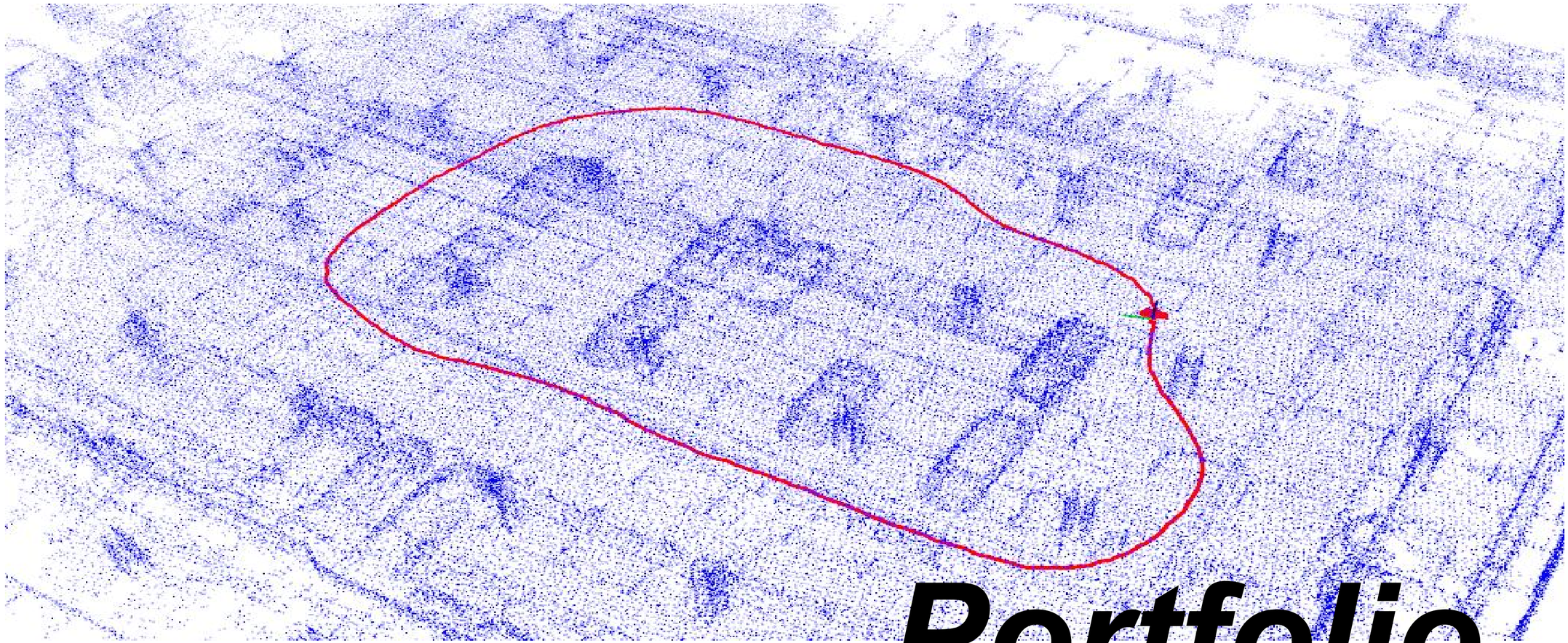
Jiajun Jiang
elkulasjiang@zju.edu.cn

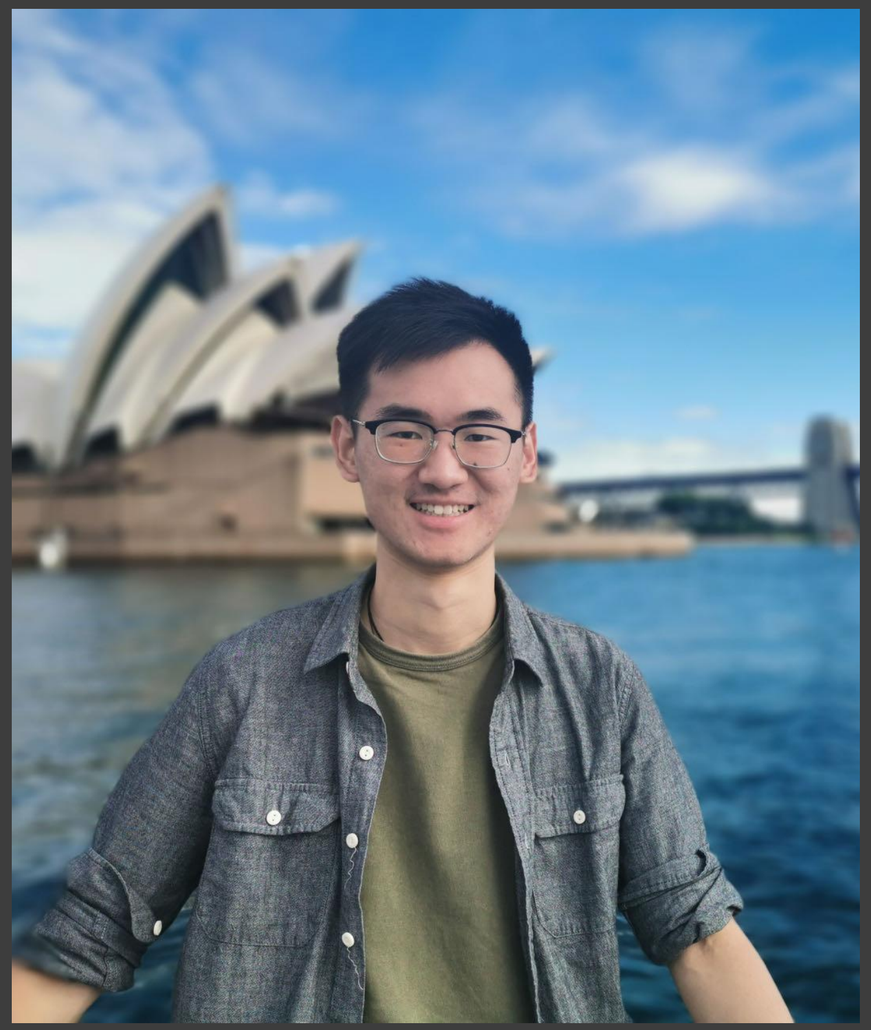


Portfolio.

EE | CS | Robotics

2016|2023 Selected Projects

www.elkula.com



Jiajun Jiang

EE I CS I Robotics

Holding a Master degree in Control Science and a Bachelor in Automation + English from Zhejiang University, I am an experienced engineer specializing in Circuit Design, Computer Science, and Robotics.
I am passionate about programming, hardware design, and new challenges. I am willing to step forward to Industrial Design, looking forward to utilizing my former skills in human computer interaction and making multidisciplinary possibilities.

Skill Tools, Education and Experience

TOOLKIT AND SKILLS

Coding Skills

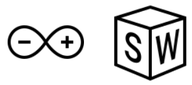
- C++
- Python
- Java
- LaTex
- Shell

Programming Tools

- ROS platform
- Git

Circuit Design

- Altium Designer
- Keil



Prototyping

- Arduino
- SolidWorks

EXPERIENCE

(2022.06 - Present, Hangzhou, China)

Algorithm Engineer

DAMO Academy, Alibaba Group, China

(2021.04 - 2021.09, Hangzhou, China)

Reasearch Internship

DAMO Academy, Alibaba Group, China

(2017 - 2019, Hangzhou, China)

Circuit Group Leader

Team ZJUDancer, Zhejiang University, China

EDUCATION

(2019.09 - 2022.07, Hangzhou, China)

Master in Control Science and Engineering

Zhejiang University

(2015.09 - 2019.07, Hangzhou, China)

Bachelor in Automation + English Language and Literature,

Zhejiang University

(2018.07 - 2018.09, Davis, USA)

Research Intern, University of California, Davis

(2017.06 - 2017.09, Berkeley, USA)

Summer Session, University of California, Berkeley

Table of Content

Chapter 1: Ciruit Design for Humanoid Soccer Robots

Chapter 2: Localization & Calibration Algorithms by Multi-spectral Sensors

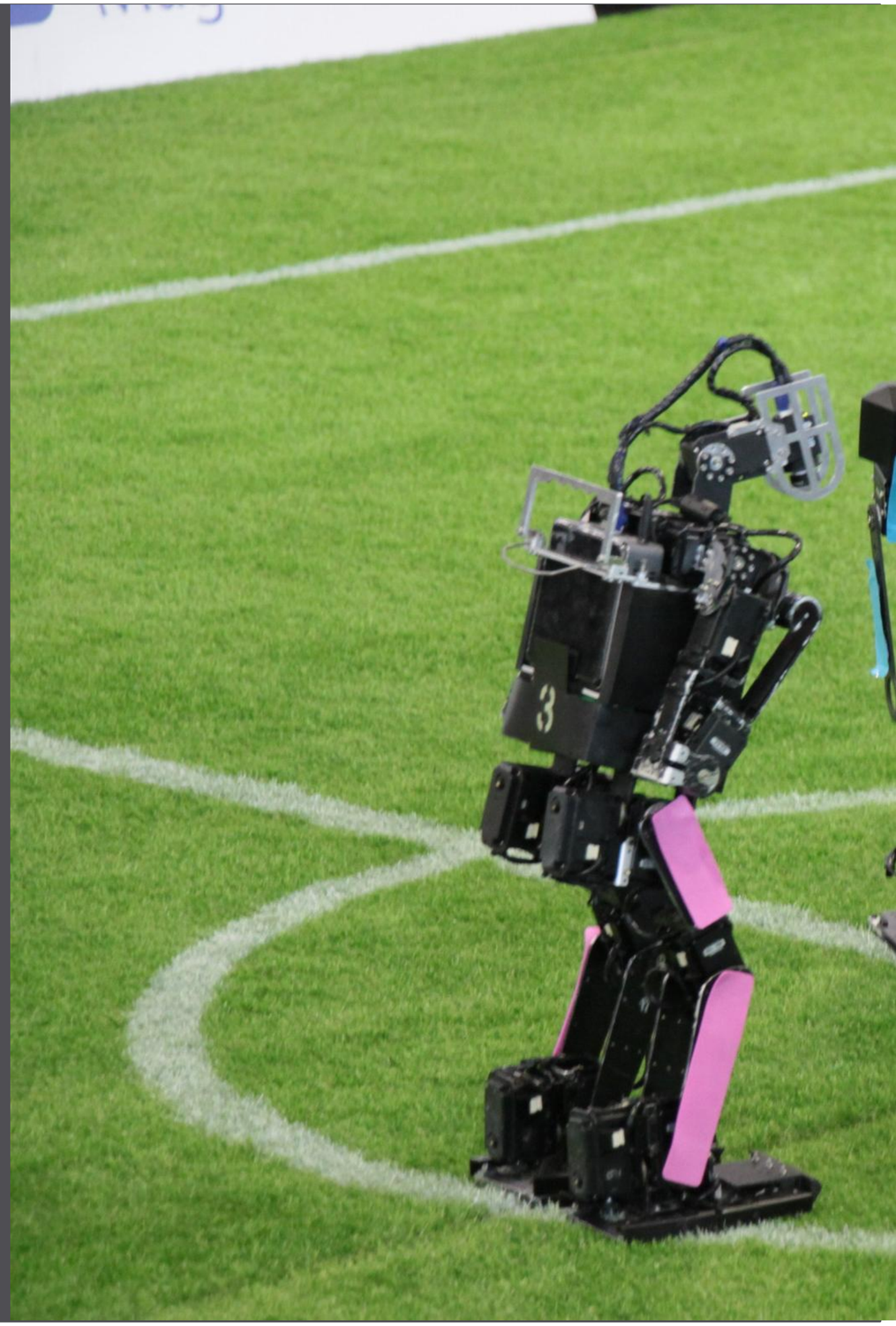
Circuit Design

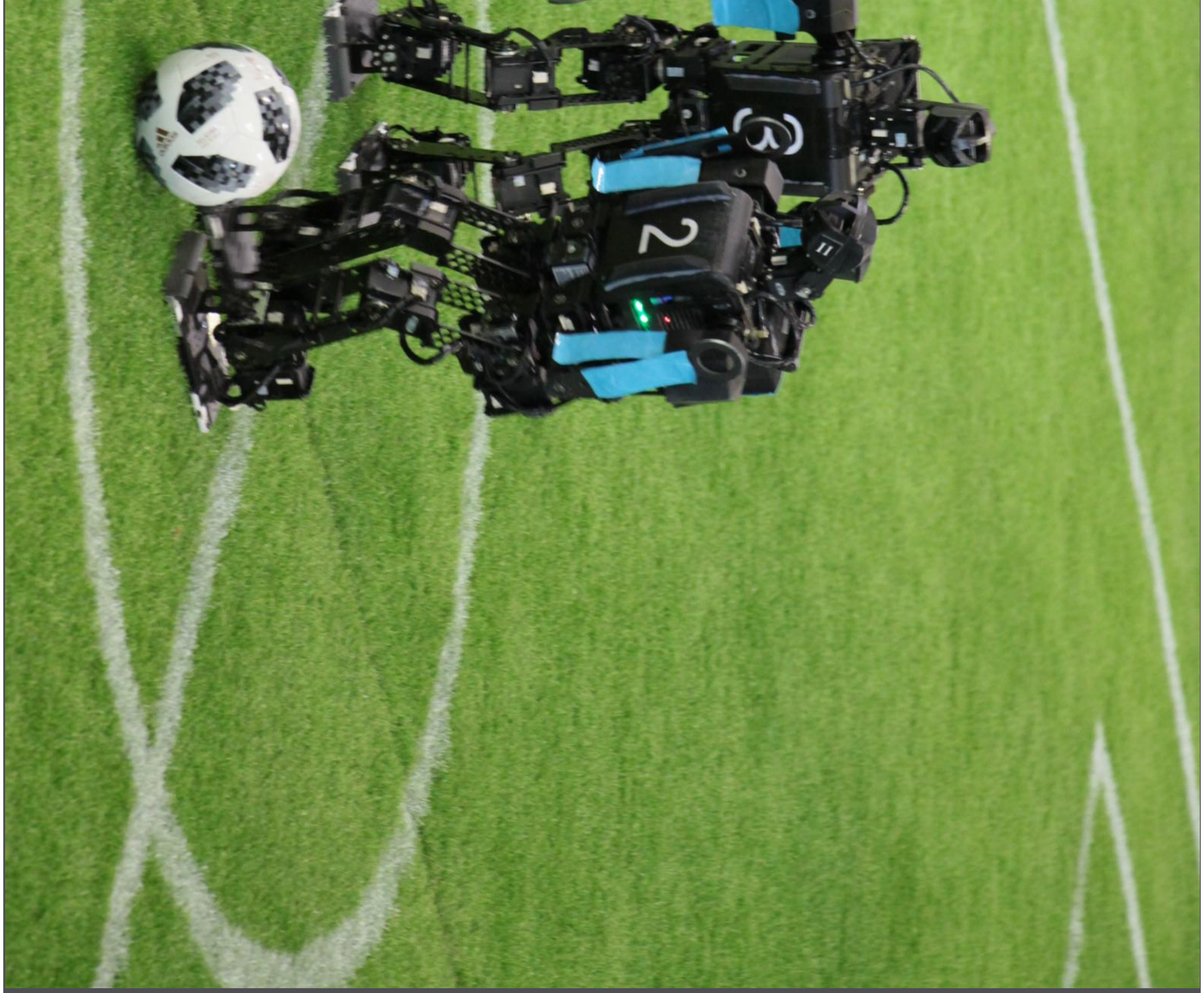
Ciruit Design for Humanoid Soccer Robots

05

Jiajun

During my two-year stay in ZJUDancer, a humanoid football robots team at Zhejiang University, I dedicated myself to making the circuit system robust and developed my skills in circuit design. I assumed responsibility for enhancing pressure-sensing modules and creating a novel signal transmission pipeline for inertial units and servos. These two improvements significantly contributed to our performance in both the RoboCup German Open 2019 and RoboCup International 2019 competitions.



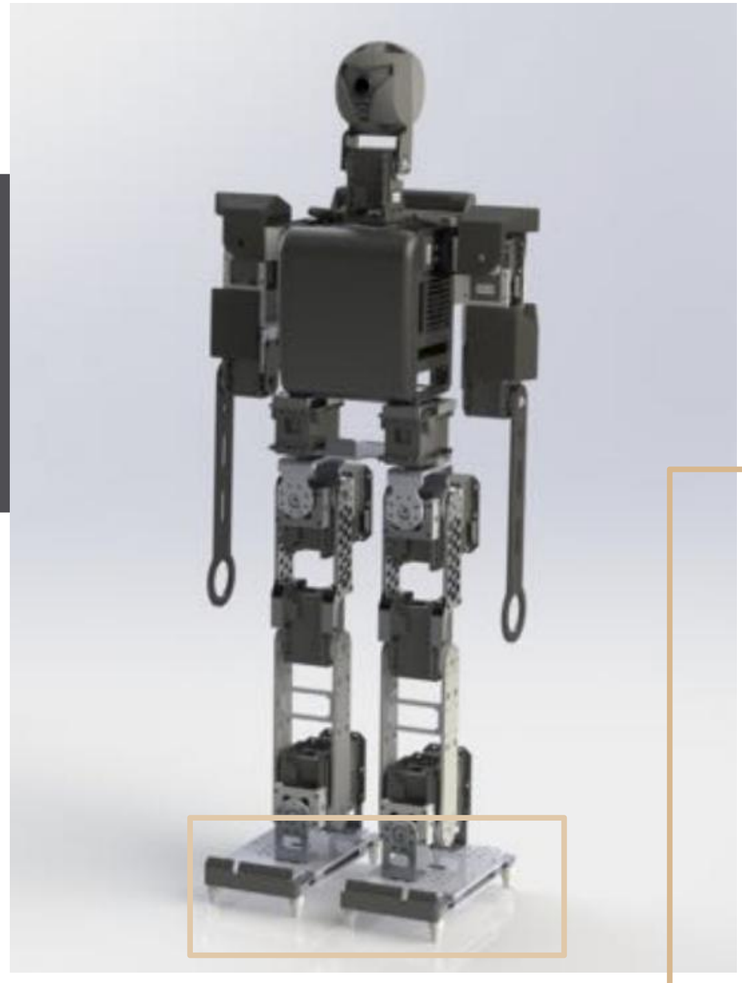


Pressure Sensing Module

01

Individual Project

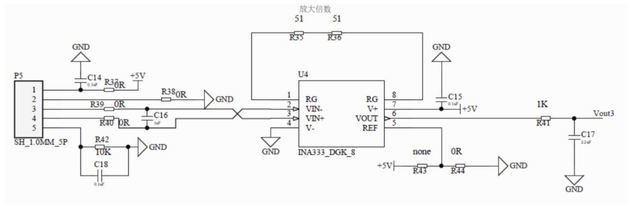
#Circuit_Design
#Schematic_Design
#PCB_Layout_Design
#Soldering
#Pressure_Sensors



Why This Module

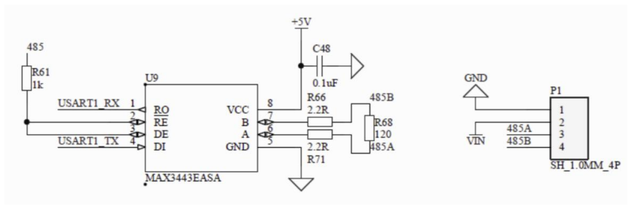
Closed-loop control is essential for maintaining the robustness of a humanoid robot's gait system, and the pressure sensing module plays a pivotal role by providing pressure data from the foot as feedback to the gait system.

Jiajun



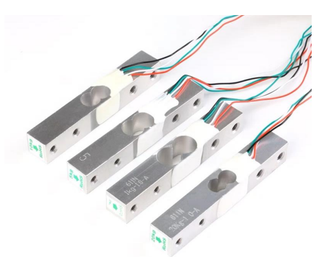
Amplifier

- INA333_DGK_8
- Foot pressure voltage amplification
- Num: 4
- Gain: 1000



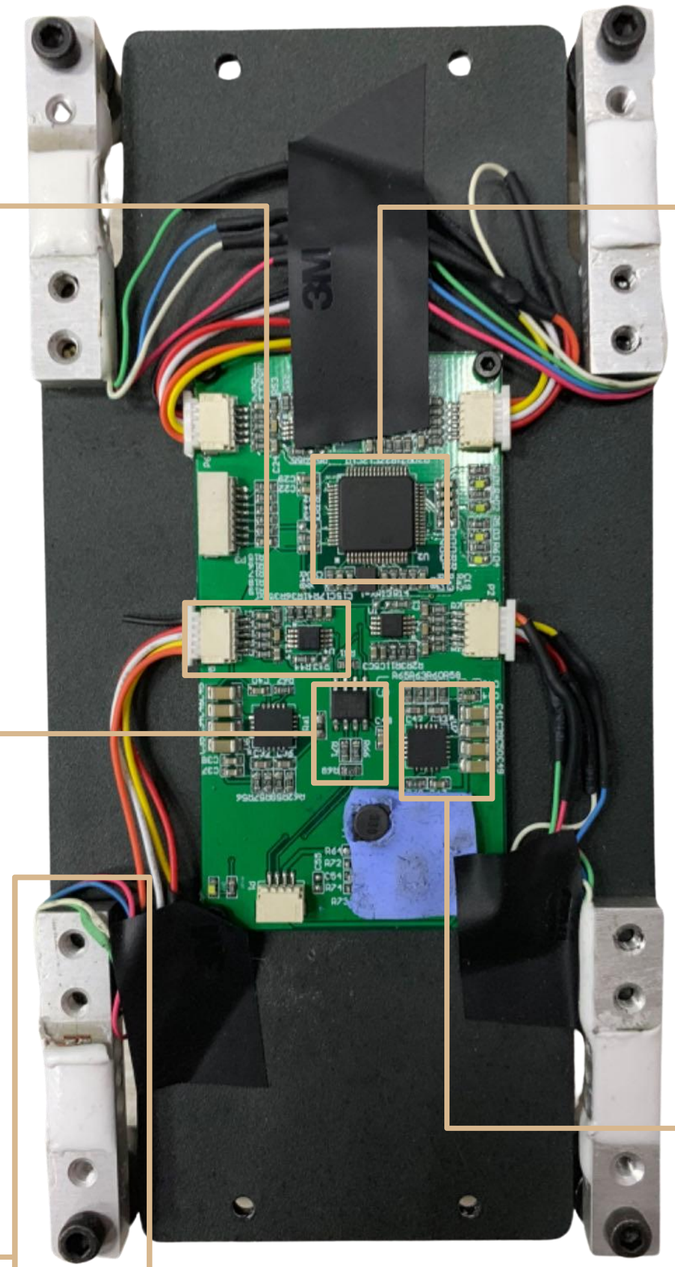
RS-485 Transceivers

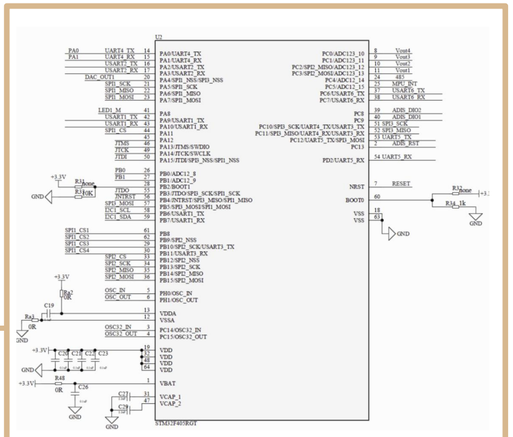
- MAX3443EASA
- Signal Transmission



Force Sensor

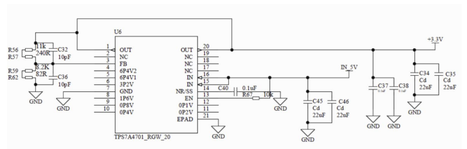
- Get Raw Pressure Signal





Main Processor

- STM32F405RGT



Voltage Regulator

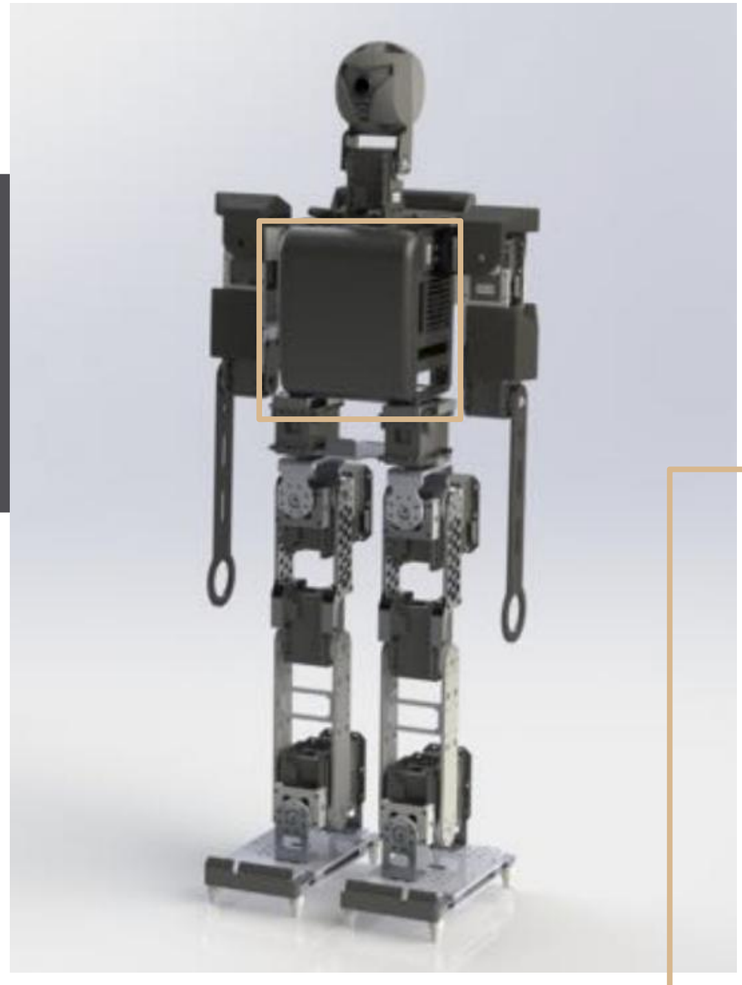
- TPS7A4701RGW
- Num: 2
- Input: 5V
- Output: 3.3V & 5V

Signal Transmission Module

02

Team Project

#Circuit_Design
#Schematic_Design
#PCB_Layout_Design
#Soldering
#IMU_Processing
#Servo



Why This Module

Every humanoid robot requires 28 DYNAMIXEL servos to function, along with a single Inertial Measurement Unit (IMU). To ensure reliable input and output performance, a module for processing data streams from the servos, IMU, and foot sensor boards is essential.

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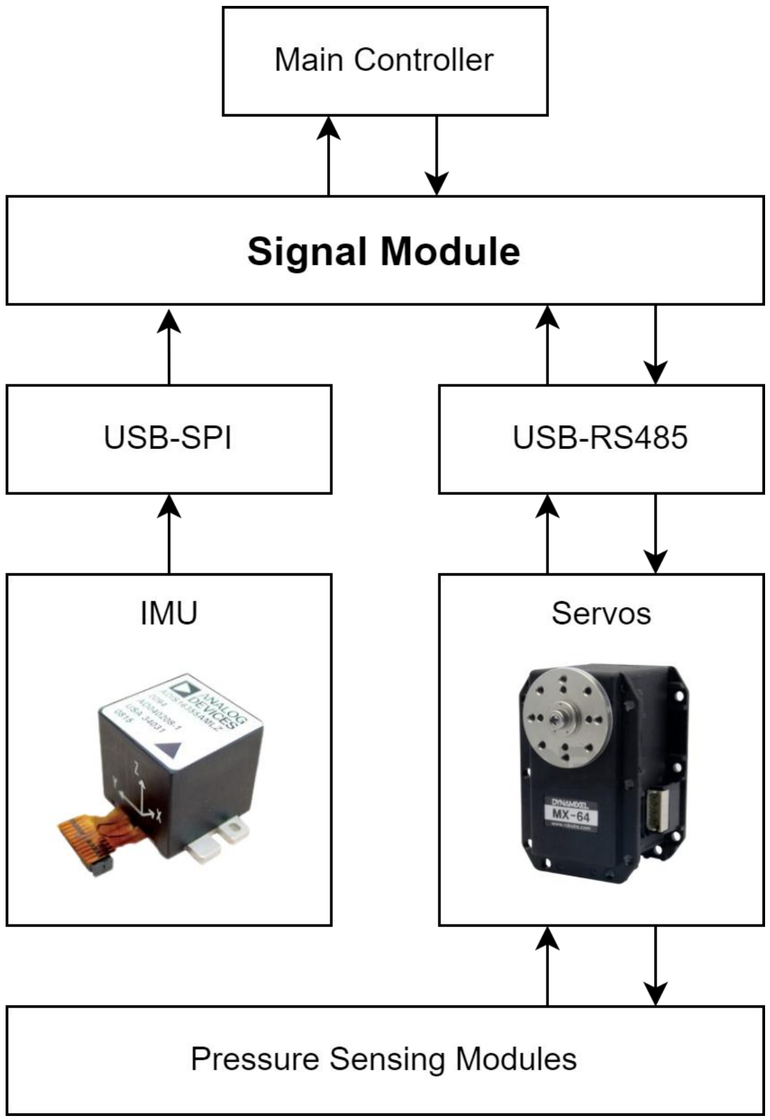
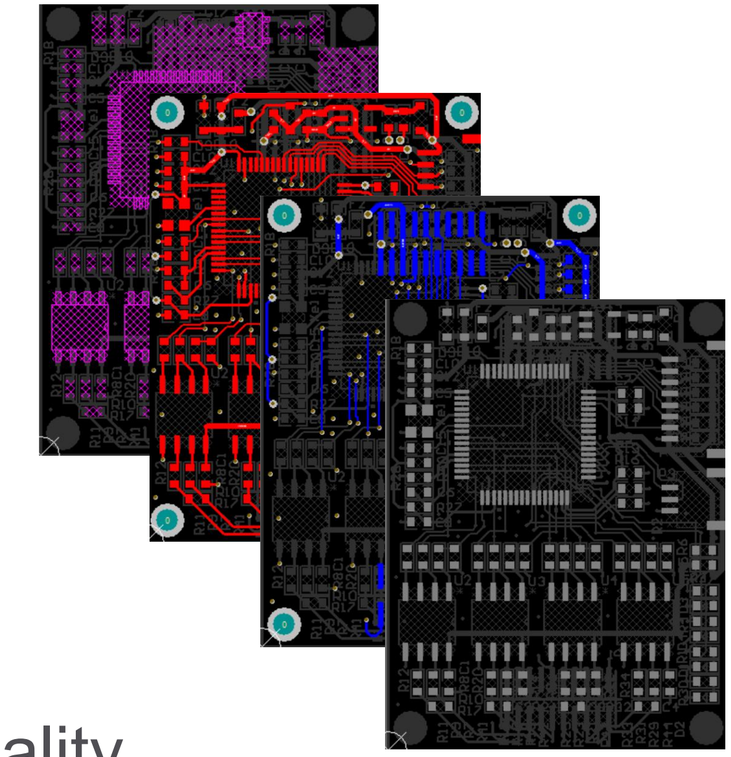




Functionality

Signal transmission module board acquires IMU data via SPI1 from the IMU, forwards this data to the upper board using UART1, and simultaneously communicates with Dynamixel servos through USART2/3/4, sending and receiving data concurrently. The act of transmitting data is essential for the robot teaching function. The data provided by the pressure sensing module is packaged according to the protocol of Dynamixel servos.

Localization & Calibration Algorithms by Multi-Spectral Sensors

Looking back on my extensive four-year journey in the field of SLAM, I developed robust localization and calibration algorithms capable of utilizing multi-spectral sensors like LiDAR and thermal cameras. These algorithms were also implemented across a diverse range of platforms, spanning from handheld devices to humanoid robots, and from logistic robots to autonomous trucks. I contributed to the field with two patented innovations and a published journal paper.

Hitch Angle Estimation for Autonomous Trucks

03

Individual Project

#LiDAR

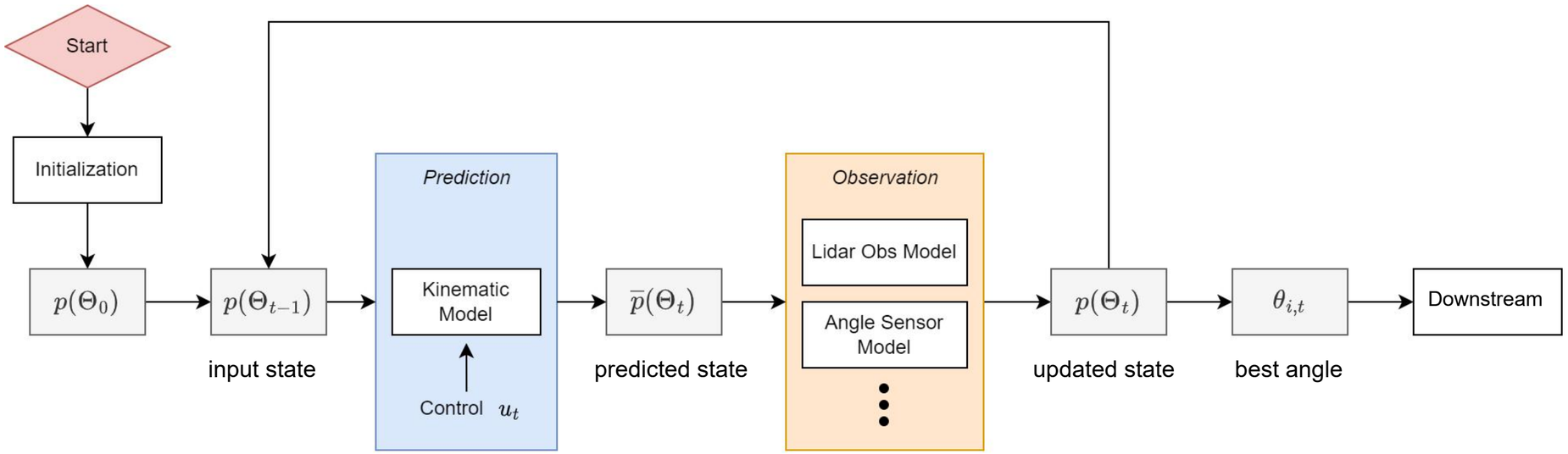
#State_Estimation

#Filter

Why This Module

The **hitch angle** refers to the angle between the **trailer** and the **tractor** in a semi-trailer truck system. Accurately estimating the hitch angle is crucial for autonomous trucks, particularly for subsequent tasks such as perception and prediction. LiDAR is all we need for this module.

Histogram Filter



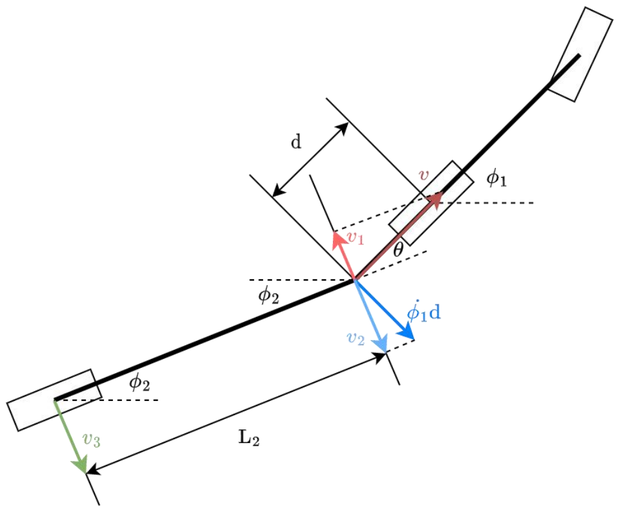
$$\mathrm{dom}(\Theta_t) = \theta_{1,t} \cup \theta_{2,t} \cup \cdots \cup \theta_{n,t} \qquad n \in \mathbf{Q}$$

$$p(\Theta_t) = (p(\theta_{1,t}), p(\theta_{2,t}), \cdots, p(\theta_{n,t})) \qquad n \in \mathbf{Q}$$

Design Concept

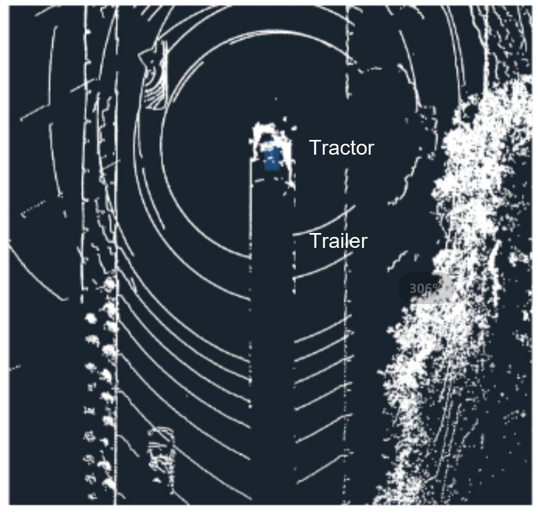
The only variable is one-dimensional angle. I use histogram filter to track this variable and explore state Θ_t based on the angle. The state will be first predicted and then updated by the LiDAR observation (mainly the points on the trailer). The angle with highest score will be selected from the updated state and sent to downstream tasks.
The state will be propagated by time and the system will keep going on.

Prediction Model



$$\theta_{t+1} = \theta_t + \left(\frac{v_t}{\mathrm{L}_1} \tan\delta_t - \frac{v_t}{\mathrm{L}_2} \sin\theta_t + \frac{\mathrm{d} \cdot v_t}{\mathrm{L}_1 \mathrm{L}_2} \tan\delta_t \cos\theta_t \right) \times \mathrm{d}t$$

LiDAR Observation



Multi-Spectral Sensors Calibration

04

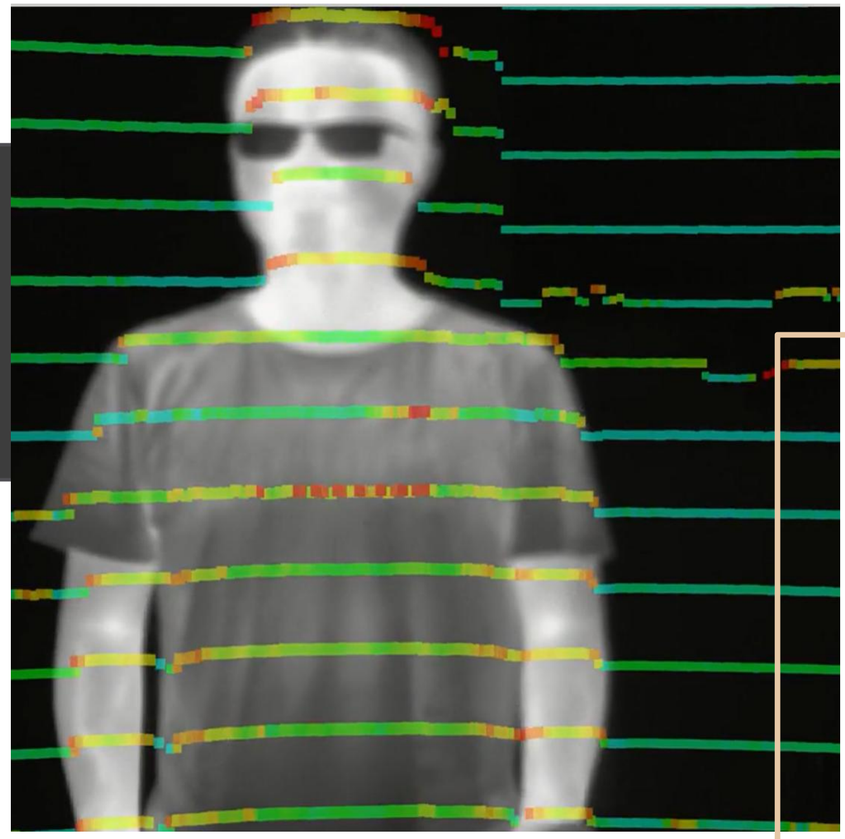
Individual Project

#LiDAR

#RGB_Camera

#Thermal_Camera

#Calibration

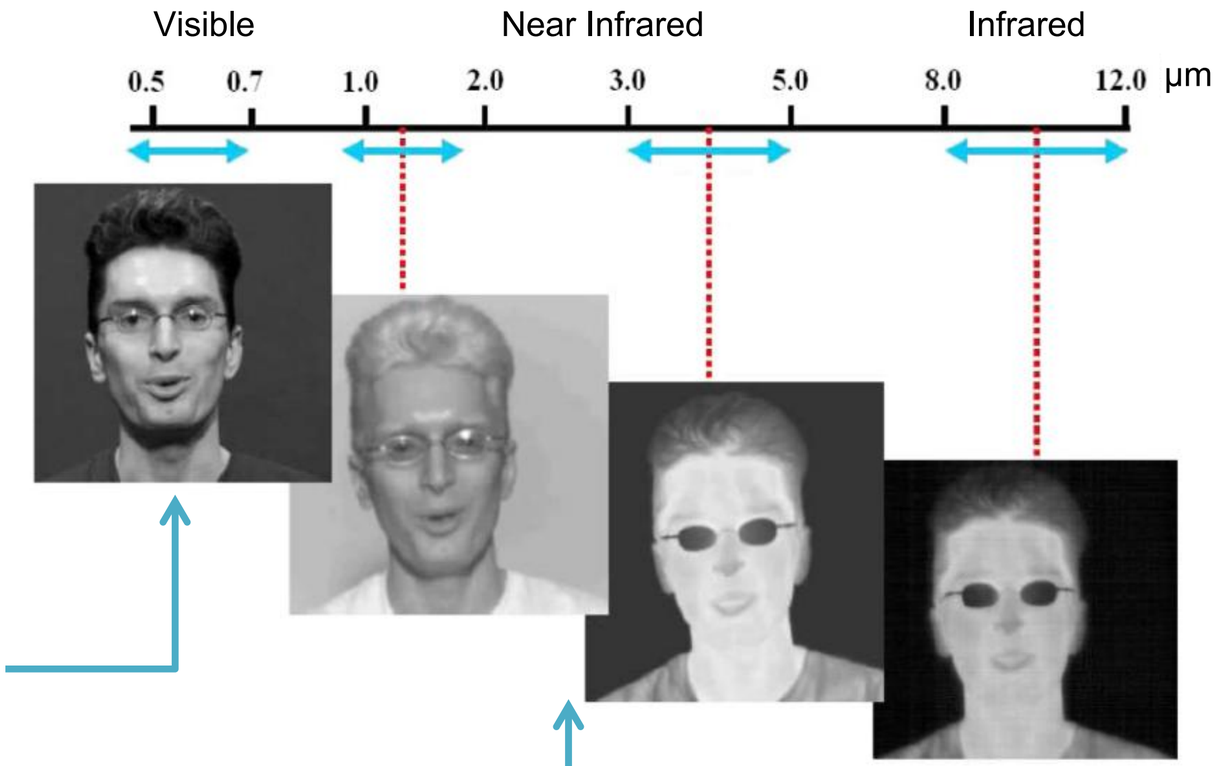


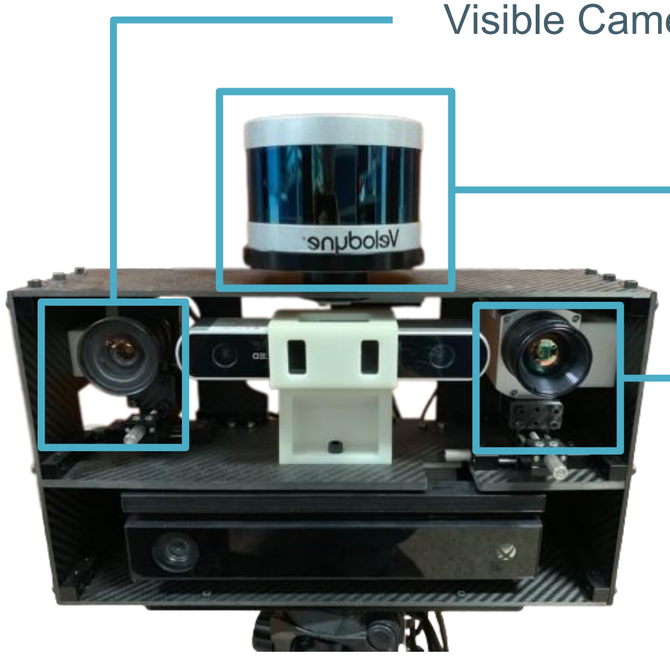
Why Calibration

Sensor calibration is the process of fine-tuning a sensor's output to ensure its measurements or readings accurately correspond to the true world. The calibration method is used to compute the parameters related to sensor functionality (intrinsic) as well as the transformations between different sensors (extrinsic).

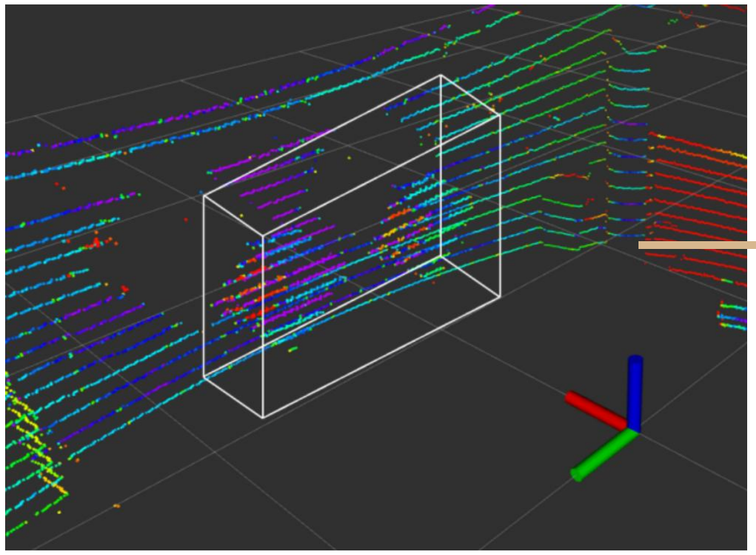
Jiajun

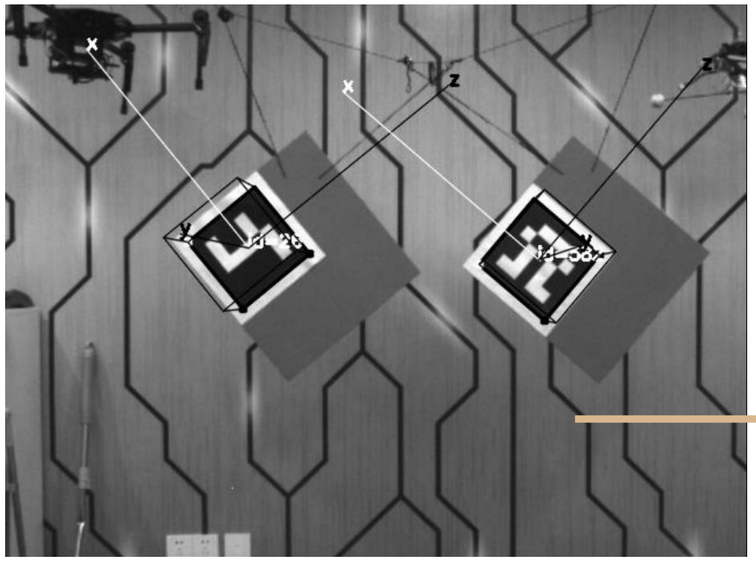
Multi-spectral sensors here refers to visible cameras (also RGB cameras), LiDARs, and thermal cameras, each providing distinct spectral types of data. Achieving successful sensor fusion enhances perception accuracy and robustness, and the first step is sensors calibration.

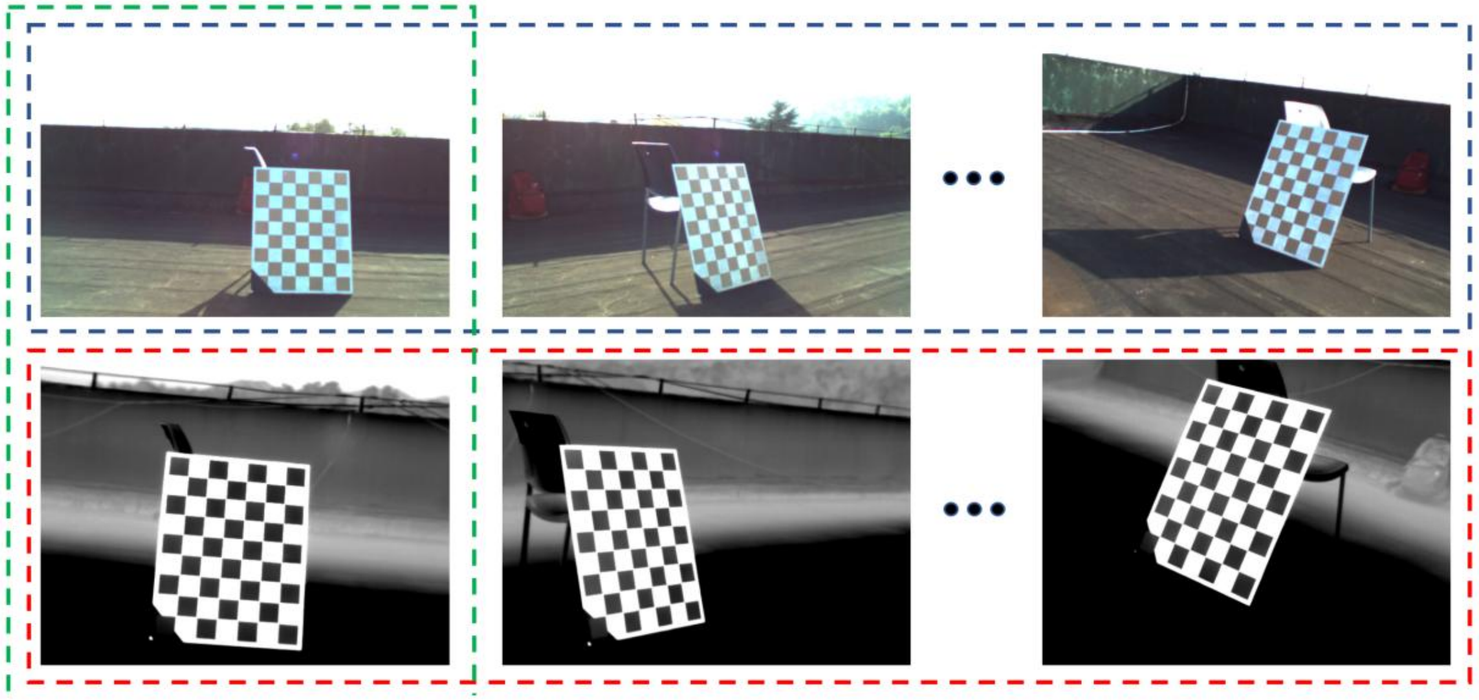




Visible - LiDAR - Thermal Calibration







Hanging two boards with ArUco markers is an essential tool for LiDAR-visible calibration. By determining and aligning the corners of these boards using 3D LiDAR points and 2D image pixels, we can establish the transformation connections between two sensors.

Paper boards and aluminum exhibit unique features when viewed through both the visible camera and thermal camera. Exploiting this phenomenon, a customized calibration checkerboard can be devised. All that's required for intrinsic calibration of both the visible and thermal cameras, including extrinsic parameters, are time-synchronized pairs of thermal and visible images.

Thermal-Inertial SLAM

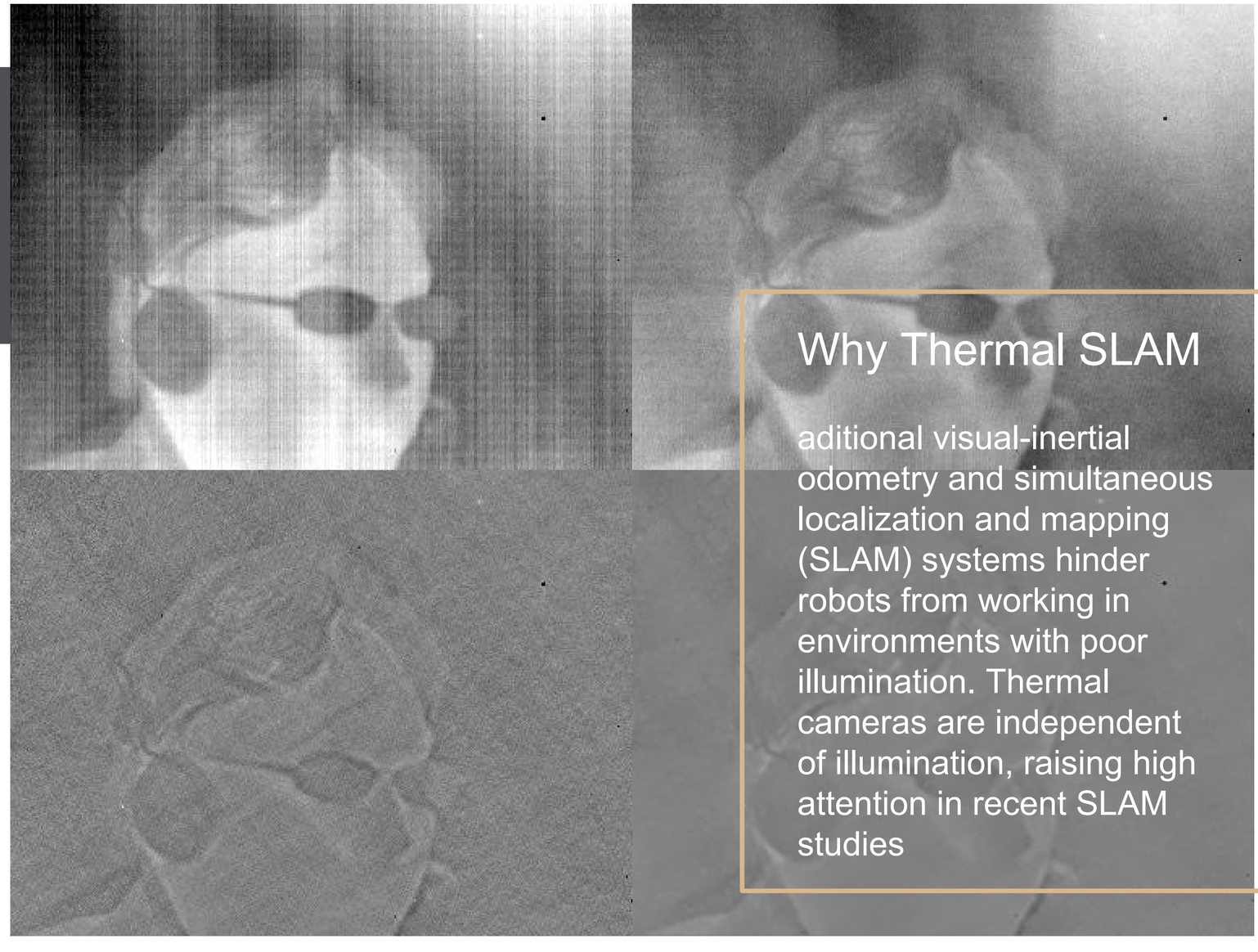
05

Individual Project

#Thermal_Camera

#IMU

#SLAM

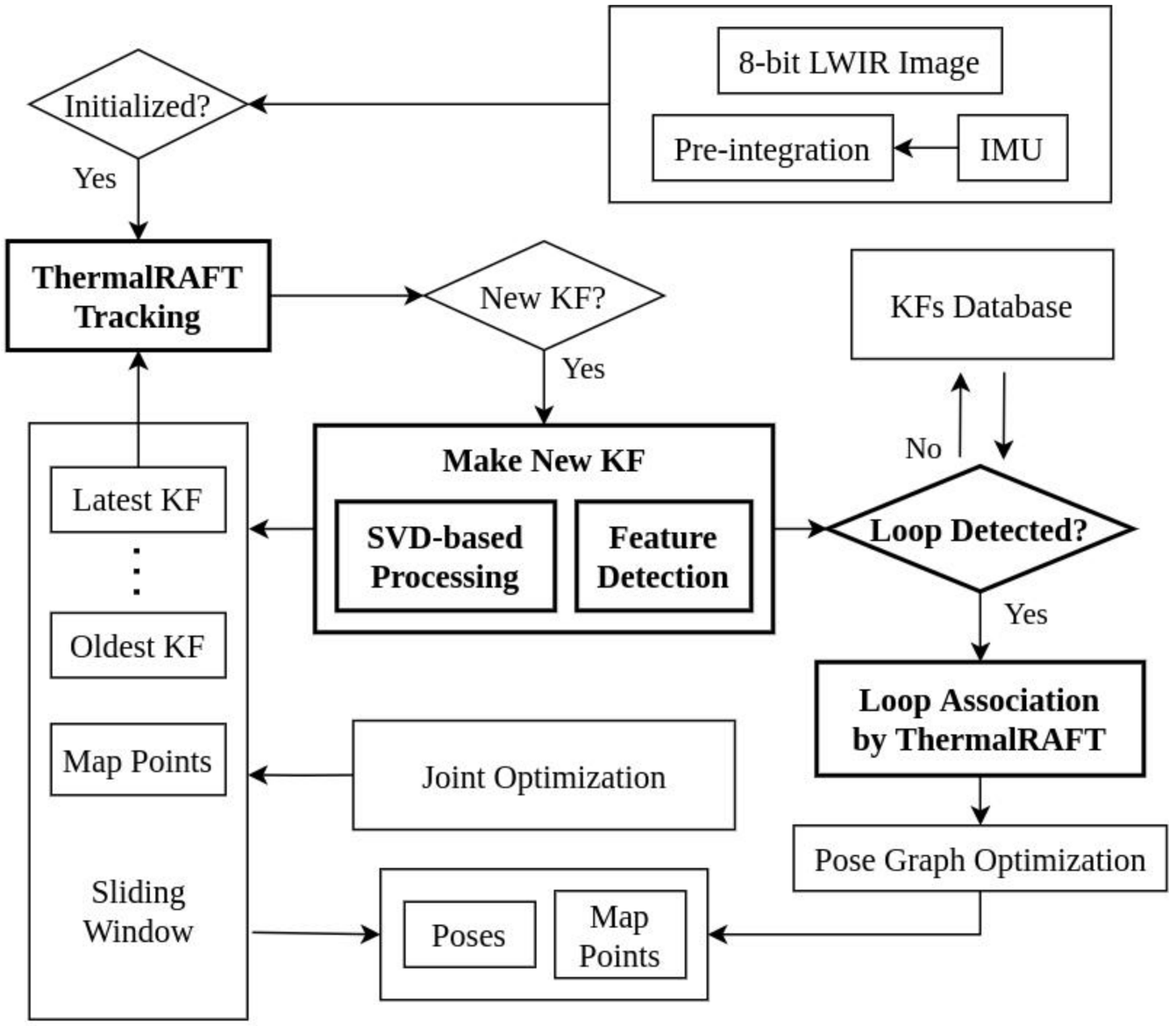


Why Thermal SLAM

aditional visual-inertial odometry and simultaneous localization and mapping (SLAM) systems hinder robots from working in environments with poor illumination. Thermal cameras are independent of illumination, raising high attention in recent SLAM studies

Contributions

- We propose an **SVD-based image processing** method, improving image quality on low contrast thermal images for SLAM by singular value reallocation
- We propose **ThermalRAFT**, a real-time optical flow network architecture with a lightweight design. ThermalRAFT produces accurate optical flow estimation on thermal images and significantly reduces the inferencetime



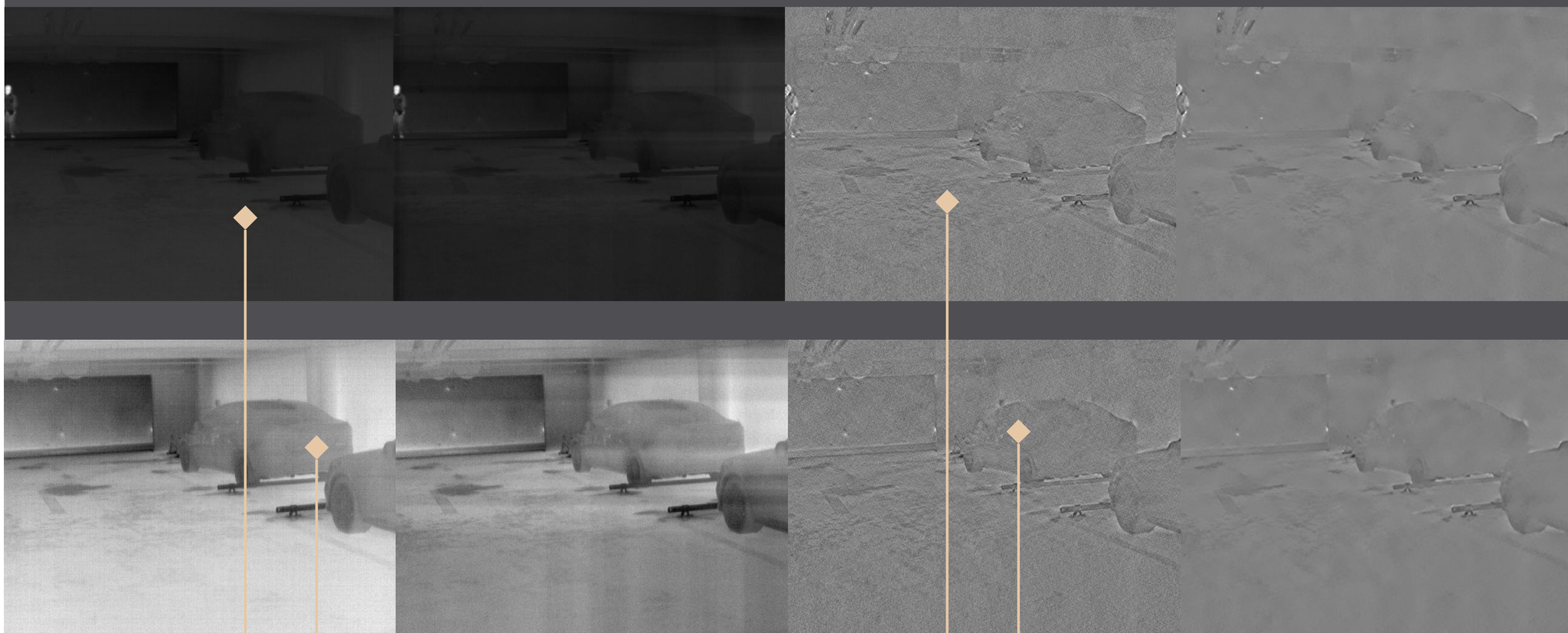
SVD Based Image Processing

Origin

Zero Largest Sigular Value

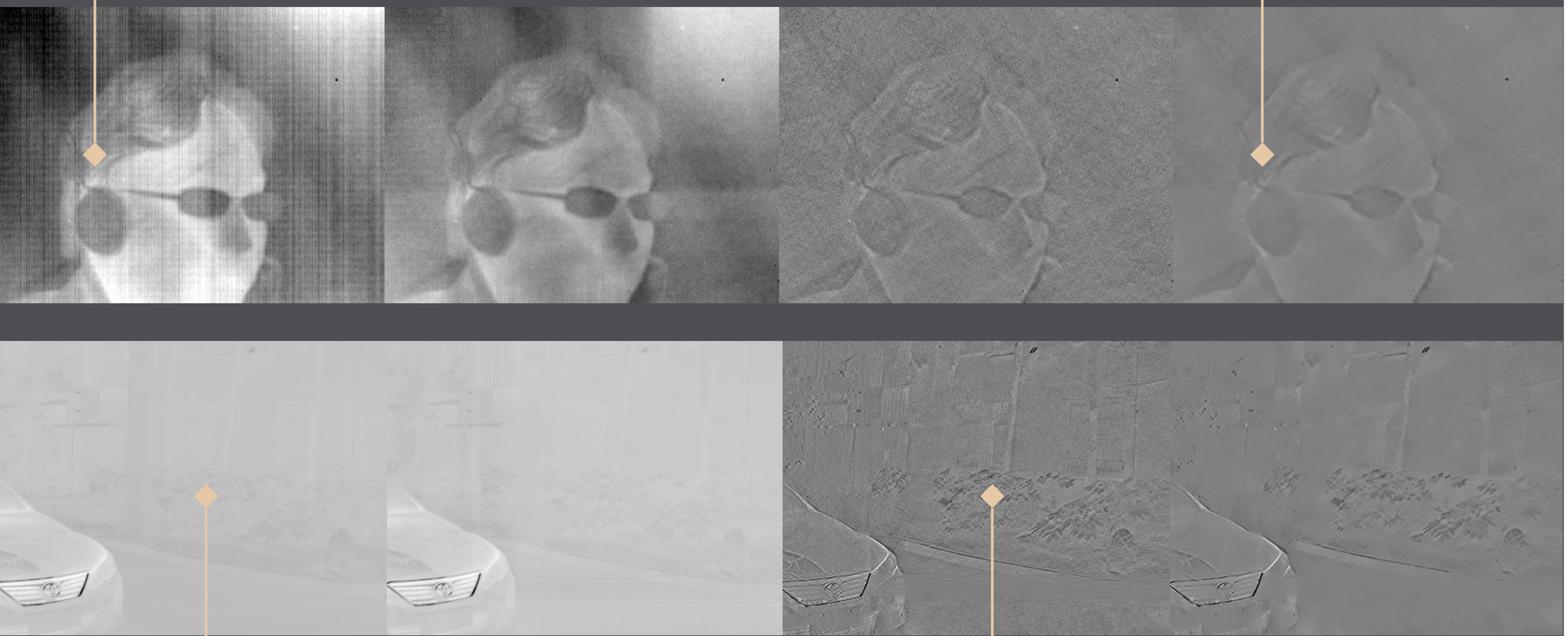
Reallocation

Rebuild



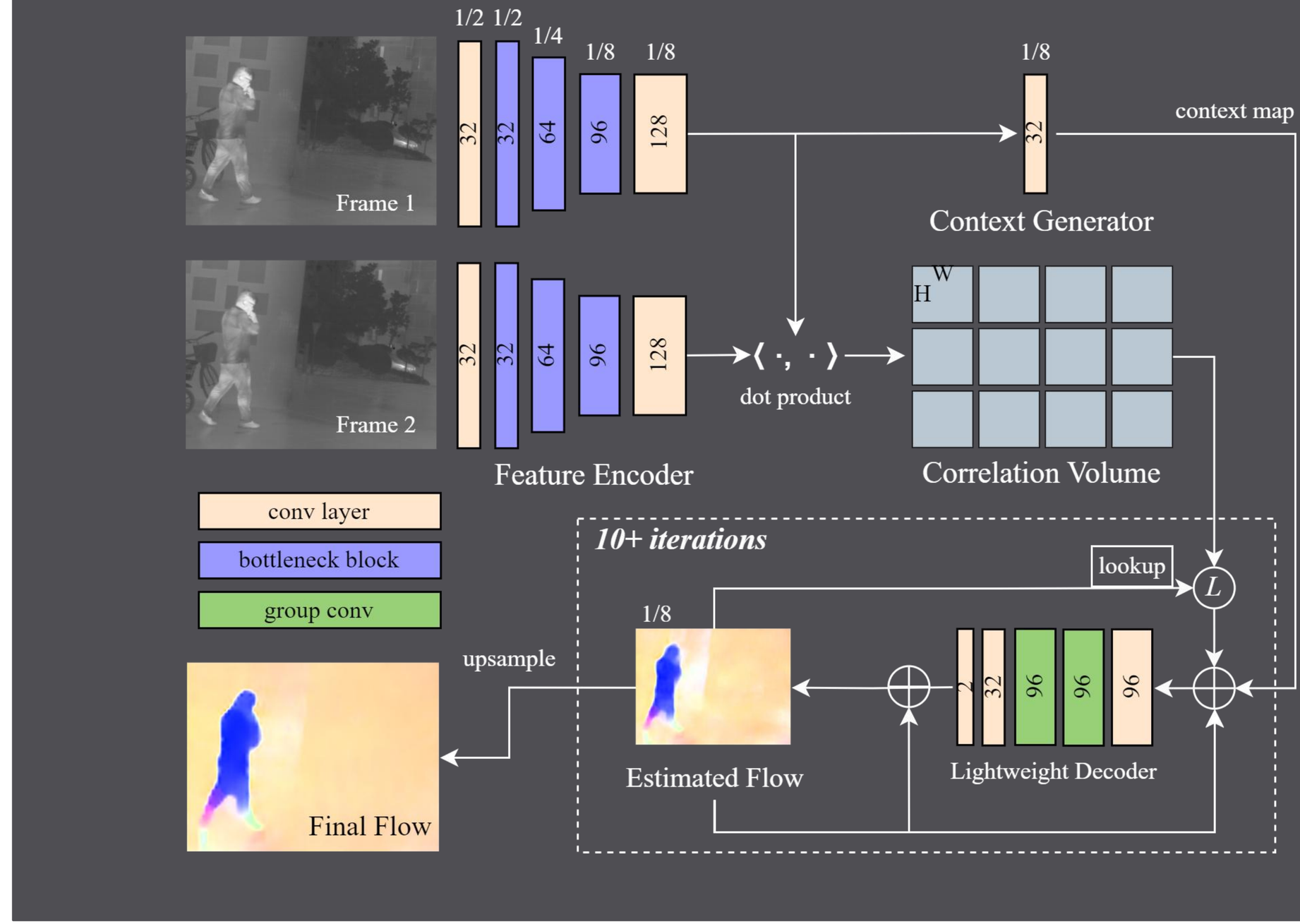
- Successive two thermal images with large photometric changes

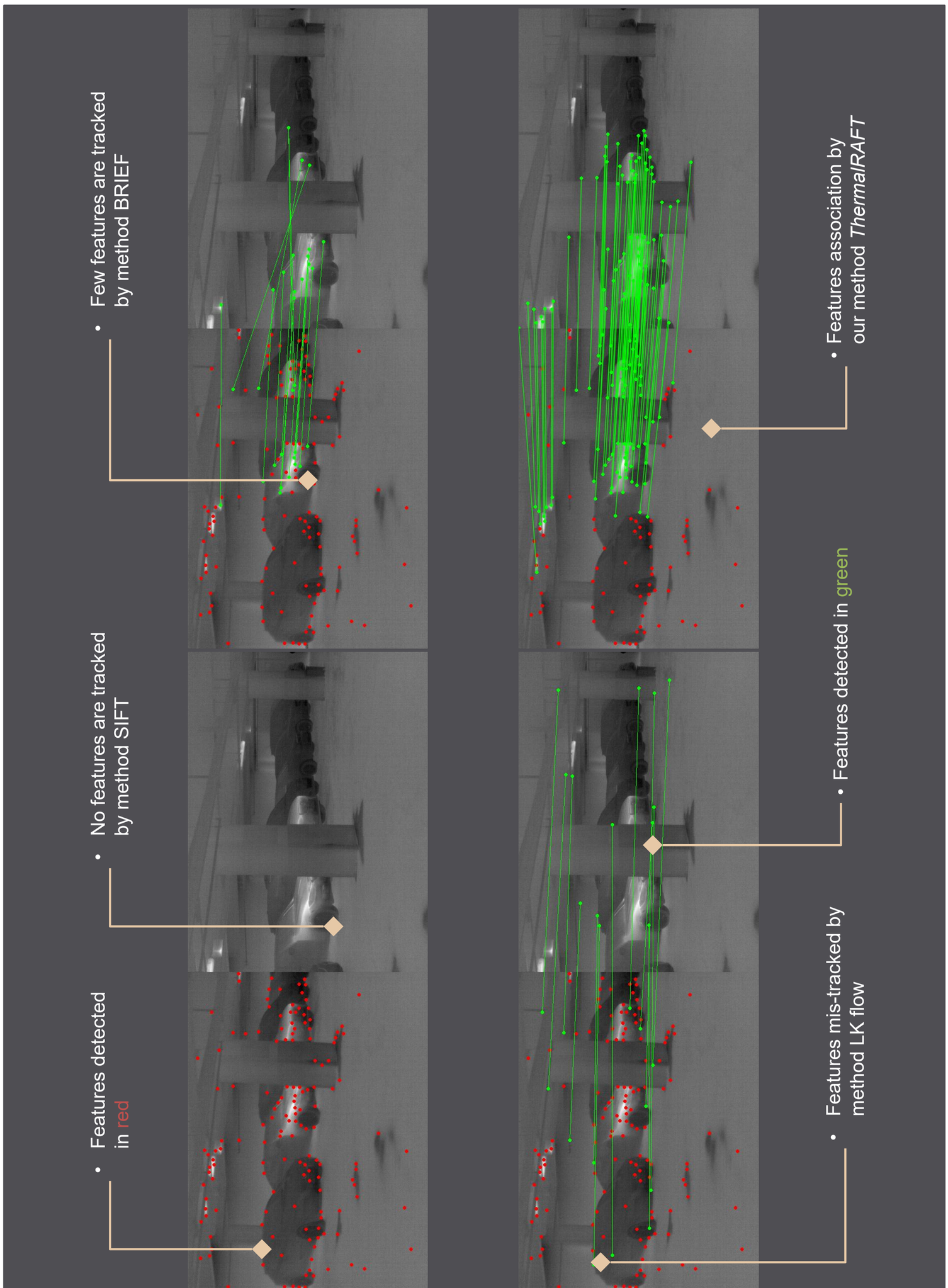
- Significant photometric changes vanish, while the structure of the environment remains intact

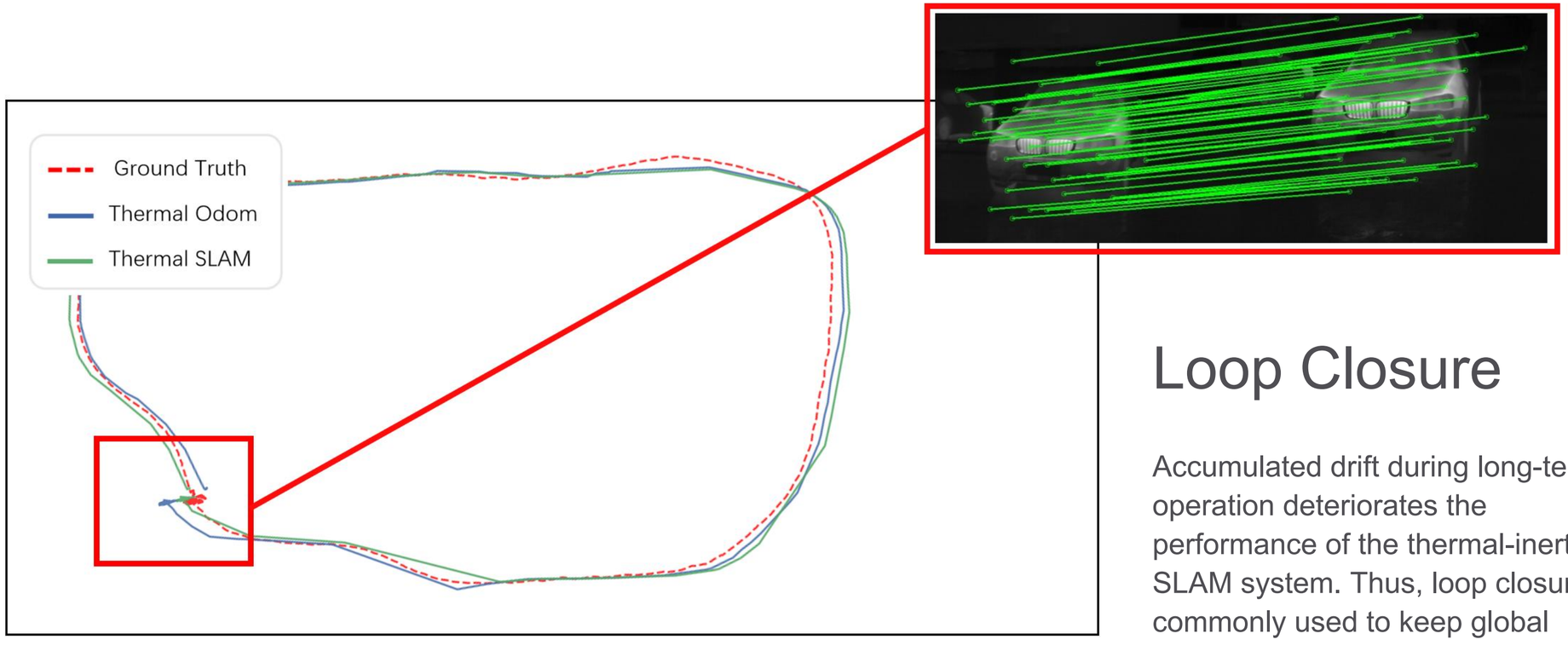


- Original thermal image with stripe noise
- Denoised thermal image
- Original thermal image with low constract
- The grass is more visible after singular value reallocation

ThermalRAFT - Feature Association Network



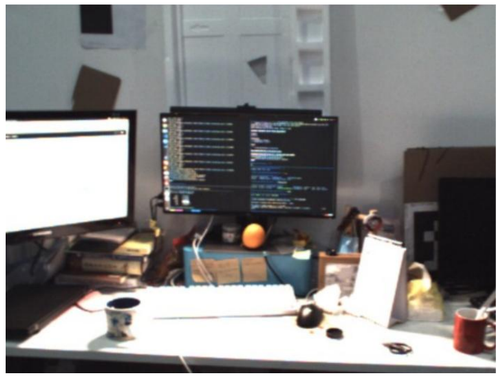
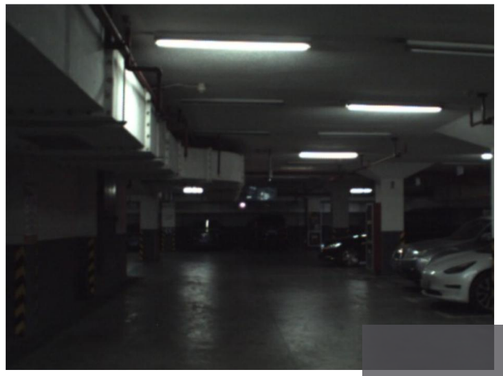
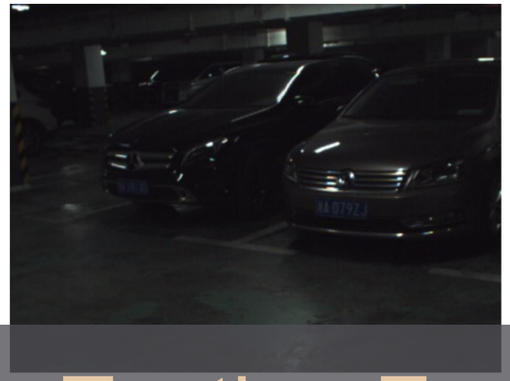
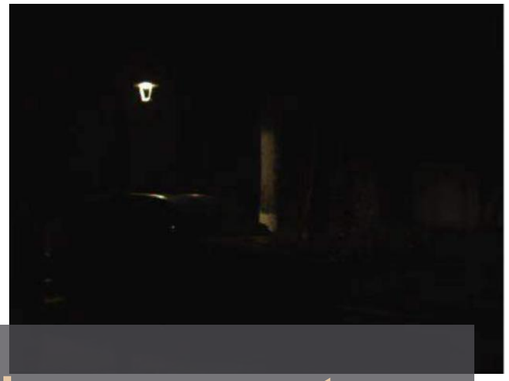

• Few features are tracked by method BRIEF
• Features association by our method *ThermalRAFT*
• No features are tracked by method SIFT
• Features detected in green
• Features detected in red
• Features mis-tracked by method LK flow



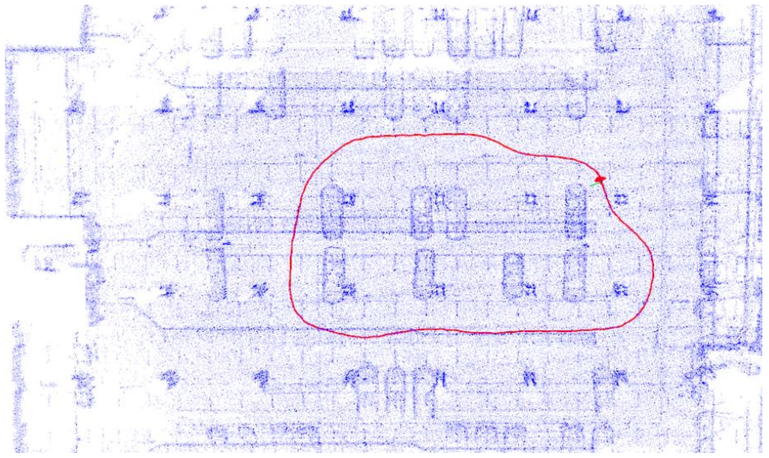
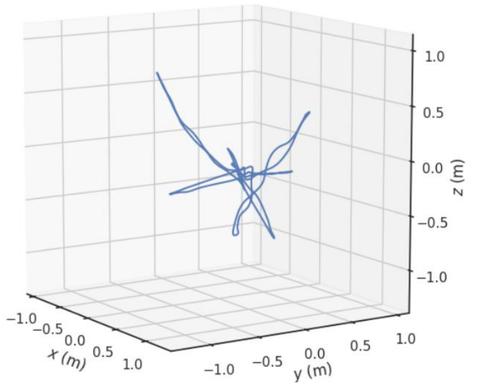
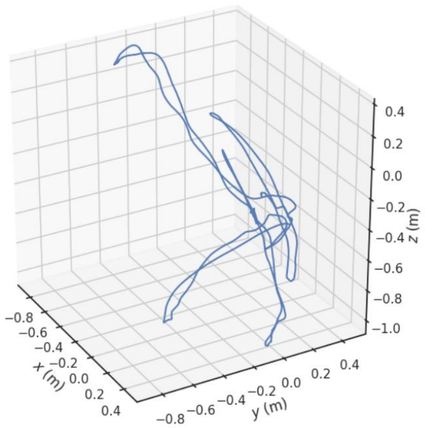
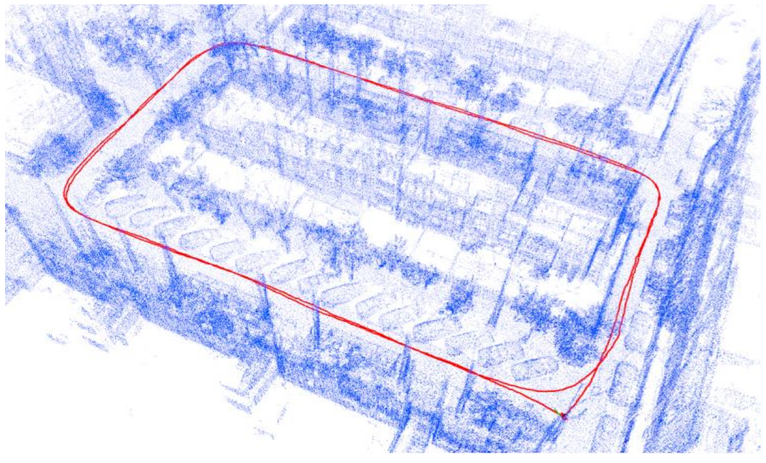
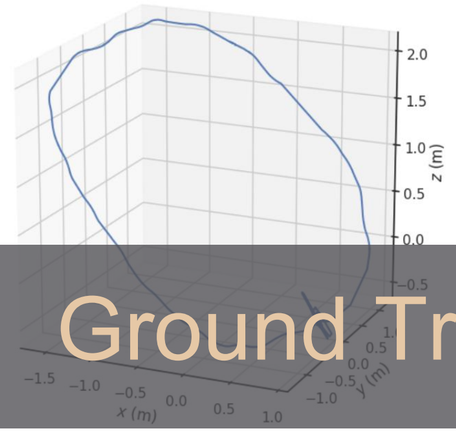
Loop Closure

Accumulated drift during long-term operation deteriorates the performance of the thermal-inertial SLAM system. Thus, loop closure is commonly used to keep global consistency.

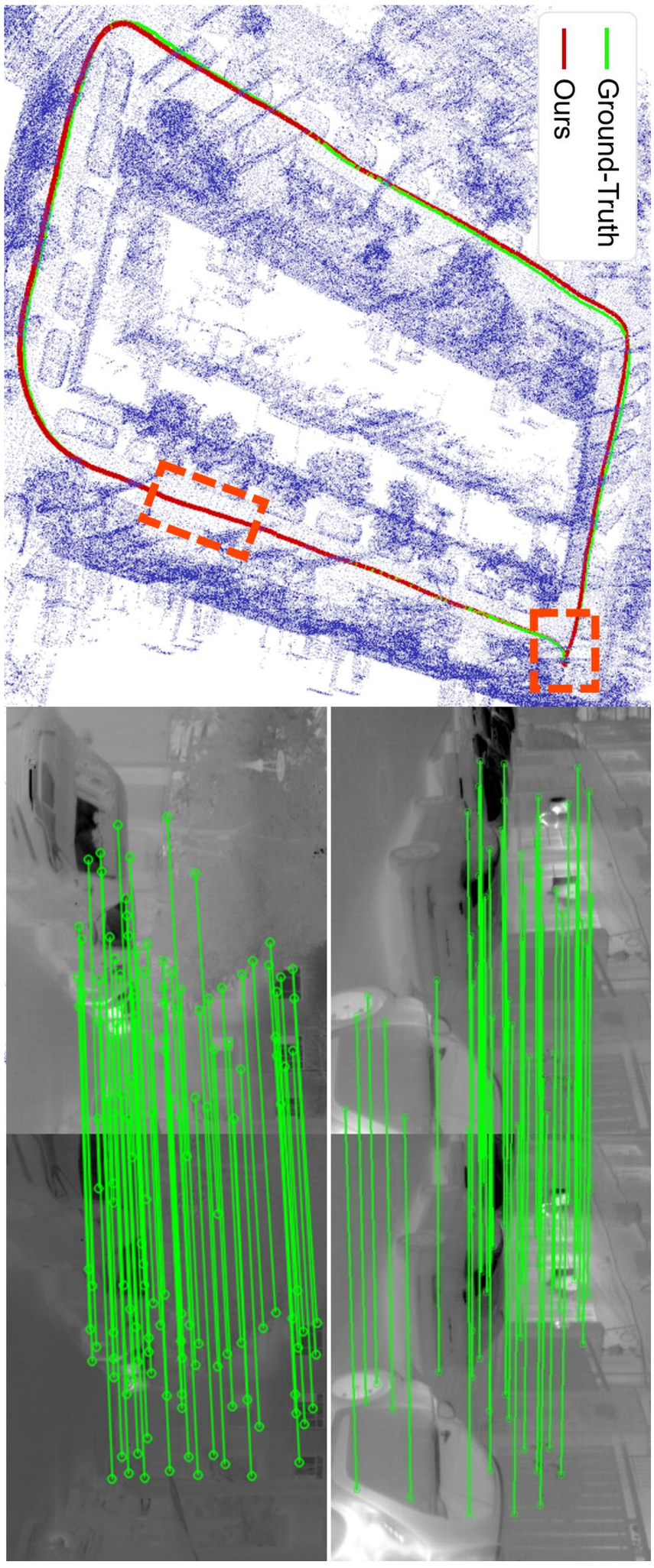
We detect a revisited place utilizing DBoW2, a commonly used place recognition approach based on bag-of-words. The candidate frames are listed by score, and the best candidate will be associated with the current frame using ThermalRAFT.

Testing Environments

Ground Truth Trajectory


Ground-Truth
Ours

Thank you for your time!

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www.elkula.com

Get in touch with this guy!

Email: elkulasjiang@zju.edu.cn
Tel: +86 18258217001

Contact

Jiang