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Research on Mission-Driven Intelligent AI Agents: From Defense Mobility to Sports Science

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Research on Mission-Driven Intelligent AI Agents

[From Defense Mobility to Sports Science]

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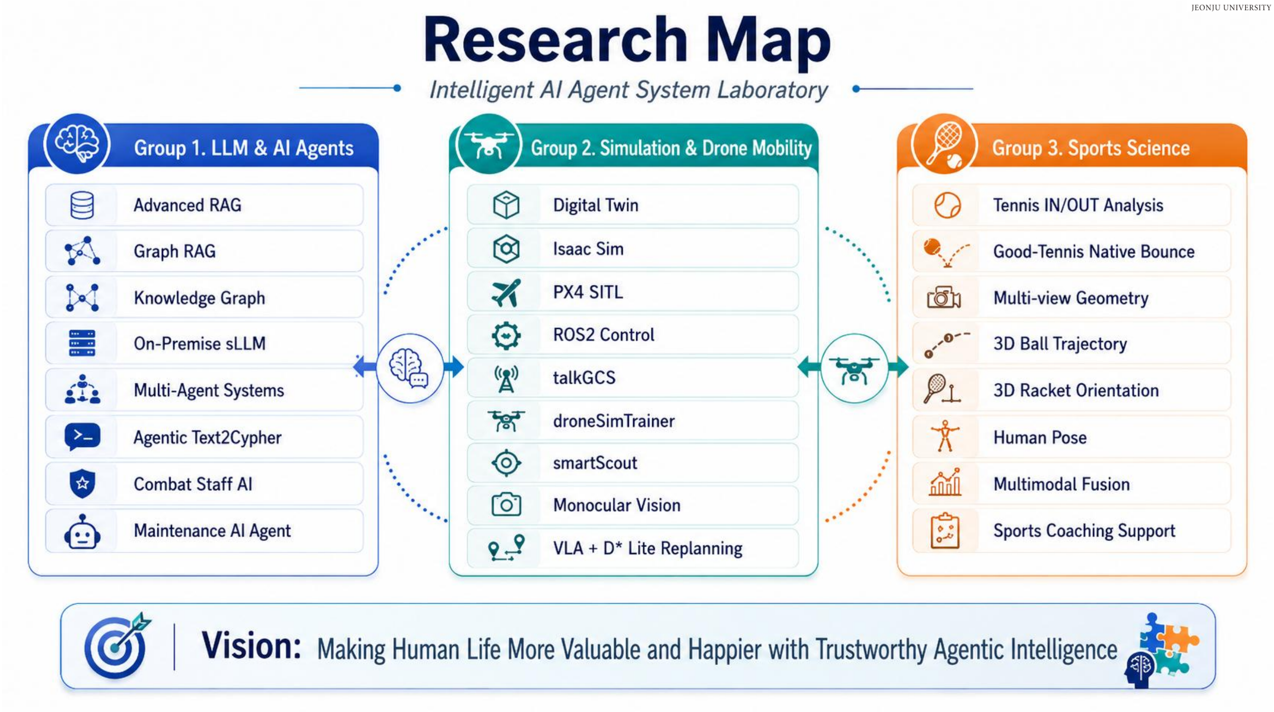

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RISE project

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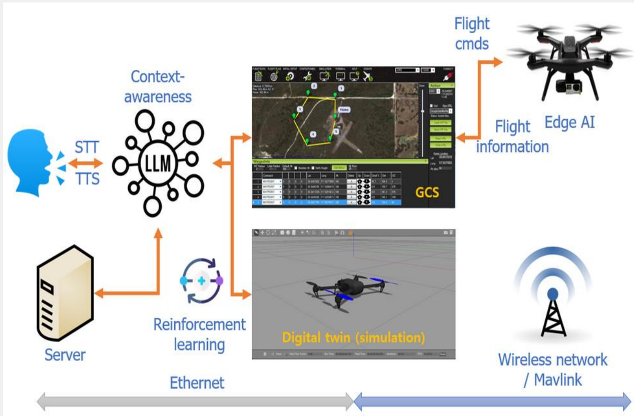
Multi-PurPose Defense AI Drone Development Platform

This study aims to develop and demonstrate an all-in-one intelligent mobility (drone) software package that automates, adds intelligence to and streamlines land, sea and air mission execution, using current AI technologies such as speech recognition, large language models (LLM), simulation and reinforcement learning, and edge AI.

Research Background

- Rapid growth of K-Defense and the widening importance of the defense industry
- Jeonbuk State selected as the national defense innovation cluster region
- Jeonbuk State selected as the 'Physical AI Proving-Ground Development Project' final target site

System Architecture



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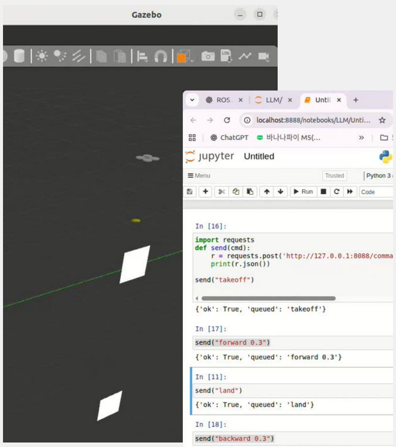
Core Modules

talkGCS

- Fine-tuning and integration of Small Language Models (SLMs) for flight control command generation

droneSimTrainer

- Development and Advancement of Gazebo/IssacSim-based Drone Control Simulation Based on Flight Control Commands



smartScout

- Development and Optimization of YOLO/VLA-based Object Detection and Identification Algorithms
- Currently conducting research on the development of a context-aware TinyLLM

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RISE project

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AI-based Autonomous Flight Path Planning on Drones

This study implements and validates a path-planning system that flies to the mission area and returns autonomously using one monocular camera and no LiDAR, even when the link to the ground control station is lost. A three-stage pipeline — A* global planning, ROI risk detection with VLA avoidance-point prediction, and D* Lite incremental replanning — was fully flight-verified on a survey-based campus digital twin (0.62 m registration residual) and a real flight stack (PX4 SITL).

Photorealistic Environment Modeling

Reference Orthophoto

(National Geographic Information Institute)

Precision Calibration

Alignment & Point Cloud
- Median residual <0.62m

3D Mesh Reconstruction
& Texturing

Completed 3D Mesh Campus

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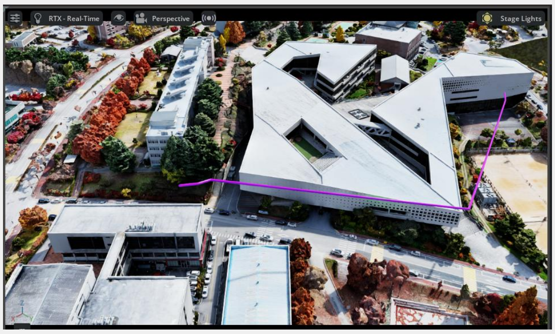
AI-based Autonomous Flight Path Planning on Drones

AI based Path Plannning

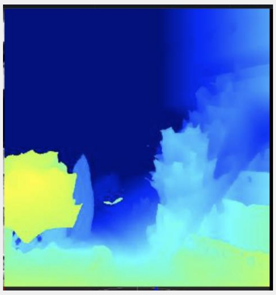
A* Global Path Planning

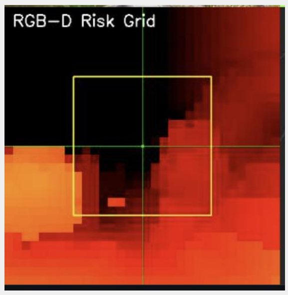
Automatic waypoint generation when operator designates a target point
- Maintains a 1.5m safety radius over the grid
- Automatic targeting of approach points via 8-directional search



Monocular Depth-based ROI Risk Detection

Estimated depth of 0–100m via monocular camera
- Intensive monitoring of the absolute defense zone covering the center 25% (16×16 cells) of the 32×32 danger grid
- Risk level R≥0.70; immediate evasion upon entering within 15m





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AI-based Autonomous Flight Path Planning on Drones

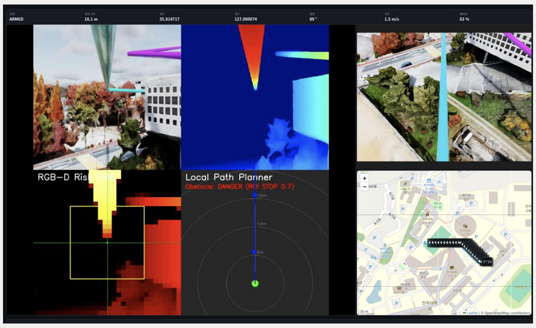
AI based Path Plannning

D* Lite Incremental Replanning

Route replanning when deviating by more than 20m

· 83% computational reduction by reusing previous search data

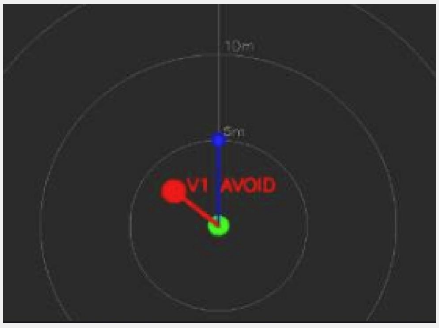
· Re-path generation speed: <14~78ms



VLA based Human Avoidance Learning

SmolVLM-500M + LoRA (Lightweight Edge Inference Optimization)

· Predicts the optimal single avoidance point (V1) in 3D space by learningon 90 human avoidance demonstrations



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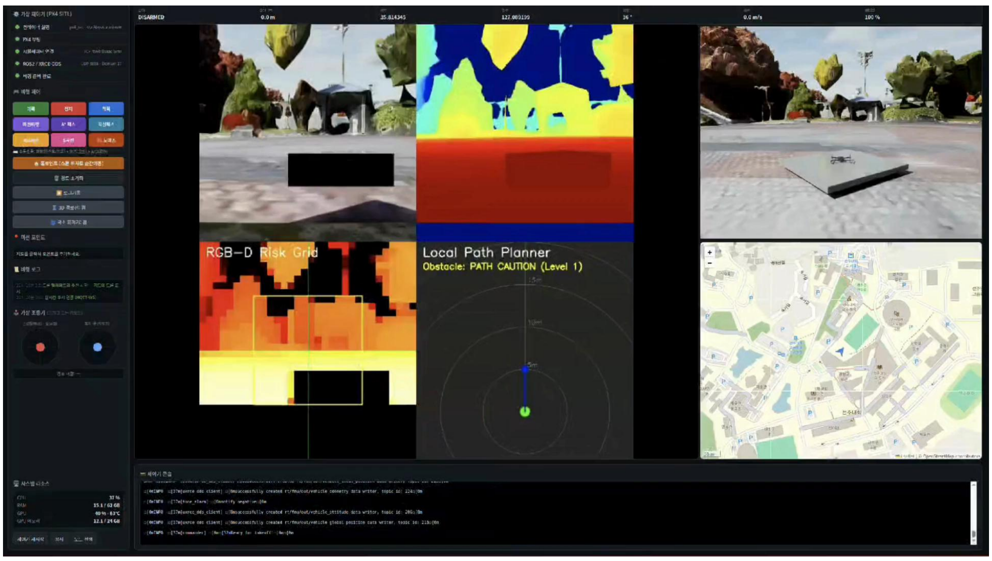
AI-based Autonomous Flight Path Planning on Drones

Demonstration



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Optimization of Advanced RAG System for Aircraft Mechanics

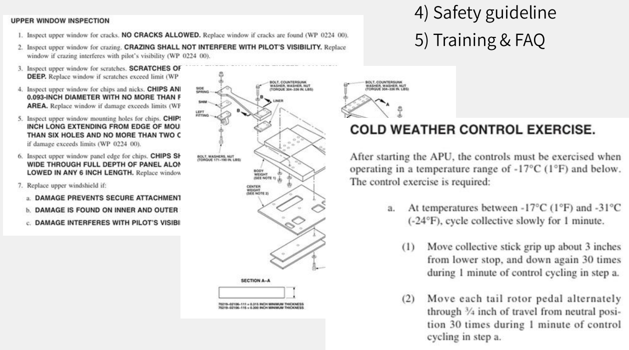
This study implements and validates a RAG-based AI agent capable of real-time question answering on the aircraft maintenance floor, and proposes an optimization approach. A configuration that is open-source, commercially deployable and Korean-capable, with optimized accuracy and response speed, was derived experimentally. As a result, answer accuracy on user queries improved by 20% and response time was cut to roughly 5 seconds, demonstrating the feasibility of an AI agent for aircraft maintenance support.

Research Background

- Aircraft accidents are critical events that cause severe human and material loss
- Accidents arise mainly from pilot or technician inexperience (human error); aircraft maintenance demands a high level of expertise
- A maintenance AI agent can stand in for a veteran technician and help new technicians build proficiency quickly

Aircraft Maintenance Data

1) Maintenance manuals 2) Parts lists & diagrams 3) Diagnostic data 4) Safety guideline 5) Training & FAQ



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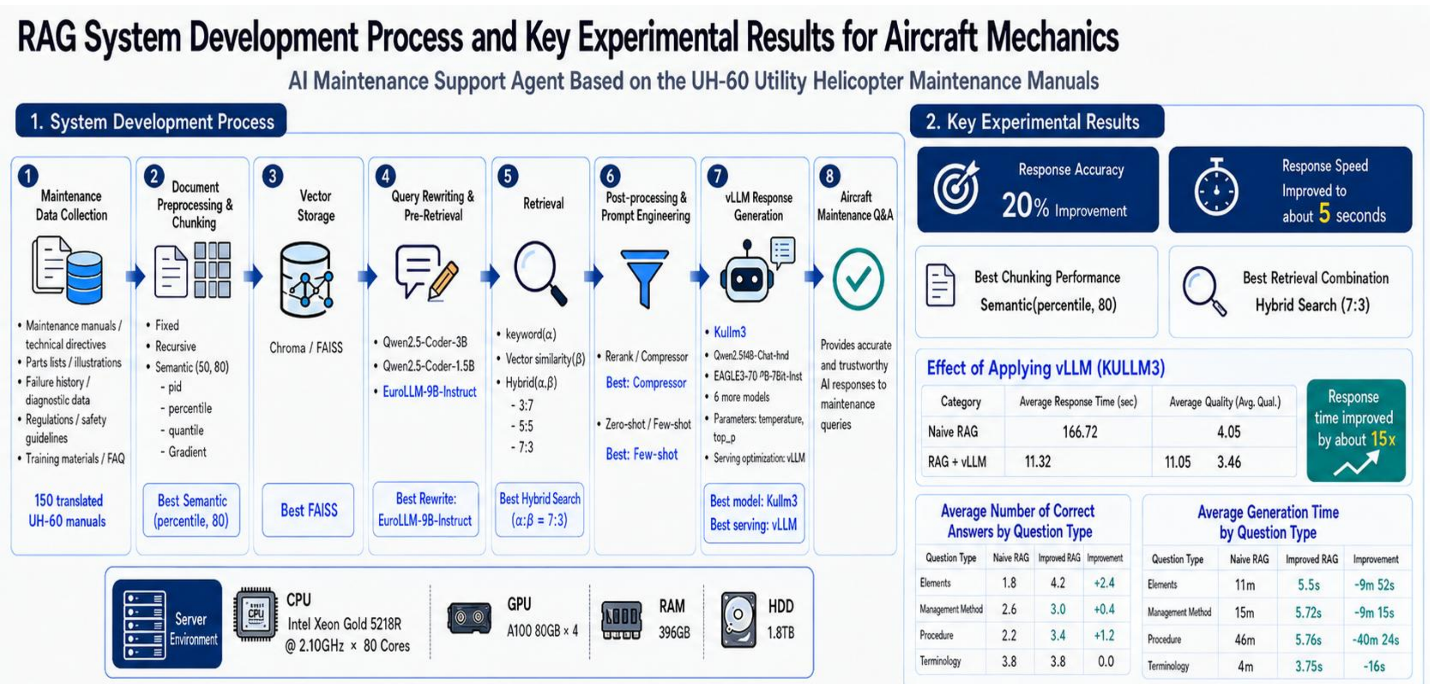

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RISE project

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Tactical Strategy Support AI Agent for Small Unit Commanders

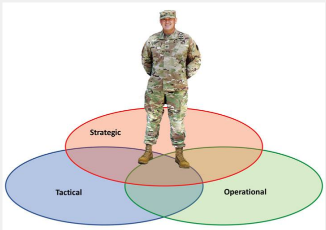
Research on AI agents for Tactical Course of Action (COA) support focuses on empowering small-unit commanders with rapid, data-driven decision-making tools in complex combat environments. Facing extreme time pressure and information overload, small-unit leaders require real-time assistance to evaluate options and maintain a tactical advantage over opposing forces.

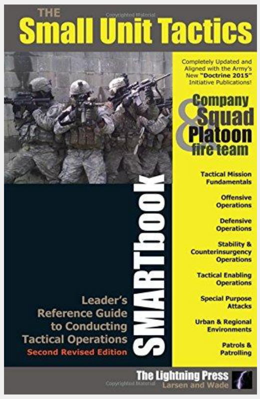
Background

- Data Deluge vs. Cognitive Limits
- Compressed Decision Timelines
- Friction & Fog of War

Key Research Pillars

- Multi-Domain Data Synthesis
- Predictive Risk Assessment
- Automated COA Generation & Evaluation
- Human-in-the-Loop Collaboration





RISE project

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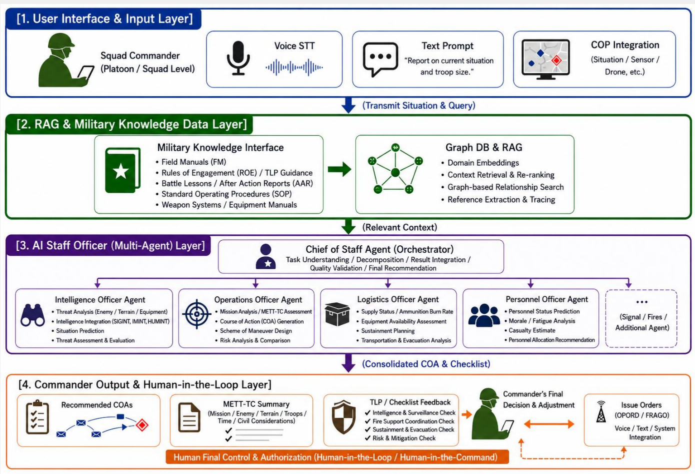
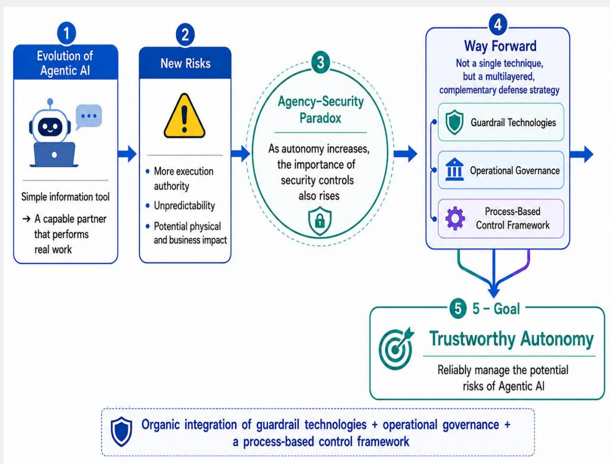
Tactical Strategy Support AI Agent for Small Unit Commanders

System Architecture



Reliable & Secuable Agentic AI



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Building Medical Ontology and Knowledge Graph

This study aims to construct a medical ontology and a Knowledge Graph using LLM to enhance the quality of medical question-and-answer services. By utilizing LLM to identify medical entities and their inter-entity relationships to build the ontology and graph databases, the study seeks to improve search accuracy and response quality for complex medical queries.

Background

- Naive RAG's plain similarity search falls short; complex medical queries need relation-based retrieval and reasoning
- Relations among diseases, symptoms, drugs and treatments are defined in an ontology, making the semantic structure explicit
- LLM-based entity and relation extraction builds a knowledge graph, structuring unstructured medical information
- Combining graph relations and multi-hop traversal with Graph RAG raises retrieval accuracy and reasoning on compound queries

Extract Entity & Relation Types


1. 임상 질환 및 증상 (Clinical Conditions & Pathology)
   - Disease (질환 / 질병)
   - Symptom (환자 자각 증상)
   - Finding (의학적 객관적 소견)
   - Pathogen (병원체 - 세균, 바이러스 등)
   - Etiology (병인 / 발생 원인)
   - Prognosis (예후 / 경과 예측)
2. 치료 및 중재 (Treatments & Interventions)
   - Drug (검증된 정식 의약품)
   - UnverifiedDrug (미검증 / 대체 의약품)
   - Treatment (치료법 / 시술 / 수술)
   - TreatmentOutcome (치료 결과 / 반응)
   - Equipment (의료 기기 및 장비)
3. 진단 및 생체 측정 (Diagnostics & Measurements)
   - DiagnosticTest (진단 검사 - 혈액검사, MRI 등)
   - Measurement (측정 수치 / 생체 지표)

1. 증상, 경과 및 질환 관계 (Symptoms, Disease Progression & Complications
   - has_symptom (증상을 동반함)
   - causes_symptom (증상을 직접 유발함)
   - manifests_symptom (증상으로 발현됨 / 표출됨)
   - causes (질환 / 병인을 직접 유발함)
   - has_complication (합병증을 동반함)
   - comorbid_with (동반 질환 / 동병 관계임)
   - induces_disease (다른 질병을 유도 / 유발함)
   - triggers (발병 / 발작을 촉발함)
   - leads_to (다른 질환 / 상태로 이행됨)
   - contributes_to (발병 / 경과에 요인으로 기여함)
   - co_occurs_with (다른 증상 / 상태와 동시 발생함)
2. 치료, 약물 및 중재 (Treatments, Interventions & Drugs)
   - treated_by (치료법 / 시술 / 수술로 치료됨)
   - treated_with_drug (약물 치료로 경과를 관리함)
   - uses_drug (치료 과정에서 특정 약물을 사용함)
   - relieves_symptom (증상을 완화 / 경감시킴)
   - achieves_outcome (특정 치료 결과 / 임상 목적을 달성함)

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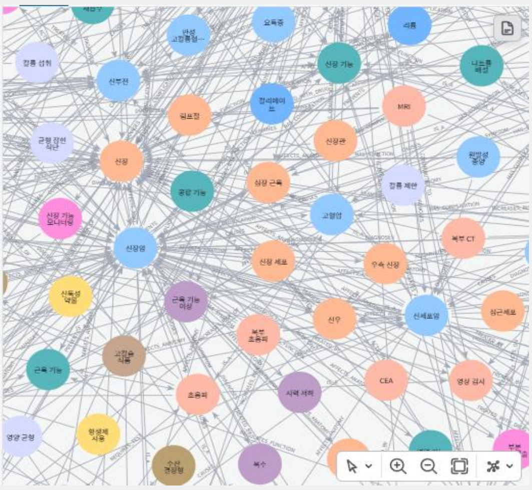
Building Medical Ontology and Knowledge Graph

Constructed knowledge graph




Node details

Drug

Key	Value
<id>	4:3f9cc9ed-a993-4bc0-b414-7e4d855d9bd7:420
aliases	["Ceftriaxone", "ceftriaxone", "ceftriaxone injection", "세프트리아손"]
aliases_text	"Ceftriaxone ceftriaxone ceftriaxone injection 세프트리아손"
chunk_ids	["HC-A-01842905_2", "HC-A-01842913_2", "HC-A-01842989_1", "HC-A-01842989_4", "HC-A-01842989_5", "HC-A-01843011_2", "HC-A-01843054_1", "HC-A-01843054_6... Show all
frequency	26
n_chunks	26
name	"세프트리악손"
note	"영문 표제 중복행 병합"

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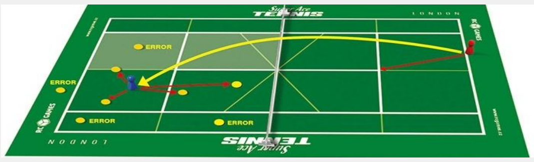
Vision-based Tennis Player Motion Analysis

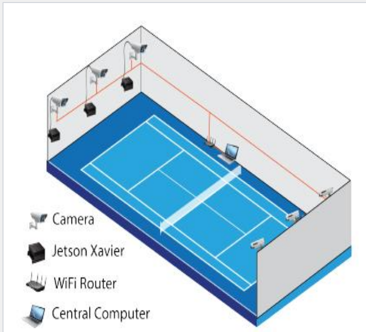
This study reconstructs tennis ball and racket motion in a single 3D coordinate system from synchronized multi-camera video, then combines it with human pose. Detection supplies 2D ball centres and racket regions; timestamps are synchronized and balls matched across views; triangulation with reprojection checks yields the 3D trajectory, while racket keypoints and masks are fused conservatively into a 3D racket direction.

Background

- A tennis ball is small, fast and often motion-blurred, so display must follow detections rather than free prediction
- A single camera cannot recover metric depth reliably, so multi-view geometry is required
- Racket orientation links player movement to ball contact and the resulting trajectory
- Ball tracking and racket pose have to be solved together, in one 3D coordinate system

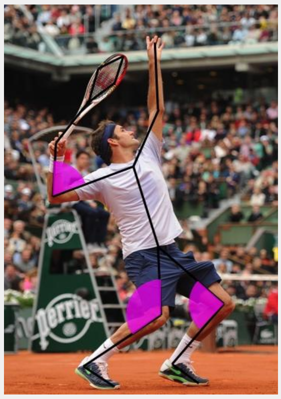


Target System (e.g.)



Multi-camera setup for locating a tennis ball.

Source: Xiao, Zaidi, and Gombolay, ICRA 2024, Fig. 4.



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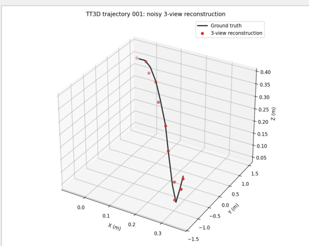
Vision-based Tennis Player Motion Analysis

Core Technologies

3D Ball Recovery

- Predicting the trajectory of a tennis ball based on geometric principles
- Predicting the trajectory of the ball using training data
- Research methods to improve accuracy by combining the two methods above



Racket Movement Analysis

- Additional Annotation and Leaning to analyze Racket Face Movement
- Analyze Racket Movement in conjunction with Key Points of the Body and Hand
- Research on more accurate exercise postures, including rackets

Multi-Camera Fusion

- Time/Spatial Synchronization & Calibration among Images from Multi-cameras
- Reconstructing Precise 3D Trajectories and Racket Direction in 3D space through Triangulation using Multi-view Geometry

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Vision-based Tennis Player Motion Analysis

Demonstration

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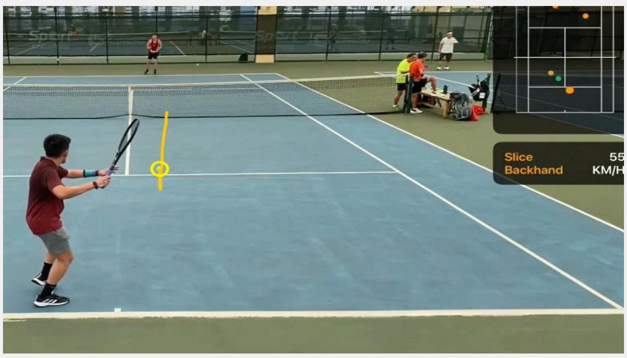
Tennis IN/OUT Landing Judgment

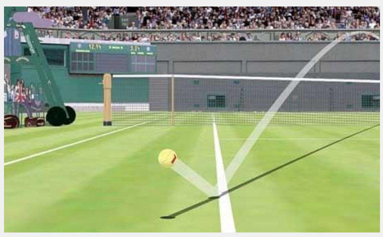
This project reuses Good-Tennis native outputs to build a conservative decision and visualization pipeline: native bounce, court mapping, IN/OUT call, then a synchronized left video and minimap. Native landing events and a homography to court coordinates drive every decision, and both views read the same authoritative event table so they can never disagree.

Background



Core Technologies

- High-Speed Multi-Camera Synchronization
- Court Area Calibration for Images from Multiple Cameras
- Ball Detection & 3D Trajectory Restoration
- Ball Bounce Point Detection and Ball Deformation (Compression) Physical Modeling



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Video Captioning

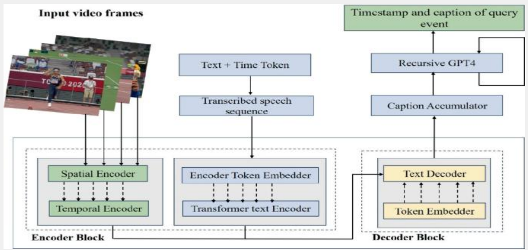
The Video Captioning (VC) combines temporal event localization with natural language generation for untrimmed videos. Unlike standard video captioning that yields a single summary, VC outputs a set of temporal segments with textual descriptions. This research investigates its technical evolution to model complex multi-event video narratives effectively.

Background

- Explosive increase in video contents (e.g. YouTube)
- A lot of time spent watching and understanding video contents
- Needed for situational assessment through streaming video, such as in surveillance and reconnaissance

Core Technologies

- Event Proposal & Localization in video
- Inter-Event Context Modeling
- Multimodal Data Fusion – Images, Audio, etc.
- Redundancy & Length Control



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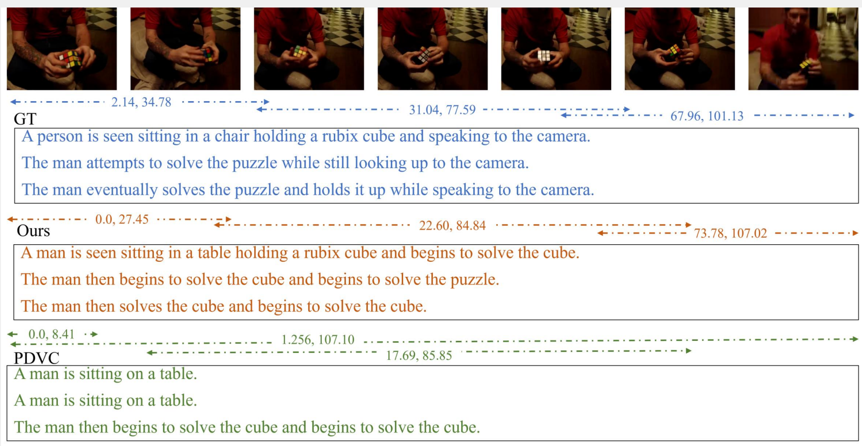
Video Captioning

Experimental Results



- PDVC repeats 'sitting on a table' and only mentions the core object, 'cube' in the last sentence.
- In contrast, our method identifies the rubix cube in the first sentence.
  - As time progresses, the process of 'begins to solve' → 'solves the cube' is revealed, making the temporal logic more complete.In the surfing example, while PDVC exhibits grammatical errors like 'beach beach' and the illusion of static description, this method captures dynamic elements such as large waves and riding along the water.

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Thank you for your attention

Q & A