Benzun Pious Wisely Babu

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(Since 06/2020)

(11/2015 - 8/2016)

(5/2012 - 8/2012)

WORK EXPERIENCE

Computer Vision Engineer (ICT5), Vision Pro Group (ARKit Productization)

Apple Inc, Sunnyvale, California

- Integrated multiple computer vision algorithms as part of the X-func team that successfully launched Vision Pro.
- Worked on various components of ARKit that provides system level spatial tracking service for VisionOS.
- Worked on development of various APIs for ARKit on VisionOS and iOS.
- Worked in X-func team to enable outdoor Geo-localization backend for pedestrian AR in Apple Maps.
- Product ideation with focus on accurate large-scale indoor and outdoor localization techniques.
- Senior Scientist, CR/RTC-HMI4 -Mixed Reality & Autonomous Systems(09/2017 06/2020)Bosch Research and Technology Center, Sunnyvale, California(09/2017 06/2020)
- Supported in the R&D of Bosch Virtual Visor in process for productization. (Best of innovation Vehicle Intelligence & Transportation award, Honoree In-Vehicle Entertainment & Safety award at Consumer Electronics Show (CES) in 2020)
- 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 AI based sensors utilizing computer vision, sensor fusion and machine intelligence.
- Developed Proof of Concept (PoC) tracking solution for mobile AR, transferred to Business Unit (BU) for product development.
- Collaborated with BU stakeholders to secure internal research funding.

• Published multiple internal technical reports and invention records in visual computing domain.

Intern, Augmented Reality & Visualization Group

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 Debatics Engineering Control CMU Dittakenals Demandering

National Robotics Engineering Center, CMU, Pittsburgh, Pennsylvania

• Developed motion features for pedestrian classification.

Summer Intern, Mobile Robotics Software Development Team International Electronics Machine, Troy, New York,

• Developed computer vision packages for detection of break rods and spring breaks in locomotive carriages.

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	

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

System and method for enhancing non-inertial tracking system with inertial constraints, U.S. Patent US11181379B2, Granted November 2021

Apparatus and warning system for intelligent helmet, U.S. Patent US10959479B1, Granted March 2021

Apparatus and system related to an intelligent helmet, U.S. Patent US11605222B2, Granted March 2023

System and method of vehicle aware gesture recognition in vehicles with smart helmets, U.S. Patent US11500470B2, **Granted November 2022**

Helmet with digital visor, U.S. Patent US11714304B2, Granted August 2023

Methods and systems for exploting per-pixel motion conflicts to extract primary and secondary motions in augmented reality systems, U.S. Patent. US10636190B2, Granted April 2020

RGB-D camera based tracking system and method thereof, U.S. Patent Application US20190377952A1, **Granted August 2021**

Gyroscope assisted scalable visual simultaneous localization and mapping, U.S. Patent Application 20160209217, **Granted December 2017**

Reducing power usage in a virtual visor, European Union. Patent. EP4046839A1, Granted October 2024

Mobile calibration of displays for a smart helmet, Germany Patent. DE102020215664A1, Pending December 2020

System and method for monitoring a cognitive condition of a driver of a vehicle, Germany. Patent. DE102020215667A1, Pending December 2020

A system and method for shadow estimation in an automatic sunvisor of a vehicle, European Union. Patent. EP4046838A1, Pending December 2020

Additionally 3+ patents filed with Apple Inc

RESEARCH EXPERIENCE

 Visual-inertial localization robust to sensor conflicts, P Explored sensor conflicts between visual and inertial s Implemented algorithms suitable for tracking in difficu Dissertation title: Motion Conflict Detection and Resolu 	h.D. Dissertation, WPI ensor in both dynamic and stationar alt environments for Augmented Rea ation in Visual-Inertial Localization A Personal Locator Project WPI	(08/2015 - 10/2018) y environments. lity applications. lgorithm. (10/2014 - 10/2015)
 Developed handheld thermal camera based localization 	n algorithm for first responders	(10/2014-10/2013)
 Designed thermal camera based localization device, per 	rformed calibration and testing.	
DARPA Robotics Challenge(DRC), Team WPI-CMU, WPI	(placed 2 nd based of score)	(8/2013-6/2015)
• Implemented sensor fusion, object detection and track	ing algorithms. Lead the perception	team.
• Managed 'Drill task' at DRC – performed task decompo	sition, state machine design, integra	tion and testing.
Gyroscope assisted vison based localization - Precision	I Personal Locator Project, WPI	(1/2013 - 1/2014)
Developed novel algorithm for fusion of gyroscope mea	asurements with visual odometry for	r indoors & outdoors.
Designed handheld device for first responder tracking.		
3D Reconstruction of a Tree for Tree Climbing Robot, M	IS Thesis, WPI	(9/2011 - 9/2013)
Tailored camera based localization and mapping algor	thm for object reconstruction.	
Implemented Extended Kalman Filter based tracking for The size title. Viewel Circulture and Man	or mesh generation.	
• I nests title: visual Simultaneous Localization and Map	ping for a Tree Climbing Robot.	(5/2010 7/2010)
Institute of Space Systems, Universität Stuttgart, Cermany	cro-satellite Flying Laptop,	(5/2010 - 7/2010)
 Performed feasibility study of artificial neural network 	classifiers for land surface classifica	tion using
multispectral camera aboard satellite using FPGA.		don using
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PRESENTATIONS:		
Invited talk – Sensor & Environment Aware Localization, SI AM Workshop (Internal), Bosch Posparch, Ponpigon, Cor	many	(05/2019)
Conference noster - Detection and Resolution of Motion Co	nflict in Visual Inertial Odometry	(05/2018)
IEEE International Conference of Robotics and Automation	, Brisbane, Australia	(03/2010)
Conference presentation - On Exploiting Per-Pixel Motion	Conflicts to Extract Secondary Motion	ns, (10/2018)
International Symposium on Mixed and Augmented Reality	r, Munich, Germany	
Industry invited poster - Exploring Motion Features for Of	f-Road Pedestrian Detection,	(07/2016)
Safe Autonomous Cyber Physical Systems Workshop, Micro	osoft Research, Seattle	

PROFESSIONAL ACTIVITIES

Program Committee member, Workshop on Visual Inertial Navigation: Challenges & Applications, IROS 2019 **Reviewer -** IEEE Access, IEEE VR, ICRA, Machine Vision and Applications Journal **Senior Member** – IEEE, IEEE Young Professionals, IEEE Robotics and Automation Society

COCURRICULAR ACTIVITIES

Sample Return Challenge Robot, WPI, Worcester	(10/2012 - 6/2013)
• Visual fiducial based home beacon detection & custom stereo camera setup for mobile re	obot.
ARC Lab Management, WPI, Worcester	(9/2012 - 12/2012)
Managed PR2 setup and administration of general lab information.	
Web Management, Image Science Research Group, WPI	(1/2013 - 1/2012)
Managed schedule and member detail webpages.	

HONORS AND ACHIEVEMENTS

Recepient of Bosch - PhD university collaboration funding for Sensor fusion in Augmented Reality	ty (12/2016)
Placed 7 th (2 nd based on score) DARPA Robotics Challenge Finals – US Govt	(6/2015)
Top 50 submissions - Tegra K1 Cuda Vision challenge – Nvidia	(5/2014)
Awarded Scholarship for Diaspora students (SPDC), MHRD –India Govt	7/2007 - 5/2011)
First Place, 'Verilogic' (Verilog Design Competition), Probe 2010, NITT	(3/2010)
First Place, 'Matrix' (Image Processing Competition), Probe 2010, NITT	(3/2010)
Third Place, 'Micromouse' (Maze Robot Competition), Pragyan 2009, NITT	(2/2009)

Second Place, 'I-bot' (Image processing Robotics Competition), Thatva, NIT – Calicut(10/2008)Second Place, All India Senior School Certificate Exam, Indian School Muscat, Oman(6/2007)

LEADERSHIP & TEACHING EXPERIENCE

Teaching Assitant, Unified Robotics II, Unified Robotics IV, WPI	(12/2012 - 10/2012)
Teaching Assitant, Unified Robotics I, WPI	(10/2012 - 9/2012)
Grader, Digital Image Processing, WPI	(9/2011 - 12/2011)
President, Robotics and Machine Intelligence (RMI) Club, NITT	(7/2010 - 5/2011)
Manager & Tutor, RMI workshops, NITT	(7/2008-5/2010)
Event Manager, Micro mouse competition, Pragyan 2010, NITT	(10/2009 - 2/2010)
Assistant Manager, Publicity Team, Festember 2009, NITT	(1/2009 - 9/2009)