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Liu Yang

Summary

R&D lead in computer vision at a MedTech startup, focusing on developing 3D vision algorithms for surgical robotics. Holds a PhD from Purdue University with research in vision-based algorithms for autonomous agents and vehicles. Extensive experience in developing 3D vision systems and real-time imaging solutions. Keen to apply my skills to advance the intersection of computer vision and intelligent agents.

Education

Purdue University, PhD **2018 - 2023**
Civil Engineering
- Area of focus: Visual Perception, Localization, and 3D Reconstruction of highly dynamic environments.
- Dissertation: "Redefining Visual SLAM for Chaotic Constructions: Addressing Dynamic Features and Semantic Composition".

University of Michigan – Ann Arbor, MS **2016 - 2018**
Civil Engineering
- Area of focus: Smart cities, Autonomous and Connected Vehicles.

Tianjin University, BS **2012 - 2016**
Civil Engineering

Technical Skills

- **Programming Languages:** Python, C++, MATLAB
- **Frameworks & Libraries:** PyTorch, Keras, OpenCV, Matplotlib
- **Hardware Integration**: Camera calibration, Sensor fusion, Video processing
- **CV Algorithms:** Object detection & tracking, Image classification, Segmentation, Motion Estimation
- **3D Vision:** Stereo vision, SfM, SLAM, Point Cloud Processing, 3D reconstruction
- **Deep Learning:** CNNs, Transformers, NeRF, 3D Gaussian Splatting

Competition Award

1st Place in *Challenge of Computer Vision for Built Environment (by CVPR)* **June 2021**
- Led a team of two to achieve first place, outperforming all competing teams globally.
- Developed a sim2real algorithm to reconstruct large-scale 3D buildings from sparse unlabeled data.
- First place in both segmentation and reconstruction accuracies, with 91% IoU and 95% completeness.

Work/Research Experience

Research & Development **2024.1 – Present**
AIScope Inc.
- **Specialization: Development of 3D Vision Systems for AI-Driven Laparoscopic Robots**
  - Engineered a *preprocessing pipeline* to enhance and synchronize low-quality in-vivo RGB and depth data, resulting in *75% model performance increase* compared to original data.
  - Designed a *transformer-based* architecture using *sparse attention* mechanism for efficient stereo depth estimation in anatomy videos, achieving a *60% reduction in inference time* while keeping accuracy.
  - Re-architected a *NeRF model with depth and semantic priors* to improve 3D rendering in *texture-less and sample-sparse anatomical environment*, achieving real-time rendering at over 100 FPS.
  - Developed a *simulation pipeline* that incorporates physical properties of soft tissues, generating a *high-quality simulation dataset* containing over 50 laparoscopic scenes.

Graduate Research Assistant **2018 - 2023**

Purdue University

- **Project 1: Unsupervised Video Object Segmentation in High Dynamic Scenes** | *Publication [1 & 2]*
  - Designed a CNN-based model to segment moving objects in videos, which ***trained without explicit labels***.
  - Integrated ***motion saliency, optical flow, and class-agnostic semantic masks*** from Mask R-CNN.
  - Deployed the model to guide a robot with SLAM, improving ***accuracy in high-dynamic scenes for 0.5m***.
- **Project 2: Weakly Supervised Indoor Segmentation with Image Tags Only** | *Publication [3]*
  - Using ***image tags solely*** as supervisions while achieving similar level (70%~80% mIoU) of segmentation accuracy as full supervisions.
  - Re-architected a model based on ***ResNet and DeepLabv3+*** to train without using pixel-level masks.
  - Embedded object size priors into a ***customized loss entropy loss***, resulting in a 15.9% mIoU increase.
- **Project 3: Automated 3D Reconstruction from Large-Scale Point Clouds** | *Publication [4]*
  - Automated the modeling for U.S. highway bridges, transforming point clouds into 3D digital models.
  - Combined semantic segmentation with geometric partition, achieving an accuracy ***within 0.15 meters***.
  - Created a synthetic dataset by ***simulating LiDAR scans in Blender***, augmenting real data for training.
- **Project 4: Vision-based Worker Tracking and Trajectory Prediction** | *Publication [5-7]*
  - Fused ***multi-modal camera and Bluetooth data*** for 3D worker tracking with 95% accuracy.
  - Adapted Faster R-CNN architecture for ***human visual focus detection*** and achieved 91% accuracy.
  - Applied ***LSTM to predict seq-to-seq worker trajectory*** based on human attention and surrounding info.

Relevant Coursework

- Computer Vision
- Learning for 3D Vision
- Robotic Systems
- Digital Photogrammetry
- Laser Scanning
- Vision Learning & Recognition
- Data Science and Smart Cities
- Computational Models and Methods
- Optimization Methods for Systems and Control

Highlighted Publications

1. **Liu Yang** and Hubo Cai, Unsupervised Video Object Segmentation for Enhanced SLAM-based Localization in Dynamic Construction Environments, *Automation in Construction,* 158 (2024), 105235.
2. **Liu Yang** and Hubo Cai, Enhanced Visual SLAM for Construction Robots by Efficient Integration of Dynamic Object Segmentation and Scene Semantics, *Advanced Engineering Informatics*, 59 (2024): 102313.
3. **Liu Yang** and Hubo Cai, Cost-Efficient Image Semantic Segmentation for Indoor Scene Understanding Using Weakly Supervised Learning and BIM, *Journal of Computing in Civil Engineering,* 37 (2023).
4. **Liu Yang,** Yi-Chun Lin, Ayman Habib, and Hubo Cai, From Scans to Parametric BIM: An Enhanced Framework Using Synthetic Data Augmentation and Parametric Modeling for Highway Bridges, *Journal of Computing in Civil Engineering*, 38(3), p.04024008.
5. Jiannan Cai, **Liu Yang,** Yuxi Zhang, Shuai Li, and Hubo Cai, Multi-task learning method for detecting the visual focus of attention of construction workers, *Journal of Construction Engineering and Management,* 147, (7), 04021063, 2021.
6. Jiannan Cai, **Liu Yang**, Yuxi Zhang, and Hubo Cai, Estimating the visual attention of construction workers from head pose using convolutional neural network-based multi-task learning, in *Construction Research Congress 2020*, American Society of Civil Engineers Reston, VA, 2020, pp.116–124.
7. Jiannan Cai, Yuxi Zhang, **Liu Yang,** Hubo Cai, and Shuai Li, A context-augmented deep learning approach for worker trajectory prediction on unstructured and dynamic construction sites, *Advanced Engineering Informatics,* 46, 101173, 2020.