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VISION **Distinguished Speakers**

2005

Make Impact on UCF Three visitors discuss their research with computer

vision group and university colleagues

In 2005, the Computer Vision Lab had the pleasure of hosting some of the most famous names in the field of computer vision. In May, Dr. J.K. Aggarwal from the University of Texas at Austin visited UCF to give a talk entitled Understanding of Human Motion, Actions, and Interactions. October brought the arrival of Dr. Rama Chellappa of the University of Maryland and his talk Machine Perceptions of Humans and their Activities. In November, Carnegie Mellon University's Dr. Takeo Kanade spoke to UCF on the topic of Modeling and Reconstruction of Deformable Object Shapes from Video.

Dr. Aggarwal's discussion looked at several fields that lead to



Dr J. K. Aggarwal

study in computer vision, including motion analysis in sports and medicine. He also discussed issues of interactions at blob and detailed levels, as well as directions of future research in motion and human activity recognition. Dr. Aggarwal is a forty-year member of the University of Texas at Austin and is currently a Cullen Professor of Electrical and Computer Engineering, as well as the Director of the Computer and Vision Research Center.

When asked about his visit to UCF, Dr. Aggarwal said: "My visit to UCF to present a seminar on my research on human activity recognition, was a very positive experience, both for me and my audience. I enjoyed giving the seminar to a standing room only crowd and I felt it was a satisfying learning experience for the audience based on the response and the questions by several persons in attendance. These positive vibes were complemented by my conversations with several researchers and administrators during my brief stay. I came away with a strong impression of a growing and energized program with resources, both intellectual

and financial. I believe that UCF will join the ranks of top universities in this country in the foreseeable future. On the whole, I had a very positive visit."

Although UCF went several months without a visitor, the next speaker was worth the wait. Dr. Rama Chellappa presented his recent work on recognizing humans and their activities using video sequences. The talk

was highly informative and presented with a bit of humor that everyone enjoyed. Dr. Chellappa is a Minta Martin Professor of



ANNUAL REPORT

Electrical Engineering and an affiliate Professor of Computer Science at the University of Maryland - College Park since 1991. He is also the director of CFAR and a permanent member of UMIACS.

"Prof. Mubarak Shah's group is a top-tier research group in video surveillance," said Dr. Chellappa. "I enjoyed visiting his group recently. His graduate students were very eager to discuss their research projects. I was also struck by their

Dr. Rama Chellappa

member since 1980.

Feb. 23

Mar. 9

Apr. 11

Distinguished Speaker

Series Schedule 2006

Dr. Jitendra Malik

Dr. Luc Van Gool

Dr. Thomas Huang

Dr. Allen Hanson

openness." In November, UCF was visited by Dr. Takeo Kanade. He shared his insights on non-rigid structure from motion and his research that has allowed him to achieve

well as head poses in real-time.



Takeo Kanade

Says Dr. Kanade about his visit to UCF, "The quality and quantity of computer vision research being conducted by Professor Shah's group is amazing. Especially impressive is emphasis of real-time video processing, application-worthy successfullv scenario, and learning from data all integrated. Another pleasing observation was the collegial. collaborative and productive working relationship among the professor, post-docs, senior students, and junior students."

> In 2006, the Computer Vision Lab at UCF looks forward to visits from several more important figures in the field of computer vision, including Dr. Jitendra Malik (University of California Berkeley), Dr. Luc Van Gool (Swiss Federal Institute of Technology Zurich), Dr. Thomas Huang (University of Illinois at Urbana-Champaign), and Dr. Allen Hanson (University of Massachusetts-Amherst).

Computer Vision Lab @ University of Central Florida

Dr. Mubarak Shah Agere Chair Professor, Director Computer Vision Lab

Sheli Carr Laboratory Manager

Research Associates

Dr. Alper Yilmaz Dr. Khurram Shafique Dr. Pingkun Yan

Ph.D. Students

Yaser Ajmal Sheikh Adeel Ali Saad Ali Nazim Ashraf Pavel Babenko Arlsan Basharat Alexei Gritai Asaad Hakeem Min Hu Amit Jain Saad Masood Khan Jingen Liu Fahd Rafi Mikel Rodriguez Imran Saleemi Paul Scovanner Yun Zhai

M.S. Students

Ryan Faircloth Phillip Berkowitz

<u>Undergraduates</u>

Vladimir Reilly Eric Leach

UCF Vision Lab Group Members



Group Members From Left to Right in Picture:

Front Row:Eric Leach, Imran Saleemi , Fahd Rafi, Mikel Rodriguez, Saad Ali, Pavel BabenkoSecond Row:Pingkun Yan, Yaser Ajmal, Mubarak Shah, Khurram Shafique, Asaad HakeemThird Row:Saad Khan, Arslan Basharat, Alexei Gritai, Phillip Berkowitz, Jingen Liu, Yun Zhai, Min HuForth Row:Ryan Faircloth, Vladimir Reilly, Nazim Ashraf, Paul Scovanner, Adeel Ali

Exchange Students @ Vision Lab

Humera Noor, Pakistan



Humera Noor works as an Assistant Professor at the NED University of Engineering and Technology (NEDUET), Karachi, Pakistan. She completed her Masters in 2003 and is currently enrolled in the Ph.D. program at NEDUET. Humera has been here at UCF since August 2005. The basic purpose of her visit is to gain exposure and confidence by working with knowledgeable professors here at UCF. Moreover, an interaction with the students in the laboratory allows discussion of ideas and helps in finding solutions to the various problems that arise during research. During this short visit, she has been able to complete a major portion of her original research, and has remained involved in the ongoing project of "Automatic Recognition of Objects". Says Humera, "This visit has been really helpful in gaining confidence and develop-

ing strong foundations for my work. Working with the knowledgeable professors and their talented students has given me a chance to enhance my vision. I myself feel the difference."

Roberto Vezzani, Italy



Roberto Vezzani hails from Italy, where he received a B.S. in Computer Engineering from the University of Modena and Reggio Emilia with a thesis on computer vision. He worked at the same university as a freelance consultant for two years. Since 2004, Roberto has been a Ph.D. student studying Information Engineering at university of Modena and Reggio Emilia under the supervision of Professor Rita Cucchiara. He is currently working as a visiting scholar with the Computer Vision Lab at the University of Central Florida for a three-month exchange program, running from September 15 to December 15. His current research focuses are human tracking, face detection, and camera calibration.

When asked about his visit to UCF, Roberto says: "I am proud to be a part of such a well-known and great team. Working with Dr. Shah and his students is a great experience, not only from a professional point of view but in every aspect possible."

Twenty-One Years of R.E.U. in Computer Vision

NSF Extends Funding Through 2008 for UCF Research Experience for Undergraduates

UCF Computer Vision Lab received yet another REU (Experience for Undergraduates) site grant from the National Science Foundation. The REU program will run through 2008, the year that will mark 21 years of REU at UCF. Principle Investigators on this project are Dr. Mubarak Shah, Dr. Niels da Vitoria Lobo, and Dr. Takis Kasparis.

(including conferences and journals) and I was also able to present my work at the prestigious European Conference on Computer Vision in Stockholm, Sweden (an exciting time for me, an undergraduate!). This successful REU program definitely prepared me for my graduate studies (and later faculty position). I am pleased that the program has

The Computer Vision lab at UCF has continued to be an REU since it's inception by NSF in 1987. During the last two decades, close to 200 undergraduate students from different schools all over the country have participated in this program. The REU participants have co-authored more than 60 research papers. Approximately half of these participants have gone to graduate schools, ten students have written Honors in the Major Theses, six participants are now faculty members at different universities, and five participants have started their



REU Participants 2005: Miko Charbonneau (UCF), Shayne Czyzewski (UCF), Jason opportunity to attend two REU Feinstein (UCF), Carlos Flores (University of Texas Pan-American), Jonathan Jarvis (SUNY Brockport), Jan Prokaj (UCF), Vladimir Reilly (UCF), Phillip Rydzewski (University of Wisconsin Madison), Chris Schwarz (UCF), Mike Sollami(Trinity College),

own companies. James W. Davis, now an Associate Professor at Ohio State University, is a former participant in the REU program. "As a former REU participant at UCF (1993-1994), I found the experience to be the watershed leading to my graduate studies at MIT in computer vision and to my tenured faculty position at Ohio State University (teaching and researching computer vision). During the time I was an undergraduate at UCF, my experience through the REU program was the highlight of my studies. My REU research successfully resulted in several publications new three-year grant. I will always be grateful for the opportunity I had with Prof. Shah in the REU program." "My positive experience with the REU program has been the most significant factor in my decision to pursue a Ph.D. degree in computer vision," says former REU participant Ankur Datta, now a Ph.D. student at The Robotics Institute at Carnegie Mellon University. "I had the

recently been continued with a

summer programs at UCF under the guidance of Dr. Mubarak Shah and Dr. Niels

Lobo who helped me in picking a topic for research and constantly guided me in my research. Interacting with the graduate students on a daily basis during the REU program gave me a very good idea about graduate school and since I liked the whole experience of doing research in the REU program, I decided to apply for the Ph.D. program in computer vision. I believe that because of my advanced training which I received from being part of the REU, I was able to obtain admissions to the top graduate schools in computer science."

Computer Vision Lab 2005 Ph.D. Graduates

OMAR JAVED



In May 2005, after five years of hard work and diligence, Omar Javed graduated from UCF with his Ph.D. His dissertation, entitled Scene Monitoring with a Forest of Cooperative Sensors, presented "vision-based scene interpretation methods for monitoring of people and vehicles, in real-time, within a busy environment using a forest of cooperative electro-optical (EO) sensors." While at UCF, Omar published several papers based on his

research, including papers accepted for ICCV, CVPR, ECCV, and other prestigious conferences. He is one of the highest cited authors in his graduating class with almost 150 citations. In 2001, Omar was a recipient of the Hillman Fellowship for Excellence in Research in a Ph.D. program and the Merit Graduate Fellowship.

Following his graduation from UCF. Omar moved to Virginia to work as a Research Scientist for Object Video, a company which provides intelligent video technology products to borders, airports, seaports, oil refineries, chemical and nuclear plants and water treatment facilities.

PAUL SMITH



Paul Smith became the most recent member of the Computer Vision Lab to obtain his Ph.D. by graduating in December 2005. Paul defended his dissertation, entitled Multizoom Activity Recognition Using Machine Learning, on November 21, 2005. Paul began his Ph.D. studies in 2001 after obtaining his M.Sc. at UCF.

Paul was a participant in the Research Experience for Undergraduates program in 1999-2000, during which time he received a Barry Goldwater Fellowship, the first ever for UCF, on his REU project. During his research career at UCF, Paul published one journal paper (with two still under review) as well as three conference papers, including ICCV, CVPR, and ICPR. His paper entitled "Determining Driver Alertness with One Camera" appeared in IEEE Transactions on Intelligent Transportation Systems in December 2003. Paul will soon be moving to Washington, D.C. to begin work for Northrop Grumman Corp.

computer vision at

Yan Receives Best Student UCF Among Finalists at Paper Honors at MICCAI



Pingkun Yan's paper, entitled MRA Image Segmentation with Capillary Active Contour, was selected as a recipient of the Best Student Paper award (which carries a cash prize of \$500) at the 8th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI) 2005 in Palm Springs, California. The award is sponsored by Northern Digital Incorporation. The conference, held from October 26-30, 2005, featured papers from several disciplines

Dr. Pingkun Yan

dealing with the topic of medical image computing, computerassisted intervention, and medical robotics. In his paper Yan proposed a novel method called Capillary Active Contour (CAC) for segmentation of three-dimensional Magnetic Resonance Angiography (MRA) images to accurately extract vasculature. The method models capillary action where liquid can climb along the boundaries of thin tubes.

"MRA Image Segmentation with Capillary Active Contour", Pingkun Yan and Ashraf A. Kassim 8th International Conference on Medical Image Computing and Computer Assisted Intervention, Palm Springs, California, USA, 2005. http://www.cs.ucf.edu/~vision/news/mccai2005 award.html

Hakeem Nominated for **Best Paper at ACM MM**



Asaad Hakeem's paper, entitled An Object Based Video Coding Framework for Video Sequences Obtained from Static Cameras, was nominated for Best Paper at the 2005 ACM Multimedia conference in Singapore. ACM Multimedia is the premier conference on multimedia, covering all aspects of multimedia computing, including underlying technologies to applications, theory to practice, and servers to networks to devices.

The paper presents a novel object-based video coding framework for videos obtained from a stationary camera. As opposed to most existing methods, the proposed method does not require explicit 2D or 3D models of objects and hence is general enough to cater for varying types of objects in the scene.

"An Object based Video Coding Framework for Video Sequences Obtained From Static Cameras", Asaad Hakeem, Khurram Shafique, and Mubarak Shah ACM Multimedia 2005, Singapore, November 6-12.

http://www.cs.ucf.edu/~vision/news/acmmm2005.html

ICCV Contest 2005



The Computer Vision Lab at UCF received Honorable Mention at the Tenth International Conference on Computer Vision (ICCV) in 2005 for achieving fourth place in the contest. The contest, dubbed Where Am I?, provides contestants with a collection of color images taken by a calibrated digital camera. The photographs are from various locations and often share overlapping fields of view or certain objects in common. The GPS locations for a subset of the images are provided. The goal of the contest is to guess, as accurately as possible, the GPS locations of the un-labeled images. The UCF team included Asaad Hakeem, Arslan Basharat, Fahd Rafi, Saad Khan, and Mubarak Shah.

The final results of the 2005 ICCV Contest are based upon expected reliability of the location estimates. The Final results can be viewed at http://research.microsoft.com/iccv2005/Contest/ Results/Results5Final.htm.

Computer Vision Lab Suffers Tragic Loss



Orkun Alatas August 16th, 1977 -September 3rd, 2005

On September 3, 2005, Computer Vision Lab member Orkun Alatas passed away. Orkun was a research colleague and a dear friend to everyone in the group. He will always be remembered for his kind hearted and loving personality.

While at UCF, Orkun published papers in ICPR and ICIP and another paper has been accepted for IEEE Transactions on Image processing. Orkun also developed a novel technique in wavelet video compression known as SPREF.

University of Central Florida

2005 Publications & Presentations

MICCAI 2005

Pingkun Yan and Ashraf A. Kassim, "MRA Image Segmentation with Capillary Active Contour", (Best Student Paper Award)

Pingkun Yan, Weijia Shen, Ashraf A. Kassim, and Mubarak Shah, "Segmentation of Neighboring Organs in Medical Image with Model Competition",

ACM Multimedia 2005

Asaad Hakeem, Khurram Shafique, and Mubarak Shah, "An Object based Video Coding Framework for Video Sequences Obtained From Static Cameras". (Nominated for Best Paper Award)

Yun Zhai, and Mubarak Shah, "Tracking News Stories Across Different Sources.

Saad M. Khan and Mubarak Shah, "Detecting Group Activities Using Rigidity of Formation".

Yun Zhai, and Mubarak Shah, "Determining Structure in Continuously Recorded Videos".

ICCV 2005

Yun Zhai and Mubarak Shah, "A General Framework for Temporal Video Scene Segmentation".

Paul Smith, Niels da Vitoria Lobo and Mubarak Shah, "Temporal Boost for Event Recognition".

Alper Yilmaz and Mubarak Shah, "Recognizing Human Actions in Videos Acquired by Uncalibrated Moving Cameras".

Saad Ali and Mubarak Shah, "A Supervised Learning Framework for Generic Object Detection in Images".

Yaser Sheikh and Mubarak Shah, "Object Tracking Across Multiple Independently Moving Cameras".

Yaser Sheikh and Mubarak Shah, "Exploring the Space of an Action for Human Action Recognition".

Paul Smith, Niels da Vitoria Lobo and Mubarak Shah, "Resolving Hand Over Face Occlusions". *IEEE International Workshop on Human Computer Interaction with ICCV 2005.*

AAAI 2005

Asaad Hakeem and Mubarak Shah, "Multiple Agent Event Detection and Representation in Videos".

ICIP 2005

Orkun Alatas, Omar Javed and Mubarak Shah, "Video Compression Using Structural Flow".

CIVR 2005

Yun Zhai, Alper Yilmaz and Mubarak Shah, "Story Segmentation in News Videos Using Visual and Text Cues".

CVPR 2005

Yaser Sheikh and Mubarak Shah, "Bayesian Object Detection in Dynamic Scenes".

Omar Javed, Khurram Shafique and Mubarak Shah, "Appearance Modeling for Tracking in Multiple Non-overlapping Cameras".

Alper Yilmaz and Mubarak Shah, "Actions As Objects: A Novel Action Representation".

Omar Javed, Saad Ali and Mubarak Shah, "Online Detection and Classification of Moving Objects Using Progressively Improving Detectors.

Jiangjian Xiao and Mubarak Shah, "Accurate Motion Layer Segmentation and Matting".

Xiaochun Cao and Mubarak Shah, "Camera Calibration and Light Source Orientation Estimation from Images with Shadows".

WACV and WMCV 2005

Yunjun Zhang, Jiangjian Xiao, and Mubarak Shah, "Motion Layer Based Object Removal in Videos".

Xiaochun Cao and Mubarak Shah, "Shadow Construction in Object Transfer".

Jiangjian Xiao, Yunjun Zhang, and Mubarak Shah, "Adaptive Region-Based Video Registration".

ICIAR 2005

Yun Zhai and Mubarak Shah, "A Multi-Level Framework for Video Shot Structuring".

TRECVID

Yun Zhai, Jingen Liu, Xiaochun Cao, Arslan Basharat, Asaad Hakeem, Saad Ali, Mubarak Shah, Costantino Grana and Rita Cucchiara, "Video Understanding and Content-Based Retrieval".

ICME 2005

Yun Zhai and Mubarak Shah, "Automatic Segmentation of Home Videos".

Saad Ali and Mubarak Shah, "An Integrated Approach for Generic Object Detection Using Kernel PCA and Boosting".

Journals 2005

Yun Zhai, Zeeshan Rasheed and Mubarak Shah, "Semantic Classification of Movie Scenes Using Finite State Machines", *IEE Proceedings on Vision, Image and Signal Processing (VIS)*, Vol.152, No.6, pp.896-901, December 2005

Zeeshan Rasheed and Mubarak Shah, "Scene Segmentation of Hollywood Movies and TV Shows", *IEEE Transactions on Multimedia*, December 2005.

Yaser Sheikh and Mubarak Shah, "Bayesian Object Detection in Dynamic Scenes", *IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI)*, Vol. 27, No. 11, pp 1778-1792, November 2005.

Arslan Basharat, Asaad Hakeem, Mubarak Shah, and Abhijit Mahanalobis, "Automatic Target Detection and Recognition in Video Sensor Network with Stationary and Mobile Nodes", *OE Magazine*, Member Publication of SPIE, November Issue, 2005.

Jiangjian Xiao and Mubarak Shah, "Motion Layer Extraction in the Presence of Occlusion Using Graph Cuts", *IEEE Transactions on PAMI*, September 2005.

Xiaochun Cao, Yuping Shen, Mubarak Shah, and Hassan Foroosh, "Single view compositing with shadows", *Visual Computer*, Vol. 21, No. 8-10, September 2005 (639-648).

Jiangjian Xiao and Mubarak shah, "Layer-Based Video Registration", *Machine Vision and Applications*, Vol. 16, No. 2, February 2005.

Khurram Shafique and Mubarak Shah, "A Non-Iterative Greedy Algorithm for Multi-frame Point Correspondence", *IEEE Transactions on PAMI*, Vol. 27, No. 1, January 2005.

Alper Yilmaz, Xin Li, and Mubarak Shah, "C-BOT: Contour Based Non-Rigid Object Tracking Using Mobile Cameras", *IEEE Transactions* on *PAMI*, January 2005.

2005 Presentations/Talks

Mubarak Shah, "Recognizing Human Actions", Electrical and Computer Engineering, University of Miami, Florida, November 16, 2005.

Mubarak Shah, "Tracking Across Multiple Moving Cameras", Istituto di Cibernetica E. Caianiello, Napoli, Italy, September 15, 2005.

Mubarak Shah, "Recognizing Human Actions", IDIAP Research Institute, Martigny, Switzerland, September 12, 2005.

Mubarak Shah, "Tracking Across Multiple Moving Cameras", Universit degli Studi di Firenze, Italy, May 13, 2005.

Mubarak Shah, "Tracking Across Multiple Moving Cameras", Responsible d'quipe Vision et Imagerie Centre de Recherche Informatique de Montreal, Montreal, Canada, April 5, 2005.

Paul Smith, "Multizoom Activity Recognition Using Machine Learning", Sarnoff, Princeton, NJ, November 14, 2005.

Yaser Sheikh, "Bayesian Modeling of Dynamic Scenes for Object Detection", Johns Hopkins University, July 19, 2005.

new systems developed

PEGASUS: A Content-Based Video Retrieval System

Yun Zhai, Jingen Liu and Mubarak Shah

PEGASUS is a content-based video retrieval system developed at the UCF Computer Vision Lab. It is designed for retrieving relevant videos from broadcast news programs given the target topics. It utilizes the content of the videos, such as speech transcript and visual content, for fast indexing and search. It consists of three components: user interface, server and feature indexing. The query formulation and result browsing are performed through the user interface. The server component parses the input query, performs the search and ranks the returned results. The feature indexing uses speech, image regions and global histograms. Two types of relevance feedback mechanisms, automatic keyword generation and region-based visual refinement, have been developed and incorporated in the system to improve the search. The system diagram is shown in Figure 1.



Figure 1. System diagram of PEGASUS with three major components and their functionalities.

One important feature of the PEGASUS system is to automatically generate the relevant keywords to refine the search query. For different video sets, the initial query formulated based on prior human knowledge often is not strongly related to the topic. By analyzing the user selected relevant video shots, a set of keywords, which are more correlated to the topic, are extracted. The extracted keywords are ranked by their frequencies in the relevant shots to represent their relevance to the search topic. They are used to assist the user to reformulate the search query, which is more relevant and meaningful for the target dataset. The snap shot of the keyword generation is shown in figure 2.

Different news networks may broadcast the same news story, but with different narrations. In this situation, the visual appearance of video key-frames plays a critical role in determining similar stories. The second relevance feedback mechanism of the PEGASUS On the Internet: http://pegasus.cs.ucf.edu:8080



Figure 2. Interface for keywords generation. The selected relevant shots are shown in the panel. Both the positive and negative keywords for the topic "Bush" are generated.

system is based on the analysis of the key-frame regions. After the user decides the relevant shots in the previous round, each region in the selected key-frames is considered as a new query for the new round of search. The returned results are ranked based on the Earth Mover's Distance between the returned key-frames and the query key-frames. One snap shot of the visual refinement is shown in figure 3.



Figure 3. Results of the visual refinement. The query images are shown in the left most panel. For each shot its similar shots are show on the right.

To demonstrate the effectiveness, we have tested this system on ten topics selected from TRECVID dataset. In our experiments refinement using automatically generated keywords increased the relevant set by $\sim 80\%$. Combining this with visual refinement boosted our results by an additional $\sim 44\%$.

at computer vision lab

Social Cocoa: Automated Aerial Video Exploitation System

Saad Ali, Min Hu, Yaser Ajmal, Paul Scovanner, Mubarak Shah

http://www.cs.ucf.edu/~vision/projects/COCOAWebsite/CocoaWebsite/featured_project.html

Unmanned Aerial Vehicles (UAVs) are becoming a core intelligence asset for multi-spectral reconnaissance, surveillance and target acquisition in urban and battlefield settings. This growing popularity is fuelling the need for multi-functional automated systems that can explore and analyze thousands of hours of visual data gathered by these UAVs everyday. In order to achieve this goal Computer Vision Lab at University of Central Florida has developed a fully automated system that integrates different stages of UAV video exploitation process into one monolithic system, called COCOA. Figure 1 shows the interface which is used to execute different functionalities of COCOA.



Figure 1. Interface of COCOA

COCOA provides end user with a host of versatile features such as robust frame to frame alignment, moving target detection, multiple target tracking, event detection and indexing of the videos.



Figure 2. Block Diagram of COCOA's System Architecture

Furthermore, archived videos can be retrieved using query events and videos. A web based reporting module handles the dissemination of search results to the user. It is developed as a stand alone application which works seamlessly across different sensor modalities. Figure 2 shows the block diagram of COCOA.

To maximize the application flexibility, in COCOA we provide multiple methods within each module. The motion compensation module uses gradient based, feature based and platform telemetry based methods to accomplish the alignment task. The moving object detection module can perform multiple object detection by employing frame differencing and scene background modeling. While the tracking module uses blob tracker and kernel based tracker to perform multiple object tracking, it also handles occlusion between the tracked object. Events are detected from the trajectories of the tracked objects in a hierarchical manner by first detection primitive motion verbs followed by detection of composite motion verbs. Extensive testing of COCOA has been performed on DARPA's *Video Verification of Identity* (VIVID) data set. Figure 3 illustrates results of alignment and tracking.



Figure 3. Alignment and Object Tracking Results.

In addition, COCOA delivers capability of querying the UAV video repository. Queries can be performed in two ways. The user can enter a query event and COCOA will return all the videos from the database containing similar events in them, or the user can input a query video. In case of query video COCOA first processes the video to obtain the list of events. This list is then used to report all the videos which have one or more similar events. Web based reporting is used to display the results. The user can interactively browse the results and can play the returned videos.

Computer Vision Lab Scores Major Funding in 2005

As Principal Investigator (PI) of several new awards in the 2005 fiscal year, Dr. Mubarak Shah lead the Computer Science department in research funding. He was inducted into the 2005 Class of The UCF Millionaires' Club for bringing in research funding of over 1 million dollars. A majority of the funding (48%) came from private industry, an indicator of the quality and applicability of research conducted at the Vision Lab. The remainder of the funding came from federal and state sponsor.

This year new awards came from the Army Research Office on "Automatic Target Recognition Using View Morphing", Lockheed Martin Integrated Systems on "Video Indexing of UAV Videos", the Florida Department of Transportation on "Visual Inspection of Railroads", Lockheed Martin Fire & Missile Systems on "FCS: Human Detection", and from ARDA on "Video Event Recognition Algorithm Assessment Evaluation (VERAAE)".



UCF Computer Vision Lab & Lockheed Martin: Future Combat Systems Project



Two humans are detected in an infrared video sequence using UCF's human detection algorithm.

The Future Combat Systems (FCS) project is the Army's new modernization program, consisting of a family of manned and unmanned vehicles that will transform the Army into a more agile force capable of going anywhere with enough power to overcome any adversary.

The FCS project is one of the most complex programs ever executed by the Department of Defense, consisting of 18 systems, 32 critical technology areas, 34 million lines of code, 129 trade studies, and a cost of at least \$22 billion through 2009.

UCF's participation in the project is highly significant. Currently, the Computer Vision Lab at the University of Central Florida is the **only** university among 360 companies covering 150 congressional districts in 35 states, participating in

the project. UCF is a subcontractor of Lockheed Martin on this project. UCF is working on aided target recognition for the FCS project by developing a human detection algorithm capable of recognizing and detecting human targets within image sequences taken under a wide range of environmental conditions and captured using LWIR and EO sensors.



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