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SD Association Student Project Competition 2025

The following 21 abstracts were submitted by students for the competition. All of the students attend universities that are ranked by Shanghai Ranking among the first 150 best in the world in Engineering (Electrical/ Computer).

(Ordered alphabetically by university name)

1	**Adaptive Path Learning and Optimization for Autonomous Racing** By: Cheung Yi Hing, Lok Yin Fung and Law Chi Chung Supervisor: Prof. Woo Kam Tim Hong Kong University of Science and Technology
	Abstract: This project proposes an adaptive driving system for autonomous miniature race cars, focusing on real-time performance optimization through first-lap mapping, enabled by SD Express technology. The system first trains a base model using behavioral cloning from data logged during remote-controlled driving from professional driver; the microSD Express card's high write speed is essential for capturing the high-frequency image and control data required. This base model handles standard track elements. During competition, the system uses the first lap to autonomously generate a map or representation of the specific track layout, saving this rapidly to the SD Express card. In subsequent laps, the system leverages the card's high read speed and low latency to access this map in real-time. This lookahead capability allows the driving algorithm to optimize performance—adjusting speed profiles, braking points, and turn-in angles based on the known upcoming track sequence—aiming for significantly faster lap times compared to the initial lap. The project demonstrates a novel use of SD Express for dynamic, on-device adaptation and optimization in high-speed autonomous control scenarios.
2	**AI Instant Photo Booth** By: Cheung King Sum Supervisor: Prof. Woo Kam Tim Hong Kong University of Science and Technology
	Abstract: This project shows the creation of a portable photo booth that offers convenient and interactive drawing experiences. Inspired by traditional photo booths, the aim is to design a portable system with AI enhancement. The system integrates a webcam for image capture, microSD Express for high-speed storage and retrieval, and Jetson Nano Orin as the AI processing module. Key features of this system include the ability to apply artistic enhancements in real-time by embedding a pre-trained model, transforming raw photos into stylized images and printing them out instantly.
3	**AquaTech SDX: High-Speed Underwater Robotics with microSD Express** By: Wong Chin Ching Supervisor: Prof. Woo Kam Tim Hong Kong University of Science and Technology

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	Abstract: The advancement of marine robotics has created unprecedented opportunities in scientific research, industrial inspection, and environmental conservation. Modern Remotely Operated Vehicles (ROVs) are expected to perform increasingly complex missions—ranging from coral reef surveys and fishery monitoring to offshore oil platform inspections and subsea cable maintenance. These missions demand the continuous collection of high-quality video and sensor data. A persistent challenge in such systems is the data bottleneck caused by conventional storage. Legacy UHS-I microSD cards, with typical sustained write speeds under 100 MB/s, cannot keep pace with multi-stream HD video capture and sensor logging. As a result, ROV operators often experience dropped frames, delayed analytics, and reduced efficiency. In addition, onboard AI systems that depend on high-throughput data access for real-time inference are hindered by slow storage, limiting autonomy. The AquaTech SDX project, developed on the HKUST Robotics Team's AquaTech platform, addresses this bottleneck by exploring the adoption of microSD Express memory cards. Built upon PCIe/NVMe architecture, microSD Express technology provides sequential write speeds of ~880–890 MB/s and significantly reduced access latency. This represents nearly a tenfold improvement compared to UHS-I cards. Such capability opens the door to continuous, high-fidelity recording and rapid AI-driven decision-making in subsea environments. The motivation of this work is therefore twofold: 1. Demonstrate a conceptual integration of microSD Express into an underwater robotic platform. 2. Provide a scalable blueprint for next-generation marine systems that require reliable, high-speed storage to support autonomy and real-time operation.
4	**EcoGuard** By: Chueng Man Ching Supervisor: Prof. Woo Kam Tim Hong Kong University of Science and Technology
	Abstract: EcoGuard is a modular edge AI system designed for real-time wildlife sound monitoring and anti-poaching. It leverages the high-speed capabilities of microSD Express memory cards to enable flexible, species-targeted conservation efforts. The system adopts a unique *"one card, one species"* architecture, where each microSD Express card stores a pre-trained AI model for detecting specific species, such as birds, amphibians, alongside a mandatory anti-poaching module to identify threats like gunshots or chainsaws. This modular design allows field researchers to swap target species in seconds by simply switching microSD Express cards, for example, from a "bird detection card" to a "frog detection card", eliminating complex firmware updates and enabling dynamic adaptation of monitoring focus. This report uses a bird call recognition model as a primary example to demonstrate the system's operation and the pivotal role of microSD Express technology.
5	**Localization with LIDAR (Robotics Related Project)** By: Siu Ming Fung, Wu Haoran and Ho Chun Ying Supervisor: Prof. Woo Kam Tim Hong Kong University of Science and Technology

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	Abstract: This project develops an autonomous indoor navigation system using the NVIDIA Jetson Nano Super, leveraging LiDAR-based simultaneous localization and mapping (SLAM) for precise localization in complex environments. The system integrates a low-cost LIDAR sensor to generate 3D maps and localize the robot, with data stored on a high-speed microSD Express card for efficient processing. The Jetson Nano Super's 70 TOPS AI compute capability enables real-time processing of LiDAR point clouds, enhanced by ROS (Robot Operating System) for robust navigation algorithms. The project aims to create a cost-effective, scalable solution for indoor robotics, applicable in warehouses, hospitals, or homes, where GPS is unreliable. The timeline spans six months, with milestones for hardware integration, software development, testing, and documentation.
6	**Synthetic Data Generation for Enhanced Robot Manipulation Performance** By: Lo Hiu Ching and Huang Haolun Supervisor: Prof. Woo Kam Tim Hong Kong University of Science and Technology
	Abstract: This project investigates a synthetic-data-driven pipeline to enhance robot manipulation for automated recycling. We generate photorealistic and procedurally varied datasets using Blender to train object-detection and instance-segmentation models that recognize common recyclables under diverse lighting, occlusion, and pose conditions. The trained models are deployed on a robotic system comprising a RealSense D435i depth camera and a RoArm-M1gripper controlled by an ESP32, coordinated via ROS 2. A microSD Express card serves as the unified high-speed storage layer for large synthetic datasets and serialized model artifacts, enabling rapid iteration and reliable field deployment with minimal cabling. The approach aims to reduce data collection cost and time while improving robustness to domain shifts typical of recycling streams. By August 2025, we have anticipated a system capable of accurate recyclable identification and manipulation, accompanied by an evaluative report and a demonstration video.
7	**AI-Powered Edge Storage for Smart Cameras Using microSD Express** **Toward Smarter, Safer Crosswalks** By: Michael Patrini Supervisor: Prof. Stefano Bregni Politecnico di Milano **Third Place Winner**
	Abstract: Urban mobility presents significant challenges for visually impaired people, particularly when crossing signalized pedestrian intersections. Ensuring safety and autonomy in these situations is crucial, and recent advances in computer vision and artificial intelligence enable the development of portable solutions capable of assisting users in real time. This work combines an AI-based detection system with modern storage technology to demonstrate how microSD Express can effectively support edge applications that demand both intensive computation and efficient data handling, and optimized power consumption, while simultaneously providing assistance to visually impaired people in safely crossing pedestrian

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	intersections, thereby reducing risks and promoting greater autonomy in everyday urban contexts. The system provides real-time voice feedback to the user, announcing the traffic light status and the proximity to crosswalks, without requiring manual interaction. In parallel, a separate benchmarking campaign compared SD Express, microSDXC1, and M.2 SSD2 devices to evaluate storage performance and energy efficiency in edge AI workloads. The solution is completely stand-alone: it requires only a Jetson Orin Nano, a camera, and headphones, without needing dedicated infrastructure or modifications to traffic lights.
8	**CopenCluster – An advanced Video Streaming/Recognition & Telemetry Focused Digital Car Dashboard** By: Alessandro Marchioro Supervisor: Prof. Stefano Bregni Politecnico di Milano
	Abstract: The CopenCluster project started at the beginning of 2025 from the idea of developing a sort of resto-mod of a car of mine, a Daihatsu Copen, which is a Japanese-regulated Kei-Car, from both the point of view of raw street performance but also, and for the most part, from a hardware and software perspective, due to it being very low on that side of things. The initial conception was to build a 1:1 replica of the original car analogic cluster, reinterpreted digitally, in order to make it seem more futuristic and have nice touches that the original car doesn't have; one example is the low level fuel gauge and icon which is strangely absent in the original car cluster.
9	**Smart Lecture Companion** By: Andrea Torti Supervisor: Prof. Stefano Bregni Politecnico di Milano
	Abstract: The Smart Lecture Companion transforms passive learning materials—video lectures and PDF slides—into an interactive, searchable knowledge base via a Retrieval-Augmented Generation (RAG) pipeline on an NVIDIA Jetson Orin Nano. This submission highlights the critical role of a microSD Express card in enabling high-performance AI/ML operations on an embedded platform. This project implements a full-stack RAG system designed for embedded hardware. It features a user-friendly web interface for file uploads and chat, alongside a powerful backend that processes multimedia files, builds a vector knowledge base, and serves a local LLM. The entire pipeline is designed to run offline, ensuring data privacy and accessibility.
10	**EmberEye - System for Real-Time Detection of Wildfires** By: Itay Hovav and Roy Cohen Supervisor: Harel Yadid Technion – Israel Institute of Technology **Second Place Winners**

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	Abstract: Due to climate change, the world continues to experience wildfires that are often not detected in time. Many existing solutions are bulky, expensive, or impractical, leaving us with the growing problem of small, manageable fires turning into large-scale disasters. Some of the approaches today are human watchtowers, which are labor-intensive and inefficient yet still in use, and satellites, which are weather-dependent and unable to detect small fires early enough. Our approach is to use edge devices for scalable and affordable wildfire detection. They are more practical than human sentinels and operate closer to the ground than satellites, giving them the ability to spot small fires as they begin. However, edge devices come with limitations: restricted RAM, modest CPU power, and slower memory. Running AI models on such hardware requires not only computational efficiency but also fast, sustained read/write performance to handle video streams and logging in real time. In this project, we demonstrate how microSD Express storage, combined with carefully selected AI models, can overcome these limitations and enable reliable, real-time wildfire detection.
11	**Remote PPG-based Vital Signs Monitoring (microSD Express-Enabled Remote PPG for 1440p Uncompressed Capture on Jetson Orin Nano)** By: Shira Barmats and Shakedd Levi Supervisor: Yair Moshe Technion – Israel Institute of Technology **First Place Winners**
	Abstract: We present a dual-mode system for contactless vital-sign monitoring from 1440p facial video using remote photoplethysmography (rPPG). Running on an NVIDIA Jetson Orin Nano Super Developer Kit, our prototype records the uncompressed stream to a microSD Express card while simultaneously executing a downscaled, low-latency pipeline for live feedback. microSD Express over PCIe/NVMe allows sustained 30 fps uncompressed 1440p capture, where legacy microSD solutions struggle to sustain comparable bandwidth, making high-fidelity offline analysis practical. On a 10-recording dataset against a Polar Verity Sense reference, our system achieved 8.3 bpm MAE in real-time and 6.6 bpm MAE offline, reflecting the accuracy gains unlocked by preserving uncompressed 1440p video for post-capture processing. By quantifying I/O throughput and end-to-end performance, and demonstrating a functioning system, we show that microSD Express is a key enabler for edge vision workloads in consumer telehealth and wellness applications.
12	**Watch Over System for Elderly Person In His Home** By: Jenan Nassar and Reem Dallasheh Supervisor: Harel Yadid Technion – Israel Institute of Technology
	Abstract: Falls are among the leading causes of injury for elderly individuals living alone, often resulting in severe medical complications if not addressed promptly. Early detection is therefore crucial, as it enables immediate intervention and can significantly reduce associated risks. This project introduces a cost-effective, real-time fall detection system built on the NVIDIA Jetson Orin Nano platform, utilizing a standard camera alongside a high-speed microSD Express card for storage and buffering. The system implements a rule-based detection strategy,

	leveraging skeleton extraction from the YOLO11s-pose model, which is optimized using TensorRT for accelerated inference. From each extracted skeleton, four key indicators are computed: torso angle, head–hip distance, hip velocity, and bounding-box aspect ratio. These metrics are integrated into a weighted decision rule to reliably identify fall events. While the full implementation of anonymization and automated alert notifications was beyond this project's scope, the completed real-time detection pipeline, together with the evaluation of SD Express performance, provides a strong foundation for future enhancements.
13	**EdgeWear** By: Seo Bin Han and Luuanne Chau Supervisor: Zhaodan Kong, PhD University of California Davis
	Abstract: The global wearable technology market is rapidly expanding, projected to reach USD 84.2 billion in 2024 and grow at a CAGR of 13.6% through 2030. Consumer adoption is driven by rising health awareness and the demand for personalized, preventive care. At the same time, fatigue-related injuries represent a pressing health and occupational challenge: musculoskeletal discomfort affects over 60% of college students, esports players face cumulative neuromuscular strain, and in high-risk professions such as firefighting, overexertion accounts for more than half of all reported injuries and fatalities. Current wearable devices provide activity tracking and basic biometrics, but lack edge-computing solutions that can detect fatigue and intervene in real time. Recent research demonstrates that combining electromyography (EMG) with inertial measurement unit (IMU) data significantly improves fatigue classification compared to unimodal systems, while emerging multimodal wearables validate the feasibility of simultaneously capturing EMG, ECG, and electrodermal activity with lab-grade fidelity. However, these systems often remain confined to laboratory settings, with limited integration into consumer-ready devices. Our project, EdgeWear, directly addresses this gap by developing a multimodal fatigue prevention wearable built around EMG and IMU sensing, with future integration of ECG. Leveraging microSD Express for high-speed, lossless logging, EdgeWear enables real-time analysis and actionable feedback. Positioned at the intersection of wearable technology, edge computing, and preventive health, our system introduces a new consumer category: multimodal fatigue monitoring with applications spanning student health, esports performance, and frontline occupational safety.
14	**Isolated Low-Current Measurement & microSD Express Data Logging on Jetson Orin Nano** By: Irwin Lopez, Vinny Fang Supervisor: Eric Prebys University of California Davis
	Abstract: We explore how a Jetson Orin Nano–based measurement stack can digitize ultra-low currents while logging directly to microSD Express (PCIe/NVMe). Building on a logarithmic-amplifier front end with galvanic isolation, we route the conditioned signal into the host for digital readout and apply 16-bit SPI digital potentiometers to trim gain and offset without rework. Although we could not explore every Nano feature end-to-end, we obtained a stable

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	digital-value path and improved effective resolution due to isolation and careful calibration. With microSD Express as the logging target, we observed smooth, low-jitter data capture suitable for on-device analysis and future ML workflows. Results indicate that SD Express provides a compact, removable, high-throughput store for long captures in embedded test systems, while the isolated log-amp chain preserves fidelity across decades of current.
15	**Age Classification System Based on Speech Signal and microSD Express Storage** (WITHDRAWN) ITT Mumbai, Department of Electrical Engineering
16	**Edge-Based High-Resolution 3D Human Avatar** (WITHDRAWN) ITT Mumbai, Department of Electrical Engineering
17	**EdgeEmbed: Accelerating on-Device Embedding with SD Express** (WITHDRAWN) ITT Mumbai, Department of Electrical Engineering
18	**Hawkeye Go** (WITHDRAWN) ITT Mumbai, Department of Electrical Engineering
19	**High Frequency Imitation Learning Platform for Autonomous RC Car using Jetson Orin Nano and SD Express** (WITHDRAWN) University of California Davis
20	**Live ASL Translator** WITHDRAWN) University of California Davis
21	**SwinTwin (Swimmer Technique Improvement Device)** (WITHDRAWN) University of California Davis