Benzun Pious Wisely Babu

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EDUCATION

Ph.D. Robotics Engineering, October 2018 **GPA 3.94/4.00**
Advisers: Dr. James Duckworth & Dr. David Cyganski
Worcester Polytechnic Institute(WPI), Worcester MA
Master of Science in Robotics Engineering, October 2013, **GPA 3.91/4.00**
Worcester Polytechnic Institute(WPI), Worcester MA
Bachelor of Technology in Electronics and Communication Engineering, May 2011**,** **GPA 8.20/10.00**
National Institute of Technology, Tiruchirappalli(NITT), India

WORK EXPERIENCES

Computer Vision Engineer – ARKit **(since 06/2020)**
Apple Inc, Sunnyvale, California
- Research and invent accurate large-scale indoor and outdoor localization techniques for ARKit.
- Work with cross-functional team to build infrastructure for Augmented Reality (AR) based localization systems.

Senior Scientist, CR/RTC-HMI4 -Mixed Reality & Autonomous Systems **(09/2017 – 06/2020)**
Bosch Research and Technology Center, Sunnyvale, California
- Managed research projects on topics related to sensor fusion and Augmented Reality for Bosch business use case.
- Established university collaboration on the topic – mixed reality in the wild.
- Assisted in development of mixed reality and robotics manipulation strategy for corporate research.
- Research focus on optimization based Visual-Inertial Odometry using lines, and planes in addition to points.
- Developed Proof of Concept (PoC) tracking solution for mobile AR, transferred to BU for product development.
- Collaborated with Business Units (BUs) stakeholders to secure internal research funding.
- Published multiple internal technical reports and invention records in visual computing domain.

Intern, Augmented Reality & Visualization Group **(11/2015 – 8/2016)**
Bosch Research and Technology Center, Palo Alto, California
- Developed dense visual odometry algorithms that model RGBD sensor noise for tracking in AR applications.

Robotics Intern, Agricultural Robotics Team **(10/2015 - 11/2015)**
National Robotics Engineering Center, CMU, Pittsburgh, Pennsylvania
- Developed motion features for pedestrian classification.

Summer Intern, Mobile Robotics Software Development Team **(5/2012 – 8/2012)**
International Electronics Machine, Troy, New York,
- Developed computer vision packages for detection of break rods and spring breaks in locomotive carriages.

PUBLICATIONS

Y. Yang, **B. P. Wisely Babu,** C. Chen, G. Huang and L. Ren "**Analytic Combined IMU Integrator (ACI²) for Visual Inertial Navigation**", *2020 IEEE Intl. Conf. on Robotics and Automation (ICRA)*

B. P. Wisely Babu, Z. Yan, M. Ye and L. Ren**, "On Exploiting Per-Pixel Motion Conflicts to Extract Secondary Motions,"** *2018 IEEE International Symposium on Mixed and Augmented Reality (ISMAR)***,** Munich, Germany, 2018, pp. 46-56. doi: 10.1109/ISMAR.2018.00028

B. P. Wisely Babu, D. Cyganski, J. Duckworth S. Kim, "**Detection and Resolution of Motion Conflict in Visual Inertial Odometry"**, *2018 IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Brisbane, QLD, 2018, pp. 996-1002. doi: 10.1109/ICRA.2018.8460870

P. Zachary, T. Trenton Tabor, H. Peiyun, C. Jonathan K, R. Deva, W. Carl**, B.P. Wisely Babu,** H. Herman, "**Comparing apples and oranges: Off-road pedestrian detection on the National Robotics Engineering Center agricultural person-detection dataset"**, *. J. Field Robotics*, doi:10.1002/rob.21760

B. P. Wisely Babu, S. Kim, Z. Yan, R. Liu, "***σ*-DVO: Sensor Noise Model Meets Dense Visual Odometry"**, *2016 IEEE International Symposium on Mixed and Augmented Reality (ISMAR)*, Merida, 2016, pp. 18-26. doi: 10.1109/ISMAR.2016.11

B. P. Wisely Babu, D. Cyganski, J. Duckworth "**Gyroscope assisted scalable visual simultaneous localization and mapping**", *2014 Ubiquitous Positioning Indoor Navigation and Location Based Service (UPINLBS)*, Corpus Christ, TX, 2014, pp. 220-227. doi: 10.1109/UPINLBS.2014.7033731

B. P. Wisely Babu, C. P. Bove, M. A. Gennert, "**Tight Coupling between Manipulation and Perception using SLAM**", *2014 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) Robot Manipulation: What has been achieved and what remains to be done?*, Chicago, IL, 2014

B. P. Wisely Babu, Eric T. Read, Justin A. Gostanian, Michael A. Gennert, "**A Tree Climbing Robot for Invasive Insect Detection",** *(2012) Adaptive Mobile Robotics - Proceedings of the 15th International Conference on Climbing and Walking Robots and the Support Technologies for Mobile Machines, CLAWAR*, Baltimore, MD, 2012. pp. 663-670.

C. G. Atkeson, **B. P. Wisely Babu**, N. Banerjee, D. Berenson, C. P. Bove, X. Cui, M. DeDonato, R. Du, S. Feng, P. Franklin, M. Gennert, J. P. Graff, P. He, A. Jaeger, J. Kim, K. Knoedler, L. Li, C. Liu, X. Long, T. Padir, F. Polido, G. G. Tighe, X. Xinjilefu, "**NO FALLS, NO RESETS: Reliable Humanoid Behavior in the DARPA Robotics Challenge**", *2015 IEEE-RAS 15th International Conference on Humanoid Robots (Humanoids)*, Seoul, 2015, pp. 623-630. doi: 10.1109/HUMANOIDS.2015.7363436

M. DeDonato, F. Polido, K. Knoedler, **B. P. Wisely Babu,** N. Banerjee, C. P. Bove, X. Cui, R. Du, P. Franklin, J. P. Graff, P. He, A. Jaeger, L. Li, D. Berenson, M.A. Gennert, S. Feng, C. Liu, X. Xinjilefu, J. Kim, C.G. Atkeson, X. Long, and T. Padır, **Team WPI-CMU: Achieving Reliable Humanoid Behavior in the DARPA Robotics Challenge.** *J. Field Robotics*. doi:10.1002/rob.21685

PATENTS

Gyroscope assisted scalable visual simultaneous localization and mapping, U.S. Patent Application 20160209217, filed November 2015. Issued December 2017
RGB-D camera based tracking system and method thereof, Patent Application WO2017220815A1, priority date July 2016
Methods and systems for exploting per-pixel motion conflicts to extract primary and secondary motions in augmented reality systems, U.S. Provisional Pat. Ser. No. 16/158,878, October, 2018

RESEARCH EXPERIENCES

Visual-inertial localization robust to sensor conflicts, Ph.D. Dissertation, WPI (08/2015 – 10/2018)
- Explored sensor conflicts between visual and inertial sensor in both dynamic and stationary environments.
- Implemented algorithms suitable for tracking in difficult environments for Augmented Reality applications.
- Dissertation title: Motion Conflict Detection and Resolution in Visual-Inertial Localization Algorithm.

Thermal gyroscope assisted visual tracking – Precision Personal Locator Project, WPI (10/2014 - 10/2015)
- Developed handheld thermal camera based localization algorithm for first responders.
- Designed thermal camera based localization device, performed calibration and testing.

DARPA Robotics Challenge(DRC), Team WPI-CMU, WPI (2nd in terms of completion) (8/2013 - 6/2015)
- Implemented sensor fusion, object detection and tracking algorithms.
- Managed 'Drill task' at DRC – performed task decomposition, state machine design, integration and testing.

Gyroscope assisted vison based localization – Precision Personal Locator Project, WPI (1/2013 – 1/2014)
- Developed novel algorithm for fusion of gyroscope measurements with visual odometry for indoors & outdoors.
- Designed handheld device for first responder tracking.

3D Reconstruction of a Tree for Tree Climbing Robot, **MS Thesis, WPI (9/2011 – 9/2013)**
- Tailored camera based localization and mapping algorithm for object reconstruction.
- Implemented Extended Kalman Filter based tracking for mesh generation.
- Thesis title: Visual Simultaneous Localization and Mapping for a Tree Climbing Robot.

Feasibility of Land Surface Classification aboard the micro- satellite 'Flying Laptop', **(5/2010 – 7/2010)**
Institute of Space Systems, Universität Stuttgart, Germany,
- Performed feasibility study of artificial neural network classifiers for land surface classification using multispectral camera aboard satellite using FPGA.

SKILLS

Programming:	C, C++, Verilog, VHDL, CUDA, Python
Packages :	OpenCV, ROS, PCL, OpenGL, Solidworks, Altium Designer

PROFESSIONAL ACTIVITIES

Program Committee member, Workshop on Visual Inertial Navigation: Challenges & Applications, IROS 2019
Reviewer for IEEE VR, ICRA, Machine Vision and Applications Journal