

JUNFENG REN

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Computer Vision / Autonomous Driving Perception / World Models

SUMMARY

M.S. student at Southern University of Science and Technology, focusing on **autonomous driving perception and 3D scene reconstruction (Occupancy Prediction)**. My research centers on **multi-agent collaborative perception, communication-efficient system design**, and extensions toward **world model learning**. I have solid foundations in deep learning and computer vision, with experience in Transformer-based models, object detection, and 3D perception. I am capable of carrying out the full research and engineering pipeline from algorithm design and system implementation to experimental analysis. I am seeking internships in **autonomous driving or computer vision**.

EDUCATION

Southern University of Science and Technology, M.S. in Electronic Information 09/2024 - Present

- GPA: 3.52/4.0
- Research focus: autonomous driving perception, multi-agent collaboration efficiency optimization
- Relevant coursework: Deep Learning, Reinforcement Learning, Probability and Statistics, Machine Learning

Shandong University of Science and Technology, B.S. in Internet of Things Engineering 09/2019 - 06/2023

- GPA: 3.56/4.0
- Focus: embedded systems, robotics, computer vision
- Relevant coursework: Data Structures, Computer Organization, Operating Systems, Computer Networks

TECHNICAL SKILLS

- **Programming Languages:** Python, C/C++, CUDA
- **Deep Learning & Computer Vision:** PyTorch, Transformers, 3D Perception, Occupancy Prediction
- **Systems & Engineering:** Linux development, multi-GPU training, distributed training, large-scale dataset processing
- **AI-Assisted Development:** Familiar with AI-driven development workflows (vibe coding); use Cursor and Claude Code for code generation, debugging, and experiment iteration to improve research productivity

RESEARCH PROJECTS

[Autonomous Driving Perception / Multi-Agent Collaboration] Communication-Efficient Multi-Agent Semantic Occupancy Prediction with Sparse Communication 10/2025 - Present

- Proposed a **multi-vehicle collaborative 3D semantic occupancy prediction framework** for autonomous driving, using tokenized scene representations for efficient information exchange
- Designed a **Spatio-Temporal Memory** module to model and reuse historical information across both time and vehicles
- Developed a **Request-Driven Communication** mechanism to selectively retrieve critical information from neighboring vehicles through query-guided interaction
- Proposed a **Communication-Aware Token Merging** strategy to compress communication bandwidth from the perspectives of relevance, reliability, and temporal novelty
- Built a complete multi-agent pipeline covering token generation, communication, fusion, and decoding
- Conducted systematic experiments on **Occ3D-nuScenes** and **Semantic-OPV2V**; achieved strong perception performance while reducing communication cost to the KB level
- Currently extending occupancy representation toward **world model learning** for unified multi-agent perception and temporal modeling

[Collaboration Efficiency Optimization] Rate-Distortion Optimization for Efficient Multi-Agent Collaborative Perception 01/2026 - Present

- Formulated the relationship between communication bandwidth (*rate*) and perception quality (*distortion*) in multi-agent collaborative perception from an **information-theoretic perspective**, modeling occupancy prediction as a bandwidth-constrained information transmission problem

- Built a **Rate-Distortion optimization framework** to characterize the quantitative trade-off among token compression, information selection, and model performance, providing a unified theoretical basis for communication policy and representation learning
- Designed an **information-aware compression mechanism** that jointly optimizes **token pruning** and **spatio-temporal memory** to adaptively filter redundant and low-value information
- Systematically analyzed performance under different communication budgets (KB level), studying the impact of bandwidth constraints on representation capacity and cross-scene generalization
- Applied the theoretical framework to the practical system (**LiteTokenOcc**); under different communication budgets, achieved approximately **70% reduction in communication bandwidth** while keeping perception performance degradation within **10%**, validating the effectiveness of the proposed method in the rate-distortion trade-off
- Explored compression mechanisms for **world model representation learning**, providing a unified information-theoretic perspective for temporal and dynamic scene modeling

[Medical Image Analysis] Federated Learning for Medical Image Segmentation with Domain Generalization 2024

- Built a multi-institution medical image segmentation framework based on **Federated Learning (FedAvg)** to enable distributed training without sharing raw data
- Addressed **cross-institution domain shift** by designing **domain generalization strategies**, including style-transfer-based augmentation and feature distribution alignment
- Implemented a **U-Net**-based segmentation model and evaluated cross-domain generalization under multi-client settings
- Studied how different client data distributions affect model convergence and generalization, analyzing the coupling between **federated learning** and **domain generalization**
- Verified the effectiveness of the method across multiple domains and improved segmentation performance on unseen domains

[Autonomous Driving Decision-Making] Autonomous Driving Perception and Decision System on NVIDIA Jetson 2022

- Built an autonomous driving system prototype on the **NVIDIA Jetson** embedded platform, covering the basic **perception–decision–control** pipeline
- Used **YOLOv5** for object detection (vehicles, pedestrians, traffic signs) and OpenCV-based methods for lane detection (**Canny + Hough Transform**)
- Designed a **rule-based behavior decision module** to implement basic driving strategies such as going straight, turning, obstacle avoidance, and deceleration
- Implemented a **finite-state machine (FSM)** to model vehicle behaviors and state transitions, improving system stability and interpretability
- Built a simple control module for steering and speed adjustment to achieve closed-loop execution
- Accelerated the detection model with **TensorRT** to enable real-time inference on embedded GPU hardware

[Embodied AI] Embodied Soccer Task System on NAO Robot 2022

- Developed a vision-driven embodied AI system on the **NAO humanoid robot** to perform ball search, localization, approach, and kicking
- Applied **HSV color segmentation** and morphological operations to detect the soccer ball region, and extracted target position through contour analysis
- Estimated target distance using a **pinhole camera model** and geometric reasoning, mapping image coordinates to relative robot positions
- Designed a **finite-state machine (FSM)** for the full behavior pipeline, including search, detect, approach, align, and kick
- Achieved closed-loop control with visual feedback by adjusting robot gait and orientation for alignment and approach
- Used the **NAOqi API** for robot motion control, including walking, turning, and kicking, to complete the perception–decision–action loop

[Edge Computing] Embedded Edge AI Face Recognition Access Control System 2023

- Implemented a lightweight face recognition system on the **STM32** embedded platform, building a complete **perception–recognition–control–communication** pipeline

- Used **MobileFaceNet** for face feature extraction and **cosine similarity** for identity matching to enable local verification
- Addressed resource constraints (storage and computation) on embedded hardware by applying **model pruning** and **INT8 quantization** for TinyML deployment
- Designed an **on-device inference + local decision-making** mechanism to reduce cloud dependency while improving real-time performance and privacy
- Integrated **ESP8266** for WiFi communication and supported remote data synchronization and device management through MQTT/HTTP-based interaction
- Developed an **Android application** for user registration, face enrollment, and remote control

EXPERIENCE

IoT Engineering Laboratory, Shandong University of Science and Technology, Research Assistant
07/2023 - 01/2024

- Participated in research on real-time scheduling optimization for embedded IoT systems, focusing on resource allocation and response-time optimization under multi-task settings
- Improved the **Rate Monotonic Scheduling (RMS)** algorithm and designed scheduling optimization strategies to enhance real-time performance and task scheduling efficiency
- Implemented algorithms and conducted experimental validation by building a simulation environment and systematically evaluating different workload and priority configurations
- Analyzed improvements in response time, system utilization, and related metrics to verify method effectiveness
- Contributed to paper writing and result organization, leading to the IEEE paper: **Scheduling Optimization Design of IoT Embedded System Based on Improved RMS Algorithm**

ADDITIONAL INFORMATION

- English: IELTS 6.0
- One software copyright
- Second-Class University Scholarship; Outstanding Student Award