Zhiwei Zhu

11 York Drive, Princeton, NJ, 08540. Cell (609)-937-4345,

zhwzhu@gmail.com, www.zhiweizhu.com

RESEARCH INTERESTS

Vision-based Localization and Navigation, Large-scale Landmark Matching, 3D Scene Reconstruction from Video, Augmented Reality, Eye and Gaze Tracking, Facial Feature Tracking, Human Computer Interaction.

EDUCATION

Rensselaer Polytechnic Institute, Troy, NY ***Aug. 2002 – Dec. 2005***
Ph.D. in Electrical Engineering

University of Nevada, Reno ***Aug. 2000 – Aug. 2002***
Master of Science in Computer Engineering

University of Science & Technology of Beijing, China ***Aug. 1996 – Jul. 2000***
Bachelor of Science in Computer Science

AWARDS&HIGHLIGHTS

- 2011 IEEE Virtual Reality Conference Best Paper Award
- 2010 Sarnoff Vision Technologies Award for outstanding technical achievement
- 2006 Sarnoff Vision Technologies Award for outstanding technical achievement
- 2006 Allen B. DuMont Prize (1969), given to an EE major graduate in RPI, "who made a substantial contribution to his/her field of study"
- 2004 IEEE VTS Best Transaction Paper Award

PROFESSIONAL EXPERIENCE

SRI International, Princeton, NJ, ***Feb. 2016 – present***
Principal Scientist, Vision Technologies Division

SRI International, Princeton, NJ, ***Feb. 2011 – Feb.2016***
Senior Computer Scientist, Vision Technologies Division

Sarnoff Corporation, Princeton, NJ, ***June 2010 – Feb. 2011***
Senior Member of Technical Staff in Vision & Robotics Lab

Sarnoff Corporation (Formerly RCA Laboratories), Princeton, NJ, ***Jan. 2006 – June 2010***
Member of Technical Staff in Vision & Robotics Lab

Key Developer for

- **DARPA Advanced Soldier Sensor Information System and Technology (ASSIST)** project (January 2006~December 2006). I conducted research and development on a real-time backpack-based visual odometry system for soldier localization and navigation using stereo-cameras. Designed novel algorithms for robust 3D camera pose estimation using local landmarks under indoor and outdoor environments.

- **ONR I2C Training System** project (December 2006~December 2007). I conducted research and

development on a real-time helmet-based visual navigation system using two pairs of stereo-cameras, IMU and GPS. Designed novel algorithms for 3D pose estimation using two pairs of stereo-cameras, sensor fusing by integrating with IMU and GPS sensors, and real-time global landmark recognition under a large-scale landmark database on-the-fly.

- **Video-Trek Robot Follower** project (December 2006~August 2007). I developed algorithms for the real-time landmark extraction, indexing and matching for a vision-guided GPS-denied navigation system, which enables an unmanned robot to follow an operator who is equipped our navigation system on his helmet remotely.

- **GPS-Denied Localization Accuracy Analysis for John-Deere Mower** project (August 2007~August 2008). I developed and performed systematic analysis to evaluate the accuracy of the GPS-denied visual navigation system.

- **DARPA Mixed Reality for Training (MR-T) Seedling** project (July 2007~January 2008). I developed optically aided Video Odometry combined with visual landmark detection to provide accurate, infrastructure-free indoor and outdoor, location of the trainee and his weapons in the mixed reality world (both real and synthetic).

- **Seamless Indoor/Outdoor Tracking of Marines and Weapons: 6 DOF location and Pose** project (November 2008~November 2010). I developed a system to pre-build a landmark database using a Lidar-aided unit given a training facility; Then using the pre-built landmark to perform real-time landmark matching to locate the marine in 6 DOF without drift.

- **Future Immersive Training Environment (FITE) -JCTD Augmented Reality** project (January 2010~December 2010). I developed and extended the landmark matching capability so that it is able to provide the 6-DOF camera pose in a large-scale training facility; By fusing the landmark matching with the Kalman Filtering, the jitter and drift of the virtual object inserted into the real environment is reduced dramatically.

- **NGA Heterogeneous Airborne Reconnaissance Team (HART)** project (August 2010 ~ February 2011). I developed the algorithm to perform real-time landmark matching to perform failure recovery for a UAV geo-registration and provide successful geo-registration when the camera video of the airplane is in zoom mode where the regular frame-to-frame geo-registration fails.

- **NGA Hierarchical Urban Natural Terrain Exploitation and Reasoning (HUNTER)** project (November 2010~December 2012). I developed algorithm for geo-locating metadata-free handheld images and videos in an urban or semi-urban environment; I'm the algorithm developer for matching features extracted from handheld imagery to features automatically extracted from LIDAR data and compute the geo-location and camera pose of the handheld imagery.

- **Lockheed Martin Augmented Reality based Training and Vehicle Repair** project (May 2011 ~ May 2012). I developed methods for using Augmented Reality for vehicle and complex machinery maintenance. I demonstrated the efficacy of building up a visual maintenance database and a repair and operation ontology and the ability to match to them in real time to provide step-by-step directions.

- **Augmented Reality Virtual Assistant for Immersive Maintenance, Training and Repair (AR-Mentor)** Project (December 2012 ~ December 2014). I'm the team leader for building an Augmented Reality based mentoring system for the US Army Bradley Vehicle Maintenance and Repair. It combines a wearable Optical-See-Through display device with high precision pose tracking, and a virtual personal assistant

(VPA) with natural language, verbal conversional interaction, providing guidance to the user in the form of visual, audio and locational cues.

- **Augmented Reality Based Individual & Collective Training for Tactical Operations (STTC)** Project (January 2015 ~ now). I'm the team leader for building an Augmented Reality based individual & collective training system that can provide an immersive, full-spectrum, training experience for small units at home station and/or while deployed without requiring any prior infrastructure. The project will design and deliver 4 dismount worn sensor units that can work both indoor and outdoor environments. The systems were based on a wearable Optical-See-Through display device with high precision pose tracking, and an instrumented weapon with a mobile processor, allowing for kinetic weapon-firing scenarios.

ON-CAMPUS WORK EXPERIENCE

Rensselaer Polytechnic Institute

Research Assistant ***August 2002 – December 2005***

- **Non-invasive Vision-based Techniques for Driver Fatigue Monitoring**
    1) Developed eye gaze tracking techniques under natural head movements
    2) Developed real-time facial feature tracking and Face Pose Estimation techniques
    3) Developed a dynamic probabilistic model based on Dynamic Bayesian Networks to infer driver fatigue level
- **Vision-based User Affect Recognition for Active User Assistance**
    1) Developed real-time facial expression recognition technique under arbitrary face orientations.
    2) Developing a dynamic probabilistic model based on Dynamic Bayesian Networks to infer the affective states.

University of Nevada, Reno

Research Assistant ***August 2000 - August 2002***

- Developed algorithms for real-time eye and gaze tracking under strong external illumination interference
- Developed in teams a video decoder circuit to separate an image frame into even and odd fields for the control of an external illuminator
- Developed a driver to control EVI-D30/D31 SONY Pan-Tilt Camera on Unix and PC (C++) to interface with the gaze-tracking system

TEACHING EXPERIENCE

Teaching Assistant, UNR ***August 2000 – June 2001***

- Introduction to Computer Engineering (CS236)

INTERNSHIPS

Honda R&D Americas Inc., Mountain View, CA ***June 2001 – September 2001***

- Designed robust algorithms for real time eye and face detection and tracking, and face pose estimation

OFF-CAMPUS WORKING EXPERIENCE

Headquarter of Chinese People's Armed Police, Vehicle Department ***January 1999 – January 2000***

Software Developer

- Worked on the LAN MIS of Vehicles and Soldiers using Delphi and Microsoft SQL Server

PUBLICATIONS

Journals

- Yongmian Zhang, Qiang Ji, Zhiwei Zhu, Beifang Yi, "*Dynamic Facial Expression Analysis and Synthesis with MPEG-4 Facial Animation Parameters*". IEEE Transactions on Circuits and Systems for Video Technology. 18(10): 1383-1396, 2008.
- Zhiwei Zhu and Qiang Ji, "*Novel Eye Gaze Tracking Techniques under Natural Head Movements.*" IEEE Transactions on Biomedical Engineering, 2007.
- Yan Tong, Yang Wang, Zhiwei Zhu and Qiang Ji, "*Robust Facial Feature Tracking under Varying Face Pose and Facial Expression.*" Pattern Recognition Journal, 2007.
- Wenhui Liao, Weihong Zhang, Zhiwei Zhu, Qiang Ji and Wayne Gray, "*Toward a Decision-Theoretic Framework for Affect Recognition and User Assistance.*" International Journal of Human-Computer Studies, Volume 64, Number 9, pages 847-873, 2006.
- Zhiwei Zhu and Qiang Ji, "*Robust Real-Time Eye Detection and Tracking under Variable Lighting Conditions and Various Face Orientations*." Journal of Computer Vision and Image Understanding, Volume 38, Number 1, pages 124-154, 2005.
- Zhiwei Zhu and Qiang Ji, "*Eye and Gaze Tracking for Interactive Graphic Display*." Journal of Machine Vision and Applications, Volume 15, Number 3, pages 139-148, 2004.
- Qiang Ji, Zhiwei Zhu and Peilin Lan, "*Real-Time Non-intrusive Monitoring and Prediction of Driver Fatigue*." IEEE Transactions on Vehicular Technology, Volume 53, Number 4, pages 1052-1068, July 2004. (**2004 IEEE VTS Best Transaction Paper Award**)
- Qiang Ji and Zhiwei Zhu, "*Non-intrusive Eye and Gaze Tracking for Natural Human Computer Interaction*." MMI-interaktiv Journal, special issue on eye-gaze tracking for human computer interaction, Nr.6, ISSN 1439-7854, March 2003.

Conferences

- Zhiwei Zhu, Vlad Branzoi, Mikhail Sizintsev, Nicholas Vitovitch, Taragay Oskiper, Supun Samarasekera, Rakesh Kumar, *"AR-Weapon: Live Augmented Reality based First-Person Shooting System"*, IEEE Workshop on Applications of Computer Vision (WACV 2015), January 5-9, 2015.
- Zhiwei Zhu, Vlad Branzoi, Michael Wolverton, Louise Yarnall, Girish Acharya, Glen Murray, Nicholas Vitovitch, Supun Samarasekera, Rakesh Kumar, *"AR-Mentor: Augmented Reality based Mentoring System"*, IEEE International Symposium on Mixed and Augmented Reality (ISMAR 2014), Sep. 10-12, 2014.
- Ziyan Wu, Zhiwei Zhu, Han-Pang Chiu, *"Virtual Insertion: Robust Bundle Adjustment over Long Video Sequences"*, British Machine Vision Conference (BMVC 2014), 2014.
- Bogdan Matei, Nicholas Vander Valk, Zhiwei Zhu, Hui Cheng, Harpreet Sawhney, *"Image to LIDAR Matching for Geotagging in Urban Environments"*, IEEE Workshop on Applications of Computer Vision (WACV 2013), January 17-18, 2013.
- Rakesh Kumar, Supun Samarasekera, Zhiwei Zhu, etc., *"Implementation of an Augmented Reality System for Training Dismounted Warfighters"*, the Interservice/Industry Training, Simulation & Education Conference (I/ITSEC 2012), December 03~06, 2012.
- Zhiwei Zhu, Han-pang Chiu, Taragay Oskiper, Saad Ali, Raia Hadsell, Supun Samarasekera, Rakesh Kumar, *"High-Precision Localization Using Visual Landmarks Fused with Range Data"*, IEEE Conference on CVPR 2011, June 21-23, 2011.
- Taragay Oskiper, Han-pang Chiu, Zhiwei Zhu, Supun Samarasekera, Rakesh Kumar, *"Stable Vision-aided Navigation for Large-area Augmented Reality"*, IEEE Virtual Reality 2011, March 19-23, 2011.(**2011 IEEE VT Conference Paper Award**)
- Taragay Oskiper, Han-pang Chiu, Zhiwei Zhu, Supun Samarasekera, Rakesh Kumar, *"Multi-modal*

Sensor Fusion Algorithm for Ubiquitous Infrastructure-free Localization in Vision-impaired Environments", IEEE Conference on Intelligent Robots and Systems (IROS) 2010.

- Aveek Das, Oleg Naroditsky, Zhiwei Zhu, Supun Samarasekera, Rakesh Kumar, *"Robust Visual Path Following for Heterogeneous Mobile Platforms"*, IEEE Conference on ICRA 2010: 2431-2437.
- Puri, M., Zhiwei Zhu, Qian Yu, Divakaran, A.,Sawhney, H., *"Recognition and volume estimation of food intake using a mobile device"*, IEEE Workshop on Applications of Computer Vision (WACV), 2009.
- Oleg Naroditsky, Zhiwei Zhu, Aveek Das, Supun Samarasekera, Taragay Oskiper, Rakesh Kumar, *"VideoTrek: A Vision System for a tag-along Robot"*, IEEE International Conference on Computer Vision and Pattern Recognition (CVPR-09), 2009.
- Zhiwei Zhu, Taragay Oskiper, Supun Samarasekera, Rakesh Kumar, Harpreet S. Sawhney, *"Real-time global localization with a pre-built visual landmark database"*, IEEE International Conference on Computer Vision and Pattern Recognition (CVPR-08), 2008.
- Zhiwei Zhu, Taragay Oskiper, Supun Samarasekera and Rakesh Kumar, "*Ten-fold Improvement in Visual Odometry using Landmark Matching.*" IEEE International Conference on Computer Vision (ICCV-07), Rio de Janeiro, Brazil, Oct. 2007. (Accept rate: 281/1190=23%)
- Taragay Oskiper, Zhiwei Zhu, Supun Samarasekera and Rakesh Kumar, "*Visual Odometry System using Multiple Stereo Cameras and Inertial Measurement Unit.*" IEEE International Conference on Computer Vision and Pattern Recognition (CVPR-07), Minneapolis, MN, June 2007. (Oral, Accept rate: 60/1250=4.8%)
- Zhiwei Zhu, Taragay Oskiper, Supun Samarasekera and Rakesh Kumar, "*Precise Visual Navigation using Multi-Stereo Vision and Landmark Matching.*" SPIE Defense & Security Conference: Unmanned Systems Technology VIII, April 2007.
- Zhiwei Zhu, Taragay Oskiper, Supun Samarasekera and Rakesh Kumar, "*An Improved Stereo-based Visual Odometry System.*" The 2006 Performance Metrics for Intelligent Systems (PerMIS'06), August 2006.
- Wenhui Liao, Yan Tong, Zhiwei Zhu and Qiang Ji, "*Robust Object Tracking with a Case-Base Updating Strategy.*" The 20th International Joint Conference on Artificial Intelligence (IJCAI-06), Hyderabad, India, January 2006. (Accept rate: 258/1353=19%)
- Zhiwei Zhu and Qiang Ji, "*Robust Pose Invariant Facial Feature Detection and Tracking in Real-Time.*" The 18th IEEE International Conference on Pattern Recognition (ICPR-06), August 2006.
- Zhiwei Zhu and Qiang Ji, "*Nonlinear Eye Gaze Mapping Function Estimation via Support Vector Regression.*" The 18th IEEE International Conference on Pattern Recognition (ICPR-06), August 2006.
- Yan Tong, Yang Wang, Zhiwei Zhu and Qiang Ji, "*Facial Feature Tracking using a Multi-State Hierarchical Shape Model under Varying Face Pose and Facial Expression.*" The 18th IEEE International Conference on Pattern Recognition (ICPR-06), August 2006.
- Zhiwei Zhu and Qiang Ji, "*Robust Real-Time Face Pose and Facial Expression Recovery.*" IEEE International Conference on Computer Vision and Pattern Recognition (CVPR-06), June 2006. (Acceptance rate: 264/1131=23.3%)
- Zhiwei Zhu, Wenhui Liao and Qiang Ji, "Robust Visual Tracking Using Case-Based Reasoning with Confidence." IEEE International Conference on Computer Vision and Pattern Recognition (CVPR-06), June 2006. (Acceptance rate: 264/1131=23.3%)
- Wenhui Liao, Weihong Zhang, Zhiwei Zhu and Qiang Ji, "*A Decision Model for Stress Recognition and User Assistance.*" Twentieth National Conference on Artificial Intelligence (AAAI-05), July

2005. (Acceptance rate: 148/803=18.4%)

- Wenhui Liao, Weihong Zhang, Zhiwei Zhu and Qiang Ji, "*A Real-time Human Stress Monitoring System Using Dynamic Bayesian Networks.*" IEEE Workshop on Vision for Human Computer Interaction (V4HCI), in Conjunction with IEEE International Conference on CVPR, June 2005. (Acceptance rate: 34.8%).
- Markus Guhe, Wenhui Liao, Zhiwei Zhu, Qiang Ji and Wayne Gray, "*Non-intrusive Measurement of Workload in Real-time.*" Human Factors and Ergonomics Society 49th Annual Meeting, September 2005.
- Zhiwei Zhu and Qiang Ji, "*Eye Gaze Tracking Under Natural Head Movements.*" IEEE International Conference on Computer Vision and Pattern Recognition (CVPR-05), June 2005. (Accept rate: 250/1160=21.6%)
- Xiaozhou Wei, Zhiwei Zhu, Lijun Yin and Qiang Ji, "*Avatar Mediated Face Tracking and Lip Reading for Human Computer Interaction.*" Proceedings of ACM Multimedia 2004 (SIGMM), NY, October 2004.
- Zhiwei Zhu and Qiang Ji, "*Real Time and Non-intrusive Driver Fatigue Monitoring.*" Seventh IEEE International Conference on Intelligent Transportation Systems, Washington, D.C., October 2004.
- Xiaozhou Wei, Zhiwei Zhu, Lijun Yin and Qiang Ji, "*Face Animation by Real Time Facial Feature Tracking.*" ACM SIGGRAPH 2004, Los Angeles, CA, August 2004 (Student poster).
- Zhiwei Zhu and Qiang Ji, *"Real time 3D Face Pose Tracking From an Uncalibrated Camera.*" First IEEE Workshop on Face Processing in Video, in conjunction with IEEE Conference on CVPR 2004, Washington, D.C., June 2004.
- Xiaozhou Wei, Zhiwei Zhu, Lijun Yin and Qiang Ji, "*A Real Time Face Tracking and Animation System.*" First IEEE Workshop on Face Processing in Video, in conjunction with IEEE Conference on CVPR 2004, Washington, D.C., June 2004.
- Zhiwei Zhu and Qiang Ji, *"3D Face Pose Tracking From an Uncalibrated Camera.*" IEEE International Conference on Pattern Recognition (ICPR-04), for Oral Presentation, August 2004. (Accept rate: 321/1781=18%)
- Haisong Gu, Qiang Ji and Zhiwei Zhu, "*Active Facial Tracking for Fatigue Detection.*" IEEE Workshop on Applications of Computer Vision (WACV), Orlando, FL, USA, December 3-4, 2002.
- Zhiwei Zhu, Qiang Ji, Kikuo Fujimura and Kuang-chih Lee, *"Combining Kalman Filtering and Mean Shift for Real Time Eye Tracking Under Active IR Illumination."* IEEE International Conference on Pattern Recognition (ICPR-02), for Oral Presentation, August 11-15, 2002. (Accept rate: 250/1240=20.2%)
- Qiang Ji and Zhiwei Zhu, *"Eye and Gaze Tracking for Interactive Graphic Display."* 2nd International Symposium on Smart Graphics, June 11-13, 2002, Hawthorne, NY, USA.
- Zhiwei Zhu, Kikuo Fujimura and Qiang Ji, "*Real Time Eye Detection and Tracking Under Various Light Conditions.*" In Proceedings of ACM SIGCHI Symposium on Eye Tracking Research and Applications, 25-27 March 2002, New Orleans, LA, USA.

PATENTS

- Manika Puri, Zhiwei Zhu, Jeffrey Lubin, Tom Pschar, Ajay Divakaran and Harpreet Sawhney, *"Food Recognition Using Visual Analysis and Speech Recognition"*, United States Patent Number: 8439683, 05/14/2013.
- Supun Samarasekera, Rakesh Kumar, Taragay Oskiper, Zhiwei Zhu, etc., "*Unified Framework for Precise Vision-aided Navigation*." United States Patent Number: 8174568, 05/08/2012.

- Zhiwei Zhu, Taragay Oskiper, Oleg Naroditsky, Supun Samarasekera, etc., "*Stereo-based Visual Odometry Method and System*." United States Patent Number: 7925049, 04/12/2011.
- Qiang Ji and Zhiwei Zhu, *"Calibration-free gaze tracking under natural head movement"*. United States Patent Number: 7306337, 12/11/2007.
- Kikuo Fujimura and Zhiwei Zhu, "*Real-time Eye Detection and Tracking under Various Light Conditions*." United States Patent Number: 7206435, 04/17/ 2007.
- Zhiwei Zhu and Yan Zhuang, "*The MIS of General Vehicles and Drivers*." patent number: *2000SR0940*, 12 June 2000, P.R. China.
- Bogdan Matei, Zhiwei Zhu, Nicholas Vander Valk, Hui Cheng and Harpreet Sawhney, *"Method and Apparatus for Inferring the Geographic Location of Captured Scene Depictions"*, Patent Application Number: 20120314935, 12/13/2012. (pending)
- Rakesh Kumar, Supun Samarasekera, Girish Acharya, Zhiwei Zhu, Ryan Villamil, *"Method and Apparatus for Mentoring Via An Augmented Reality Assistant"*, Patent Application Number: 20130315670, 12/17/2012. (pending)
- Zhiwei Zhu, Supun Samarasekera, Rakesh Kumar, *"Method and Apparatus for Performing Measurements Using A Mobile Device"*, Patent Application Number: 20130216981, 08/24/2011. (pending)
- Rakesh Kumar, Taragay Oskiper, Oleg Naroditsky, Supun Samarasekera, Zhiwei Zhu and Janet Kim. *"System and Method for Generating a Mixed Reality Environment"*, Patent Application Number: 20100103196, 10/27/2009. (pending)