Lichao Xu

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INTENTIONS

SLAM
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.