required a broad collection of remote sensing techniques to locate and monitor the oil spill.
Surface oil was monitored primarily from the air using aircraft and satellite assets. Satellite visible, infra-red, and radar satellite imagery helped to locate the position of oil in the northern Gulf of Mexico and its potential movement away from the spill site. Daily overflights by NOAA and other aircraft provided higher spatial and temporal resolution data that were assimilated into daily products.
These remote sensing assets were able to track the surface oil, but the subsurface oil required different techniques. In addition to salinity and temperature profiles to determine the subsurface structure, fluorometry and dissolved oxygen measurements provided information related to oil and its consumption by microorganisms. Water samples collected from CTD casts were analyzed on-board for particle size distribution using a Laser In-situ Scattering Transmissometry (LISST) sensor. Water samples were also returned to on-shore laboratories, where they were subjected to Gas Chromatography and Mass Spectrometry to determine the chemical constituents in the seawater.
Quote from Chair Weilin (Will) Hou: (this conference) will feature a joint special session on oil spill especially studies focused on Deepwater Horizon spill. Approaches ranging from measurement techniques (Paper 8030-18), to combined numerical modeling efforts and observations (Paper 8030-19) are presented, along with 9 other papers

Paper 8012-50 - Wide-area infrared surveillance: performance requirements and technology needs (Keynote Presentation)
Wednesday: 11:30 AM - 12:00 PM
Author(s): Michael T. Eismann, Air Force Research Lab. (United States)
Abstract: The emergence of asymmetric and terrorist threats as a prime focus of military operations is placing high demands on airborne reconnaissance, surveillance, and targeting systems. When placed within the context of a complex, urban landscape, a need arises for advanced electro-optical and infrared (EO/IR) sensing techniques to deal with the combination of small, diverse, and elusive targets and broad area, complex, and highly structured regions of interest. One particular research emphasis within the Air Force Research Laboratory (AFRL) has been toward the development of wide area IR surveillance
capabilities that can continuously image city-sized areas with sufficient fidelity to detect and track individual personnel, or dismounts, in order to monitor their activity and ultimately assess their intent. This research has involved infrared signature phenomenology investigations of dismount activity to understand performance requirements, prototype infrared sensor system development to assess current technology capabilities, and enabling sensor component research to provide the necessary future advancements. This presentation will provide a summary of this on-going research, with a specific focus on establishing the technical requirements for dismount detection and tracking and the future infrared technology advances that will likely be required in order to address this challenging need.

**Conference 8048 - Track Plenary Presentation: Evolution of Airborne Chemical and Radiological Remote Sensing for Emergency and Natural Disaster Response**

Presenter: Paul E. Lewis, National Geospatial-Intelligence Agency

Wednesday 5:00 PM - 6:00 PM

Abstract: In 2001 the United States Environmental Protection Agency's (EPA) Airborne Spectral Photometric Environmental Collection Technology (ASPECT) Program became the United States only civil 24/7 operational airborne chemical, radiological, and situational awareness reporting capability. Since 2001 the ASPECT aircraft has completed 107 successful airborne emergency response and homeland security related missions. The ASPECT model of operation combines an airborne operational remote sensing suite with a research and development support team to provide essential situational awareness information to first responders and their local, state and federal lead agencies in accordance with the National Contingency Plan and EPA's responsibility under Emergency Support Function 10 of the National Response Plan. This presentation will showcase the effectiveness and necessity of the ASPECT operational model in meeting the needs of the civil emergency response and homeland security communities. Highlights from a variety of ASPECT airborne missions will be presented including industrial accidents, homeland security situational awareness missions, and natural and anthropogenic disasters such as Hurricane Katrina and the Deepwater Horizon Oil Spill along with issues, and lessons learned.

**Thursday**

**Paper 8031-63 - Cancer nanotechnology: new pipeline for diagnostics, imaging agents, and therapies**

Thursday - 12:45 PM - 1:15 PM

Author(s): Krzysztof Ptak, NCI Ctr. for Strategic Scientific Initiatives (United States)

Abstract: Nanotechnology offers the potential on how cancer is diagnosed and treated. Research sponsored by the NCI Alliance for Nanotechnology in Cancer has lead to development of nanomaterials of increasing complexity and devices of superior sensitivity, speed and multiplexing capability. Input from clinicians has guided researchers in the design of technologies to address specific needs in the areas of cancer therapy and therapeutic monitoring, in vivo imaging, and in vitro diagnostics.

Quote from Chair Tom George: The DSS Conference has thus far had few opportunities to showcase important advances made in the field of medicine and the sophisticated technologies being employed to address extremely challenging problems. In this regard, the National Cancer Institute has taken the bold and visionary step of recognizing that it takes a multi-disciplinary approach allowing for a convergence of molecular biology, oncology, physics, chemistry, and engineering leading to the development of clinically worthy technological solutions for the most important medical challenge of our time, namely the conquest of cancer. Nanotechnology as 'disruptive technology', has shown the greatest promise for creating a generation of new diagnostic and therapeutic products, aimed at
dramatically improved cancer outcomes. By creating and hosting the Micro- and Nanotechnology for Health Care Applications session within this conference, the organizers hope to achieve a significant amount of "cross-fertilization" between knowledge gained in the other application sectors being showcased in this conference with those made by Micro and Nanotechnologies in the medical sector.

**Potential or future applications of research:** The future applications of Micro and Nanotechnology research are essentially limitless and touch every application sector listed above, as well as practically every area of human endeavor including Aerospace, Transportation, Sports/Entertainment and Agriculture.

**Paper 8058-24 - Infrared imaging using carbon nanotube-based detector (Invited Paper)**
Thursday - 9:00 AM - 9:40 AM
Author(s): Ning Xi, Michigan State Univ. (United States)

**Abstract:** Using carbon nanotubes (CNT), high performance infrared detectors have been developed. Since the carbon nanotubes have extraordinary optoelectronics properties due to its unique one dimensional geometry and structure, the CNT based infrared detectors have extremely low dark current, low noise equivalent temperature difference (NETD), high response time, and high dynamic range. Most importantly, it can detect 3-5 um middle-wave infrared (MWIR) at room temperature. This unique feature can significantly reduce the size and weight of a MWIR imaging system by eliminating a cryogenic cooling system. However, there are two major difficulties that impede the application of CNT based IR detectors for imaging systems. First, the small diameter of the carbon nanotubes results in low fill factor. Secondly, it is difficult to fabricate large scale of the detector array for high resolution focal plane due to the limitations on the efficiency and cost of the manufacturing. In this paper, a new CNT based IR imaging system will be presented. Integrating the CNT detectors with photonic crystal wave guide, the fill factor of the CNT based IR sensor can reach as high as 0.91. Furthermore, using the compressive sensing technology, a high resolution imaging can be achieved by CNT based IR detectors. The experimental testing results show that the new imaging system can achieve the superb performance enabled CNT based IR based detectors, and, at same time, overcame its difficulties to achieve high resolution and efficient imaging.

**Quote from Chair Harold Szu:** "It will be the first compressive sensing imaging based on the nanotechnology."

**Potential or future applications of research:** Compared to traditional MWIR camera, the 1-D CNT camera requires no cumbersome liquid nitrogen for FPA sensor cooling.

**Paper 8028-4 - Sensitive fluorescence detection with microstructured optical fibers**
Thursday 9:20 AM - 9:40 AM
Author(s): Erik P. Schartner, Heike Ebendorff-Heidepriem, Tanya M. Monro, The Univ. of Adelaide (Australia)

**Abstract:** Optical fibers are ideal for environmental sensing applications because of their ability to transmit optical signals to and from the sensing region without the use of free-space optics. Through the use of suspended core MOFs we can exploit the interaction between the evanescent field of the fiber and a target molecule to facilitate detection. The aim of this work is to increase the sensitivity of the system, and to examine the primary factors such as the background glass fluorescence currently restricting the detection limit. This work is focused on biological detection in liquid samples using Quantum dots.
**Paper 8028-18 - Surface scattering plasmon resonance fibre sensors: demonstration of rapid influenza A virus detection**

Thursday 5:30 PM - 5:50 PM  
Author(s): Alexandre Francois, Jonathan Boehm, The Univ. of Adelaide (Australia); Sawyin Oh, Tuckweng Kok, Institute of Medical and Veterinary Science (Australia); Tanya Monro, The Univ. of Adelaide (Australia)  

**Abstract:** The existence of Surface Plasmons Resonance is usually inferred from absorption features that correspond to the coupling of light to the surface plasmon. However, under certain conditions, the surface plasmon can couple to the local photon states, and emit light. Here we show that by collecting and characterising this re-emitted light, it is possible to create new SPR sensing architectures that offer significant advantages compared to existing approaches. It is applicable to a range of SPR geometries, including optical fibres. Moreover, this technique allows to combine SPR sensing and fluorescence sensing into a single platform for a more reliable diagnostic.

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**Friday**

**Paper 8012-112 - Classification of thermal face images using radial basis function neural network**

Friday - 9:20 AM - 9:40 AM  
Author(s): Mrinal K. Bhowmik, Debotosh Bhattacharjee, Dipak K. Basu, Jadavpur Univ. (India)  

**Abstract:** This paper is an approach to classify thermal face images for face recognition using feature extraction method and Radial Basis Function (RBF) neural network with a back propagation learning algorithm as classifier. In first step line features are extracted from thermal polar images to construct feature vectors. Feature vectors thus obtained passes through principal component analysis (PCA) for dimensionality reduction of feature vectors. Finally, the images projected into eigenspace are classified using a Radial Basis Function (RBF) neural network. Object Tracking and Classification beyond Visible Spectrum (OTCBVS) database has been used for the experiments. Experimental results show that the proposed approach significantly improves the verification and identification performance and the success rate is 100% (maximum) but on an average it is 94.44%.  

**Quote from Chair Bjorn Andresen:** A security system based on facial thermogram would be non-intrusive, robust, accurate, and very efficient in nature. This part of the project is to design, develop and implement an affordable, robust, accurate, and efficient security system based on facial thermogram, which would have commercial values; i.e. the Technology can be successfully used for different difficult situations of authentication and against security threats.