Lichao Xu

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INTENTIONS

Robotics
Computer Vision

SKILL SETS

Highlights:
SLAM (visual, marker-based, LiDAR-based)
Computer Vision
Robotics (design, control, perception, reasoning)
Efficient C++ programming
Strong math foundation
Hands on ability

Languages/OS:
C++ (mostly used)
C, Python, MATLAB, Java
Linux, Git, Vim
ROS, LCM
Make, CMake

Libraries/Software:
OpenCV, G2O, DBoW2
Caffe, OpenAI Gym
Simulink, Solidworks,
Pro/Engineering

HONORS & AWARDS

Rackham International Student Fellowship (Umich)
C.E.Bottum and R.Harris Fellowship (Umich)
Outstanding Master's Thesis (USTC)
Outstanding Student Scholarships (USTC)

09.14.2019

EDUCATION

University of Michigan — Ann Arbor, MI
Ph.D. in Civil Engineering, GPA:4.00/4.00 — 09.2015 - 12.2019
  • Visual SLAM, computer vision and robotics

Master in Robotics, GPA:4.00/4.00 — 01.2016 - 05.2017
  • Robot control, perception, reasoning, and computer vision
  • Relevant courses: Mobile Robotics, Math for Robotics, Robotic System Laboratory; Computer Vision, Advanced Topics in Computer Vision; Machine Learning, Reinforcement Learning; Linear System Theory, Nolinear System & Control; Algorithms

University of Science and Technology of China — Hefei, P.R.China
Master in Mechatronic Engineering, GPA:3.66/4.3 — 09.2010 - 07.2013
  • Amphibious robot, mechanics experiment design, robot-terrain interaction, and robot design.

B.E. in Mech. Design, MFG. and Automation, GPA:3.69/4.3 — 09.2006 - 07.2010
  • Wheeled robot, mechanical design, and wheel-terrain interaction

EXPERIENCE

LIVE Robotics Lab, University of Michigan — 09.2015 - present
Research Assistant — Ann Arbor, Michigan
  • Algorithm development for autonomous navigation
  • Sensor calibration, filter/optimization based measurement fusion
  • Visual SLAM, Appearance-based place recognition
  • Robot platform design and localization accuracy evaluation

Machine Vision Lab, USTC — 09.2013- 09.2015
Research Intern — Hefei, P.R.China
  • Algorithm development for camera calibration
  • Vision-based large field of view measurement
  • Design and decoding of ring coded points
  • MAV design and application

Intelligent Machinery and Robotics Lab, USTC — 09.2010- 05.2013
Research Assistant — Hefei, P.R.China
  • Amphibious robot design
  • Composite propulsion mechanism design and verification
  • Modeling of robot-terrain interaction
  • Robotic fish design
  • Development of DC motor control system

PROJECTS

Vision-based autonomous tunnel inspection   01.2019 - present
- Camera and IMU calibration, pinhole and omnidirectional camera models
- vSLAM system evluation and improvement, quaternion and Lie algebra, VIO initialization
- IMU pre-integration and error propagation, Vision and IMU related jacobians
- Linearization of nonlinear least squares problems, sliding-window optimization
- Nonlinar optimization (Decent and Newton's methods,Gauss-Newton, LM, and Dog Leg for least squares problems, and heuristic methods)

vSLAM-based robot navigation and 3D reconstruction   03.2018 - 12.2018
- Improved vSLAM with 2D occupancy grid map built with virtual laser scan
- Developed algorithms to save&load maps, and switch between SLAM and localization
- Developed each system component as a ROS package, including vSLAM, occupancy grid mapping, A*-based path planing, and fiducial marker detection (only for evaluation)
- Designed a fiducial maker-based method to evaluate vSLAM's localization accuracy
- Implemented ROS-based visualization of pose, laser scan, map, and planned trajectory
- Implemented 3D dense reconstruction with vSLAM

Learning descriptor-based vSLAM   01.2017 - 02.2018
- Proposed a scene adaptive feature transform (SAFT) to improve feature matching robustness and vSLAM's applicability in challenging environments
- Designed a learning architecture for Deep SAFT based on a descriptor neural network and evaluated its offline matching performance
- Proposed a strategy to integrate Deep SAFT into ORB SLAM for online learning and self-adaptation to optimized descriptor
- Designed different variations of Deep SAFT-embed ORB SLAM and evaluated their performance on two widely used public datasets

Data sharing framework for distributed coupling simulation   10.2016 - present
- Built a LCM-based information exchange framework for distributed coupling simulation
- Developed a message wrapper to receive and publish messages for simulators
- Involved in design of a data sharing platform using socket and JSON formatted messages

Unguided video object segmentation (course project)   01.2017 - 04.2017
- Estimated dynamic objects with optical flow
- Trained modified OSVOS with original images and their results after optical flow
- Compared with OSVOS and achieved some improvement.

Model-based upper-body pose estimation (course project)   01.2017 - 04.2017
- Modelled upper-body structure with their approximate relative positions
- Designed matching function and deformation cost function to measure a pose's cost.
- Utilized distance transform to efficiently find the optimize pose
- Tested and validated the algorithm on a public dataset

Modeling and control of self-balancing two-wheel robot (course project)   09.2016 - 12.2016
- Built a two-wheel robot from scratch with aluminum extrusion, wheels, DC motors, encoders, IMU and an embedded computer.
- Derived model-based linear & nonliner feedback control for a inverted pendulum on a cart
- Implemented dynamic control of DC motors to balance the BalanceBot
- Designed cascaded control for position, velocity and turning using encoders and IMU data.

2D Lidar-based SLAM and autonomous exploration (course project)   09.2016 - 12.2016
- Implemented differential-drive robot odometry using encoder and gyro readings, wheel base, wheel diameter and gear ratio.
- Interfaced with motion capture system to get ground-truth pose
- Designed a controller to drive the robot to each pose in a given path
- Implemented a 2D Lidar SLAM including occupancy grid mapping, odometry motion model, Lidar sensor model, and particle filter-based pose optimization.
- Implemented A*-based path planning and maze exploration algorithm
- Tested robot to explore, map, and escape a maze environment

Vision-guided control of 6 DOF robotic arm (course project)   09.2016 - 12.2016
- Implemented forward and inverse kinematics for robotic arm control
- Designed an easy-to-install and efficient gripper for grab and drop purpose
- Developed algorithms to detect objects with color, counter and dimension information and recover their coordinates in the world frame

Vision-based barcode extraction for efficient inventory management   11.2015 - 07.2016
- Built a framework to exact 2D barcodes from videos collected by a camera
- Proposed and implemented a barcode direction estimation algorithm based on Harris corner points and Hough transformation
- Detected and selected potential barcode regions using contour-related operations
- Utilized Image histogram to remove redundant frames for fast barcode extraction

Control points-based large field of view measurement   09.2013 - 09.2015
- Implemented algorithms to calibrate a camera with manufactured targets
- Developed algorithms to solve PnP problem
- Optimized camera intrinsic and extrinsic parameters with BA and Gauss-Newton Method
- Detected circular feature points and decoded ring coded points

Design and control of an Amphibious robot   09.2010 - 07.2013
- Involved in design of a leg-flipper composite propulsion mechanism for walking on ground and swimming under water.
- Involved in robot body design, circuit design and waterproof design
- Modelled robot-terrain interaction using resistive force model
- Optimized robot leg shape and control strategy for efficient ground propulsion
- Developed a heuristic path planning algorithm that worked in campus-scale environment

Robotic fish design   12.2011 - 06.2012
- Involved in mechanical design, circuit design and waterproof design
- Designed a DC motor speed control system for pose adjustment
- Developed algorithms for the robotic fish to rise, sink, hover and avoid side walls of a pool.

PUBLICATIONS

Journal:
- Xu, L., Lin, S.Y., Hlynka A.W., Lu, H., Kamat, V.R., Menassa, C.C., El-Tawil, S., Prakash, A., Spence, S.M., and McCormick, J. (2019). "Distributed Simulation Platforms and Data Passing Tools for Natural Hazards Engineering: Reviews, Limitations, and Recommendations", Journal of Computing in Civil Engineering, American Society of Civil Engineers, Reston, VA. (In Review)
- Xu, L., Feng, C., Kamat, V. R., and Menassa, C. C. (2019)."A learning-based descriptor and its integration with visual SLAM for locating applications", Automation in Construction, Elsevier Science, New York, NY. (in Review)

- L. Xu, C. Feng, V.R. Kamat, C.C. Menassa. (2019). "An Occupancy Grid Mapping enhanced visual SLAM for real-time locating applications in indoor GPS-denied environments", Automation in Construction, 104 (2019) 230-245.
- S.-Y. Lin, W.-C. Chuang, L. Xu, S. El-Tawil, S.M. Spence, V.R. Kamat, C.C. Menassa, J. McCormick. (2019). "Framework for Modeling Interdependent Effects in Natural Disasters: Application to Wind Engineering", Journal of Structural Engineering, 145 (5) (2019) 04019025.
- L. Xu, V.R. Kamat, C.C. Menassa. (2018). "Automatic extraction of 1D barcodes from video scans for drone-assisted inventory management in warehousing applications", International Journal of Logistics Research and Applications, 21 (3) (2018) 243-258.
- L. Xu, S. Zhang, N. Jiang, R. Xu. (2015). "A hybrid force model to estimate the dynamics of curved legs in granular material", Journal of Terramechanics, 59 (2015) 59-70.
- S. Zhang, X. Liang, L. Xu, M. Xu. (2013). "Initial development of a novel amphibious robot with transformable fin-leg composite propulsion mechanisms", Journal of Bionic Engineering, 10 (4) (2013) 434-445.
- L. Xu, S. Zhang. (2013). "Study of path planning in obstacle environment based on an improved ant algorithm", Machinery and Electronics, 7 (2013) 61-64 (in Chinese).

Conference:
- L. Xu, C. Feng, V.R. Kamat, C.C. Menassa. (2019), "Enhancing Visual SLAM with Occupancy Grid Mapping for Real-Time Locating Applications in Indoor GPS-Denied Environments", Computing in Civil Engineering 2019: Data, Sensing, and Analytics, American Society of Civil Engineers, Reston, VA, pp. 344-351.
- S.-Y. Lin, L. Xu, W.-C. Chuang, S. El-Tawil, S.M.J. Spence, V.R. Kamat, C.C. Menassa, J. McCormick. (2018). "Modeling Interactions in Community Resilience", Structures Conference 2018.
- L. Xu, V.R. Kamat, C.C. Menassa. (2017). "Automatic Barcode Extraction for Efficient Large-Scale Inventory Management", Computing in Civil Engineering 2017, pp. 340-348.
- Y. Zhao, L. Xu. (2015). "Self-calibration of monocular vision system based on planar points", Image Processing: Machine Vision Applications VIII, Vol. 9405, International Society for Optics and Photonics, 2015, p. 94050H.
- Y. Zhao, D. Zhang, Y. Li, H. Liu, L. Xu, L. Zhu, W. Li. (2014). "A large field-of-view scene measurement based on control points with a single camera", Interferometry XVII: Techniques and Analysis, Vol. 9203, International Society for Optics and Photonics, 2014, p. 92030J.
- L. Xu, X. Liang, M. Xu, B. Liu, S. Zhang. (2013). "Interplay of theory and experiment in analysis of the advantage of the novel semi-elliptical leg moving on loose soil", 2013 IEEE/ASME International Conference on Advanced Intelligent Mechatronics, IEEE, 1467353205, 2013, pp. 26-31.
- X. Liang, M. Xu, L. Xu, P. Liu, X. Ren, Z. Kong, J. Yang, S. Zhang. (2019). "The amphihex: A novel amphibious robot with transformable leg-flipper composite propulsion mechanism", 2012 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 1467317365, 2012, pp. 3667-3672.