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Portfolio

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AstairoPets Robot Hardware and Visual Perception

Robotics Engineering Internship, Jul–Oct 2026

Robot Hardware Architecture

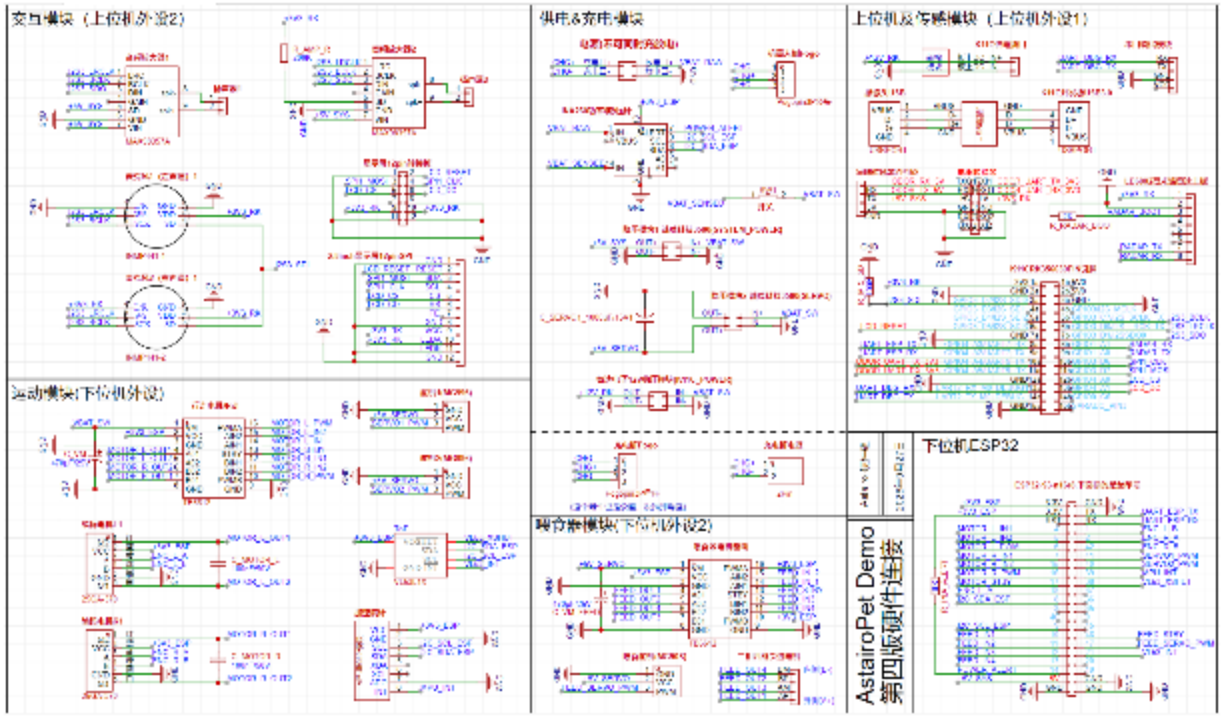
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Robot prototype photo

- Designed an RK3566 host and ESP32-S3 controller architecture for the pet companion robot.
- Allocated interfaces for sensing, wheel drive, pan-tilt motion, feeding and audio interaction.
- Produced four revisions of component selection, schematics and connection documentation.

Whole-robot photograph can be inserted here

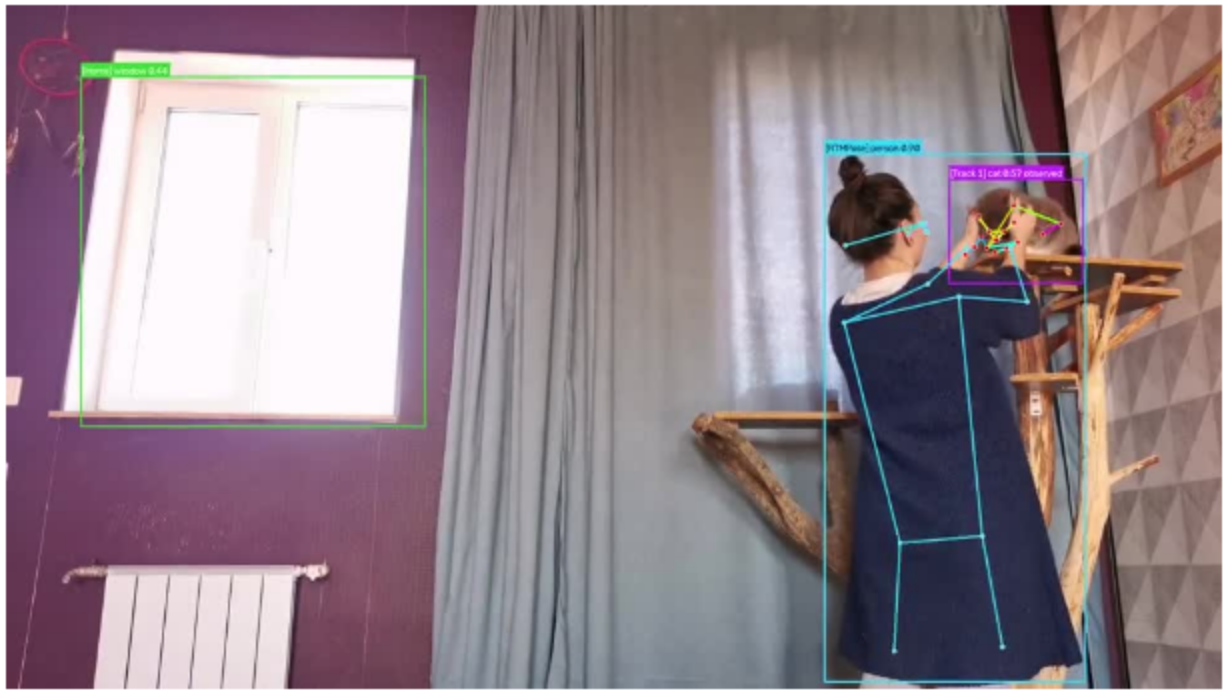
Power and Interface Design



Fourth-revision system schematic

- Separated the 5 V system and actuator supplies, with regulated 12 V power for the host.
- Specified current monitoring, local decoupling and signal connections for each module.
- Reassigned the display reset pin to free a UART and added 3.3 V/5 V translation for odor sensing.

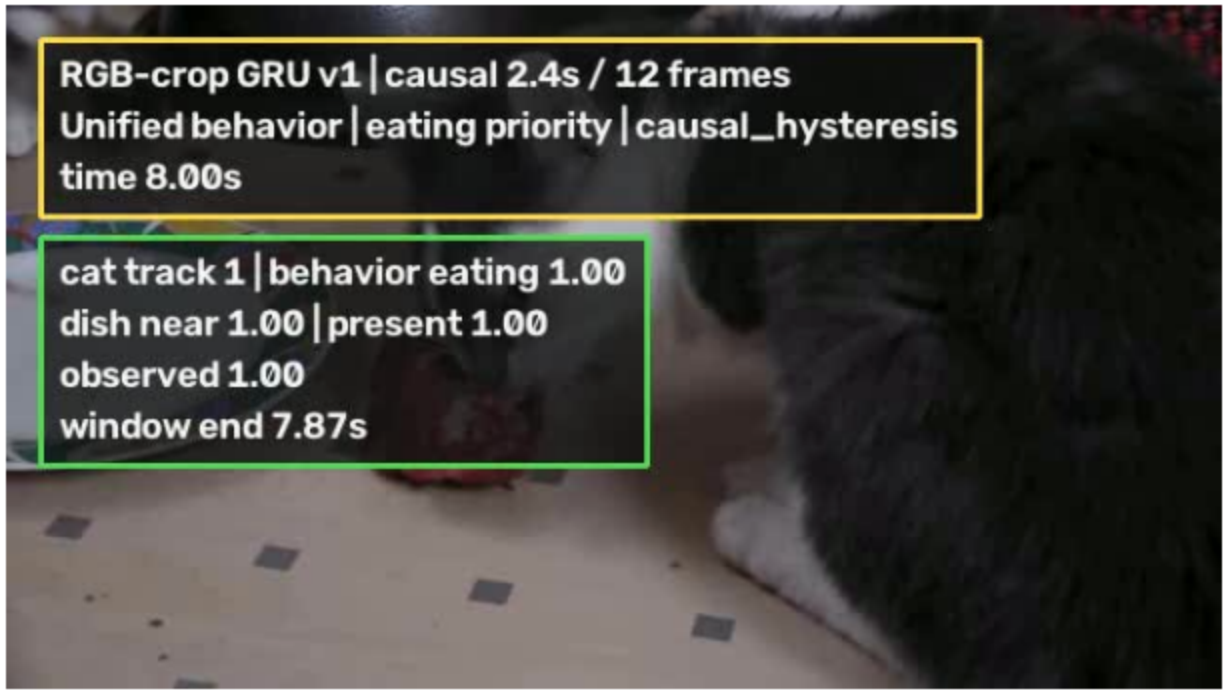
Unified Visual Perception



Recorded development demo with human and pet pose overlays

- Integrated scene detection, 20-keypoint cat/dog pose and RTMPose human pose in one video pipeline.
- Assigned each detection type to one output branch and maintained stable pet track IDs.
- Published raw predictions, smoothed tracks and behavior results as structured JSON.

Multi-Model Behavior Decisions



Earlier eating-rule demo using a 2.4 s RGB window

- Combined RGB-GRU and Pose-GRU evidence over aligned two-second causal windows.
- Used nearby dish evidence and hysteresis to stabilize eating decisions.
- Resolved static/temporal conflicts with confidence rules while retaining source scores and selection reasons.

Model Selection and Deployment

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Static classifier comparison

Architecture	Params	Accuracy
ResNet-18	11.18 M	78.55%
EfficientNet-B0	4.02 M	83.04%
MobileNet-V3	**4.21 M**	**82.70%**

Seven-class development accuracy after exact-image duplicate removal

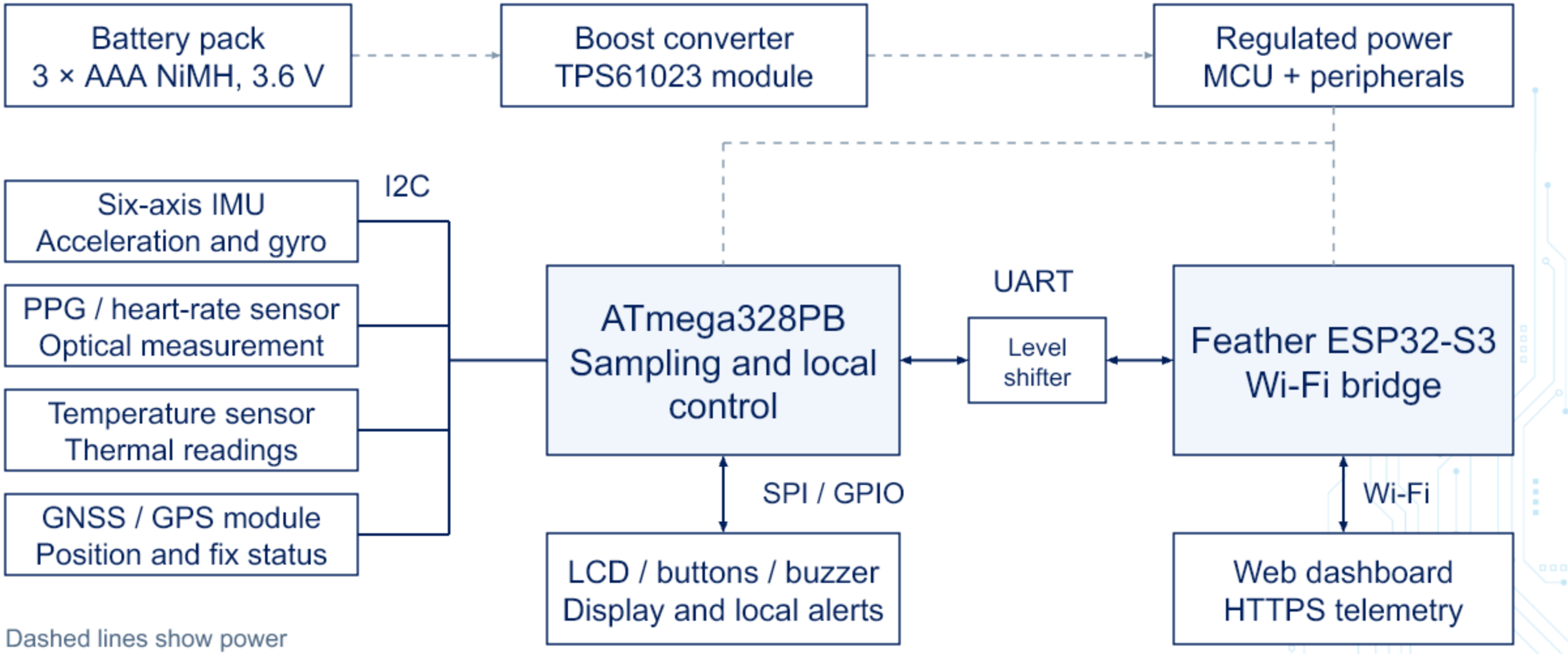
- Compared six static architectures and selected MobileNet-V3-Large for the accuracy/compute tradeoff.
- Validated FP16 RKNN conversion against ONNX on 104 real inputs in server simulation.
- Built versioned Linux releases with dependency locks, integrity checks and rollback support.

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Paw Pulse
Embedded Pet Monitoring

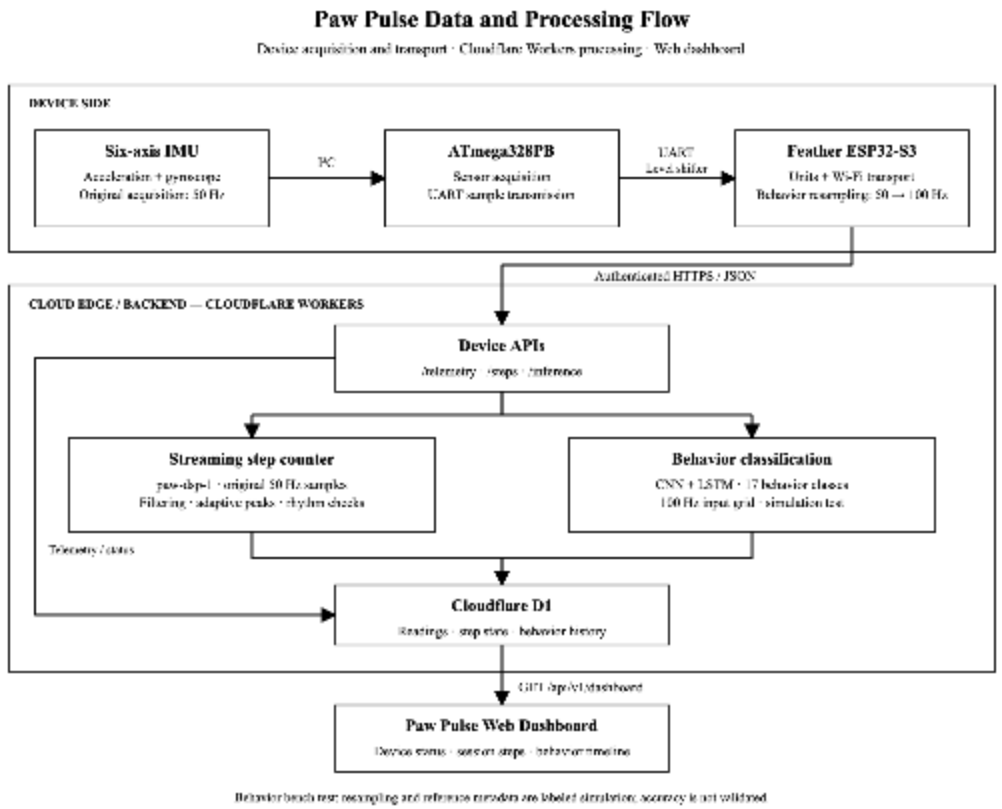
University of Pennsylvania, ESE 5190, Fall 2026

Hardware Architecture and Plan



Module assembly with wired connections. Local acquisition and alerts stay independent of Wi-Fi.

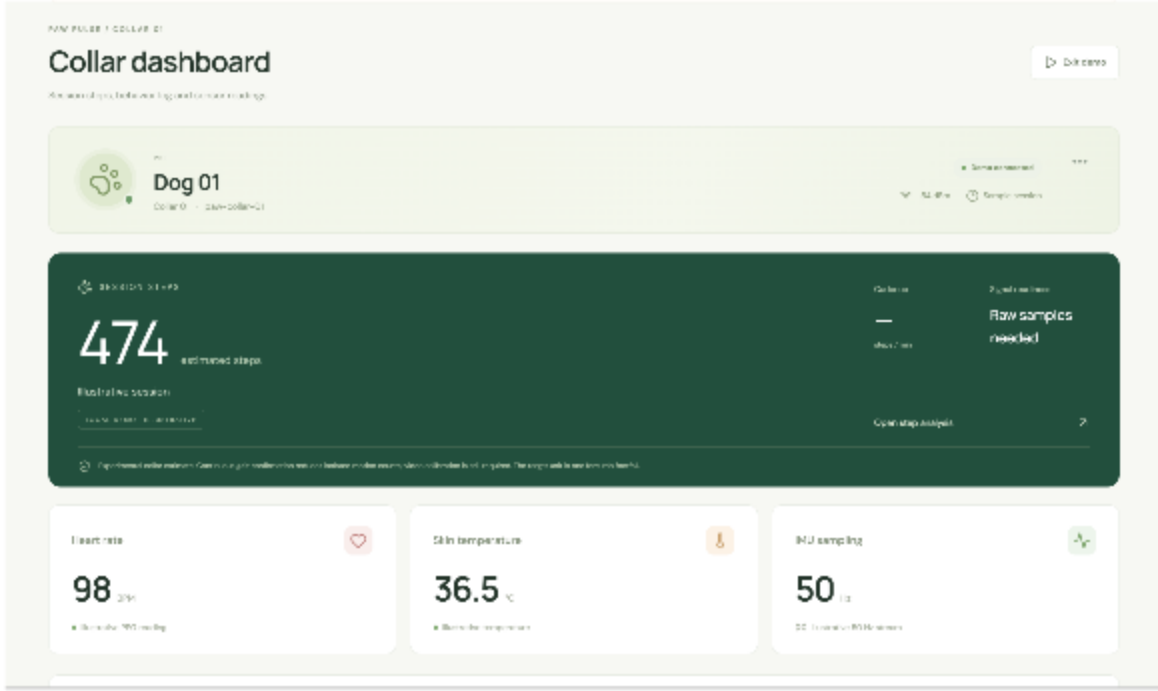
Embedded Acquisition and Transport



IMU acquisition, wireless transport and cloud processing

- Built a modular ATmega328PB and ESP32 path for six-axis motion acquisition and wireless reporting.
- Configured timer-driven 50 Hz sampling and nonblocking UART transmission with CRC and sequence checks.
- Kept acquisition independent of HTTPS uploads using buffering and explicit gap handling.

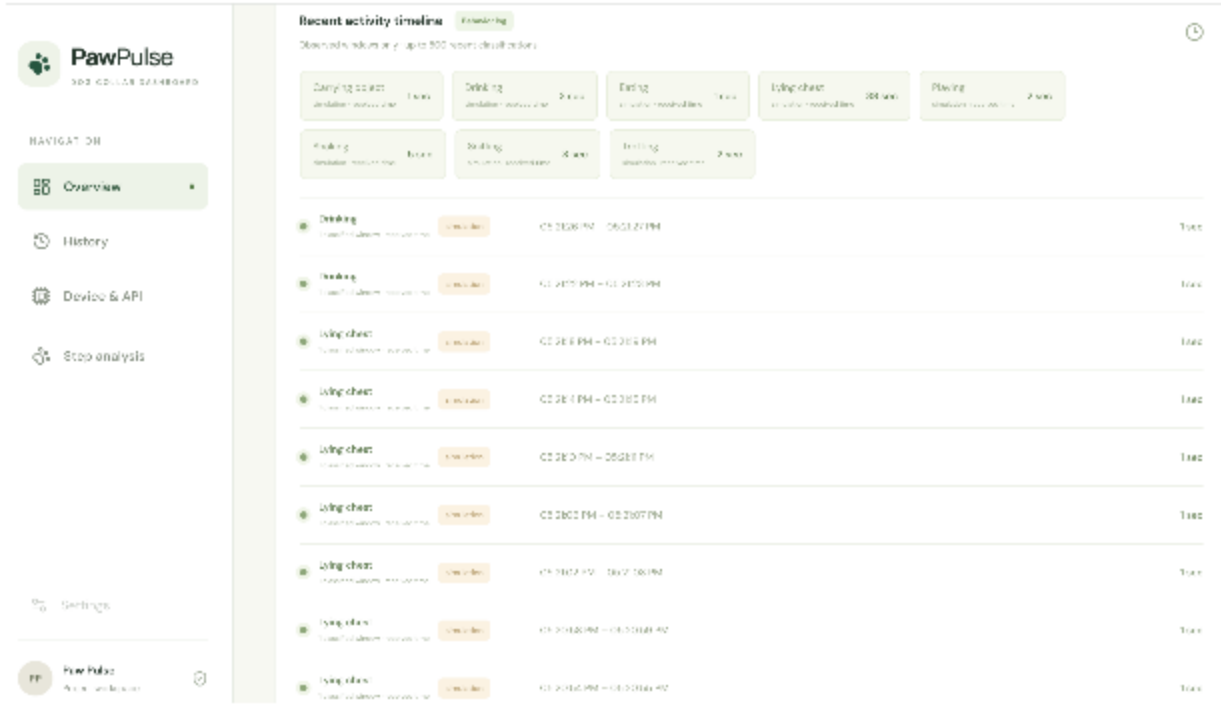
Streaming Step Estimation



Interactive dashboard demo with illustrative values

- Estimated gravity direction and filtered dynamic acceleration with adaptive amplitude thresholds.
- Confirmed rhythmic motion before counting and rejected large impacts or rapid rotation.
- Preserved state across batches and handled duplicate uploads and missing samples explicitly.

Behavior Model and Dashboard



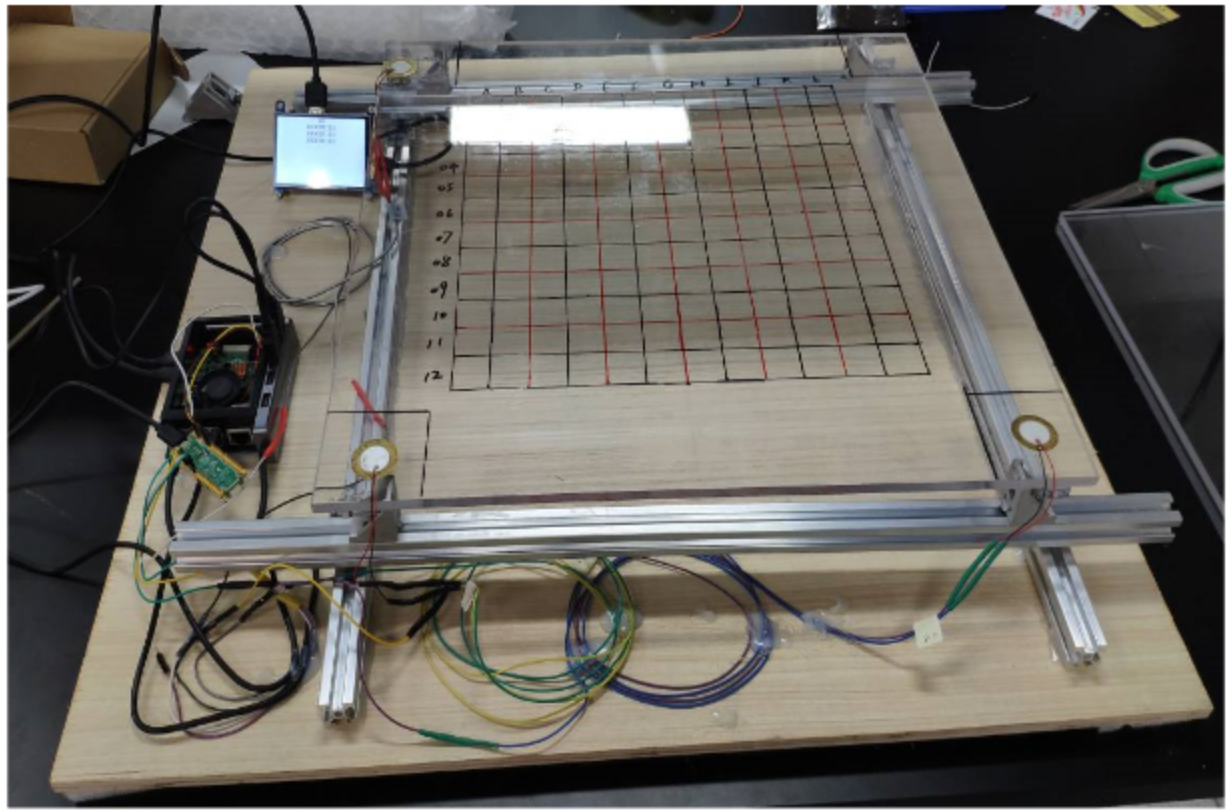
Simulation-labeled behavior timeline and stored observation windows

- Integrated a pretrained 17-class CNN–LSTM through a dependency-free JavaScript runtime.
- Matched an independent NumPy reference within 2.44×10^{-7} probability difference on three synthetic windows.
- Stored telemetry and timed behavior windows in D1 with authenticated APIs and CSV export.

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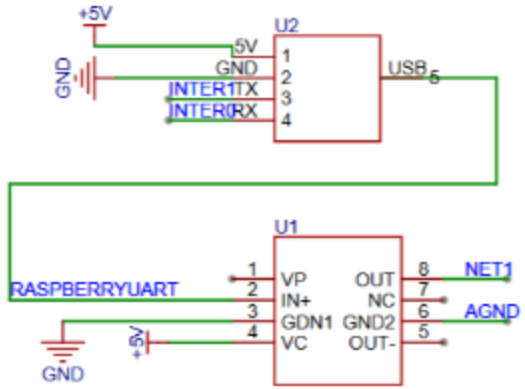
Ultrasonic Sound Localization in Solid Media

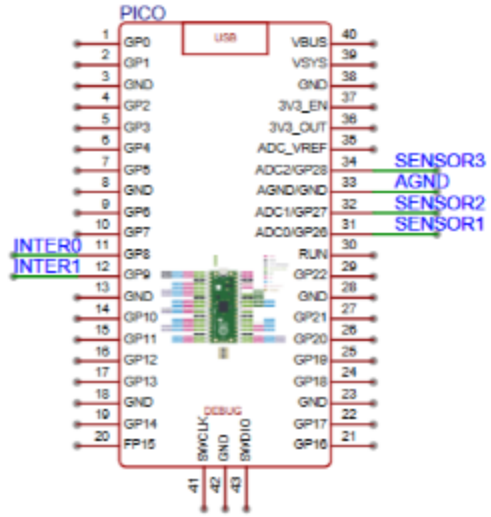
System Structure

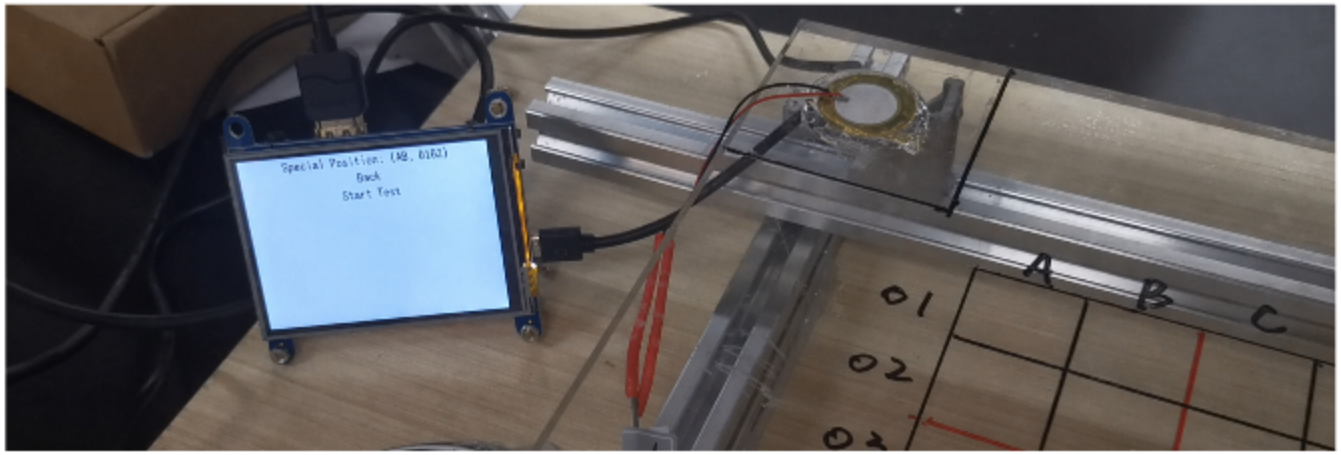


- Built an ultrasonic localization prototype on an acrylic board with PZT sensors mounted at the edges.
- The system detects location of knocking event happened on the acrylic board.

Circuit Schematic







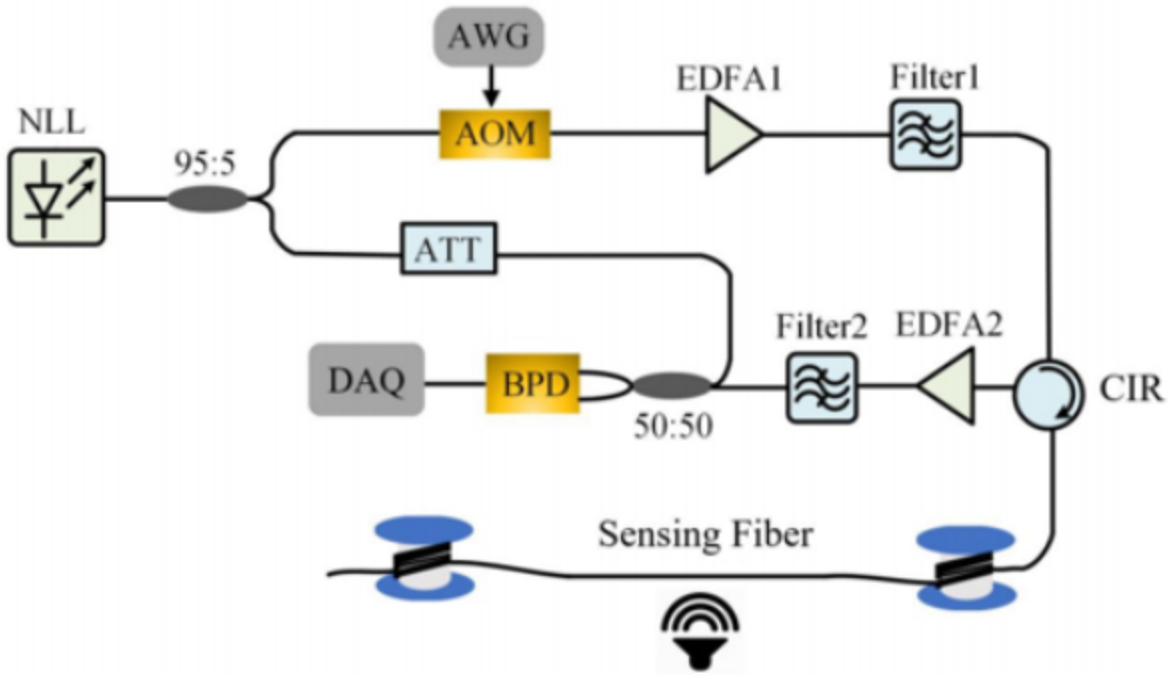
- Applied Raspberry Pi as controller of the system, and Raspberry Pi PICO as ADC/DAC interface.
- Developed geometry-based and MLP-based localization methods for impact position classification.

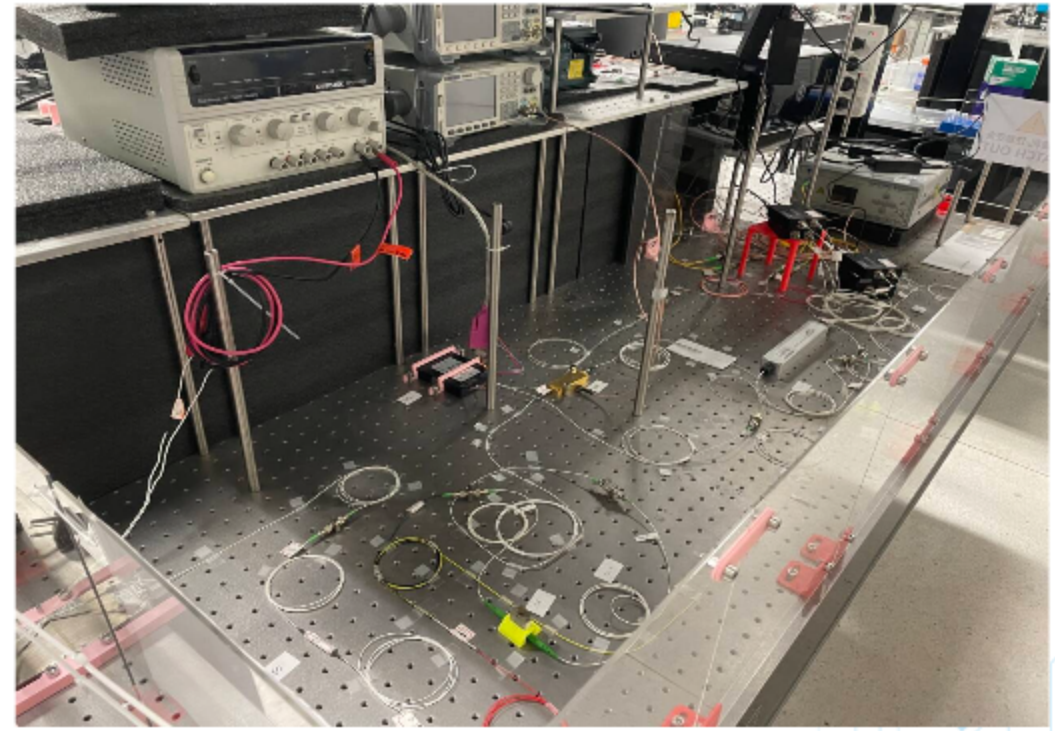


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Dynamic Event Recognition in Acoustic Sensing

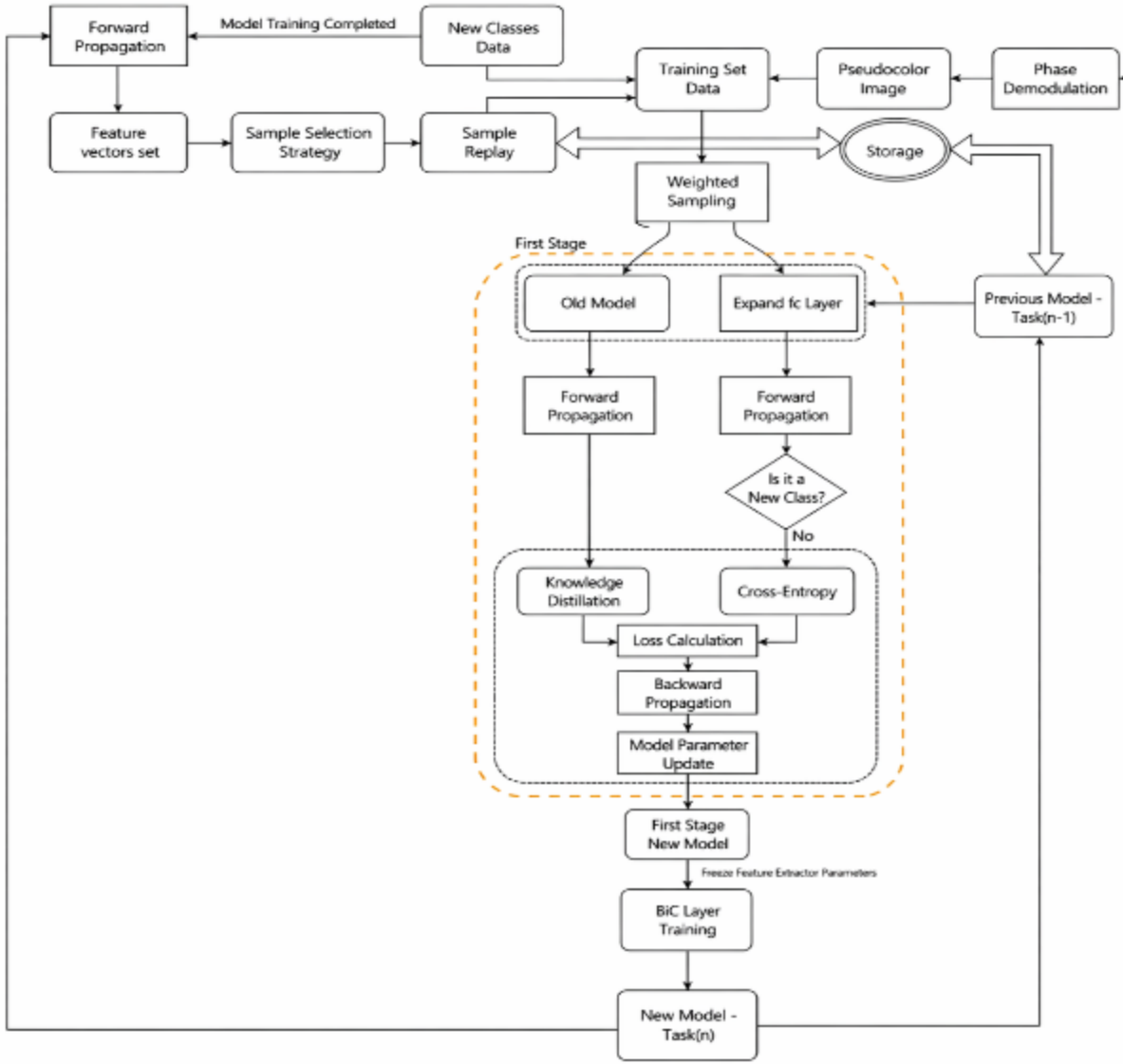
Sensing System Structure





- Used backscattered signal in the fiber as detection signal
- Applied heterodyne detection for phase demodulation of the back scattered signal, then used phase to extract acoustic features.

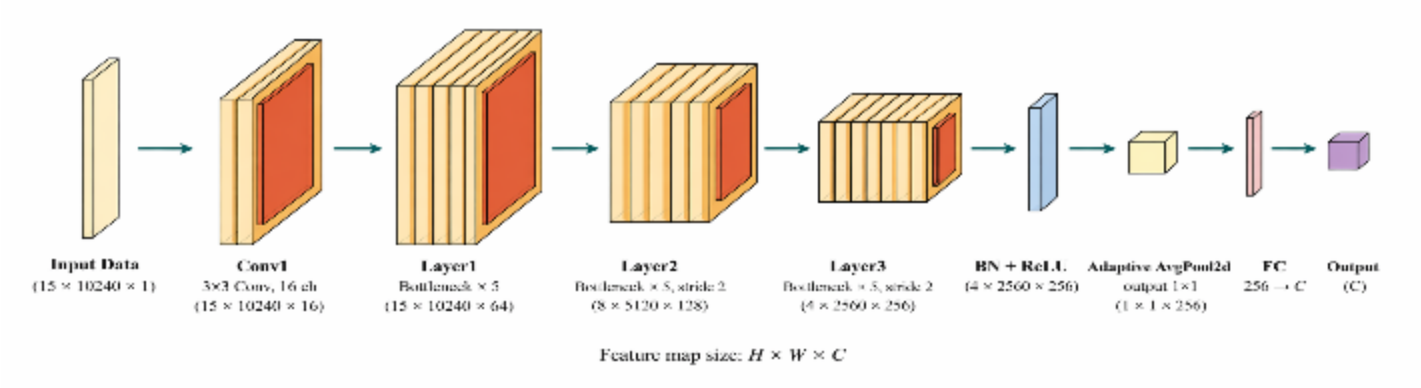
Sequential Training and Model



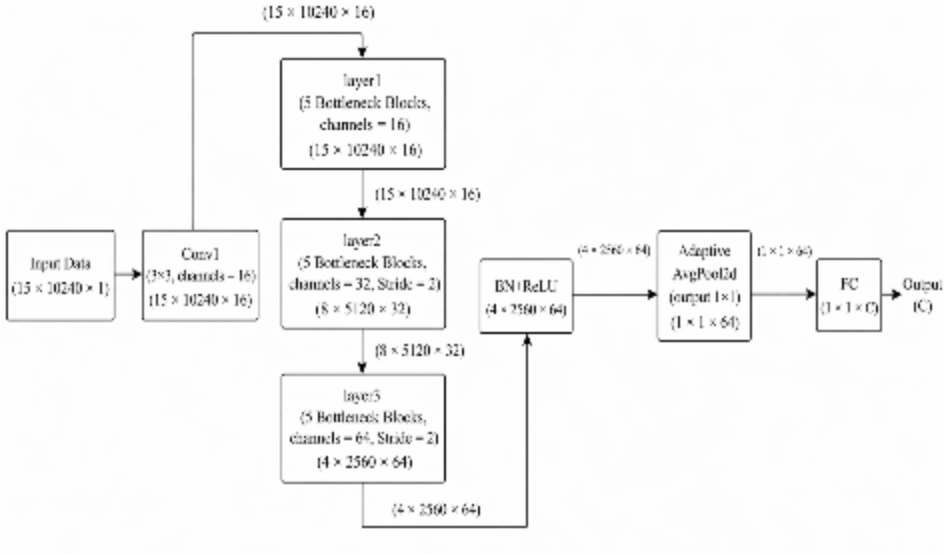
- Developed a class-incremental learning framework, enabling low-cost and low-forgetting continuous learning on distributed acoustic sensing dataset:

- Based on a ResNet, applied CIL strategies including bias correction, exemplar replay, logits distillation, and attention alignment.

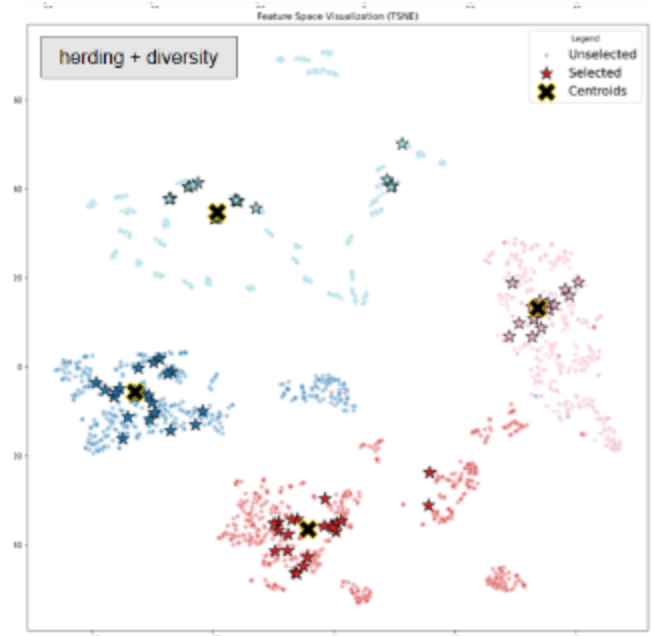
Model Architecture and Results



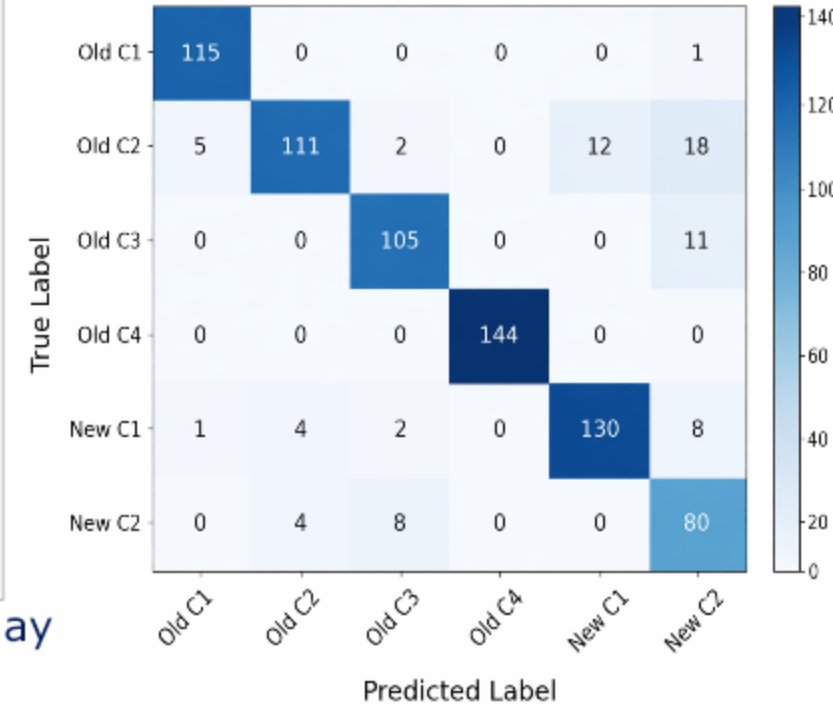
Network architecture diagram



Feature extractor



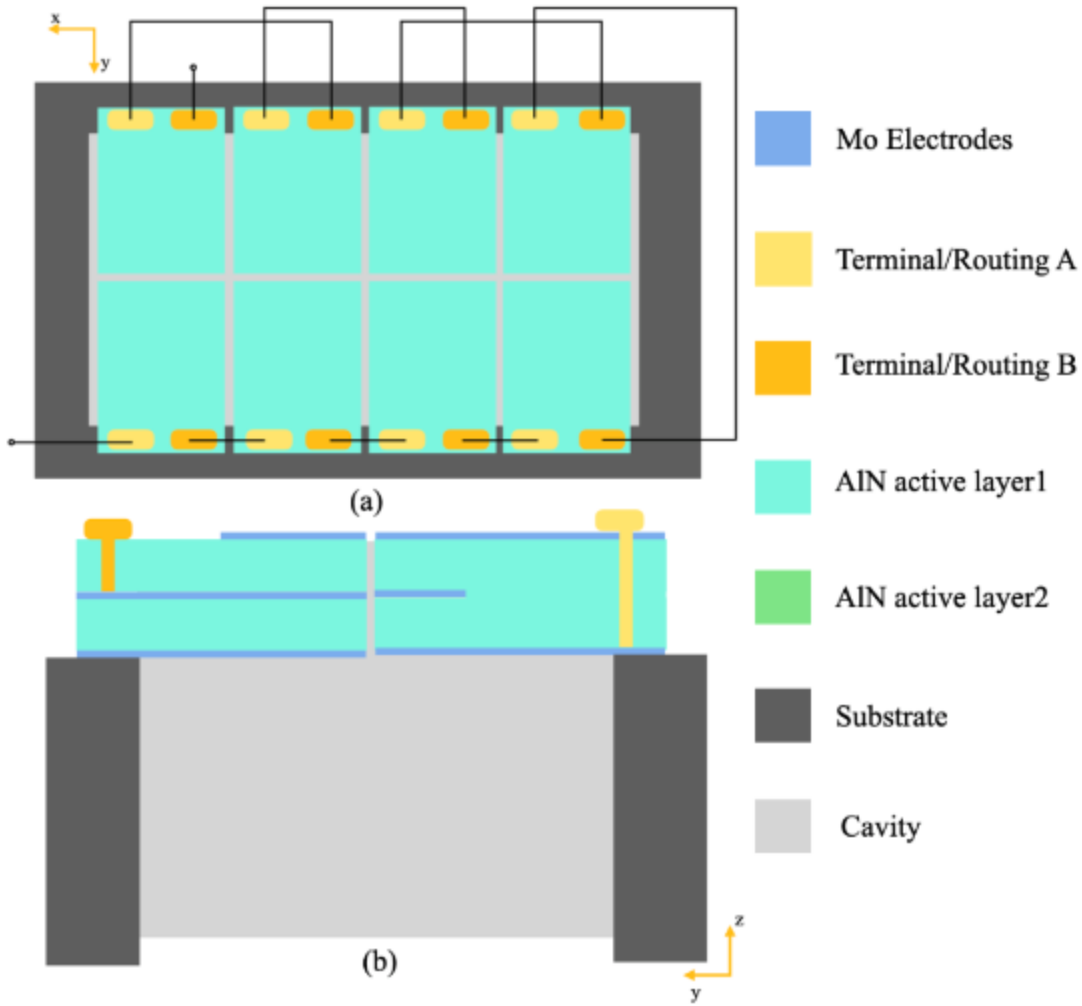
Feature space and sample replay



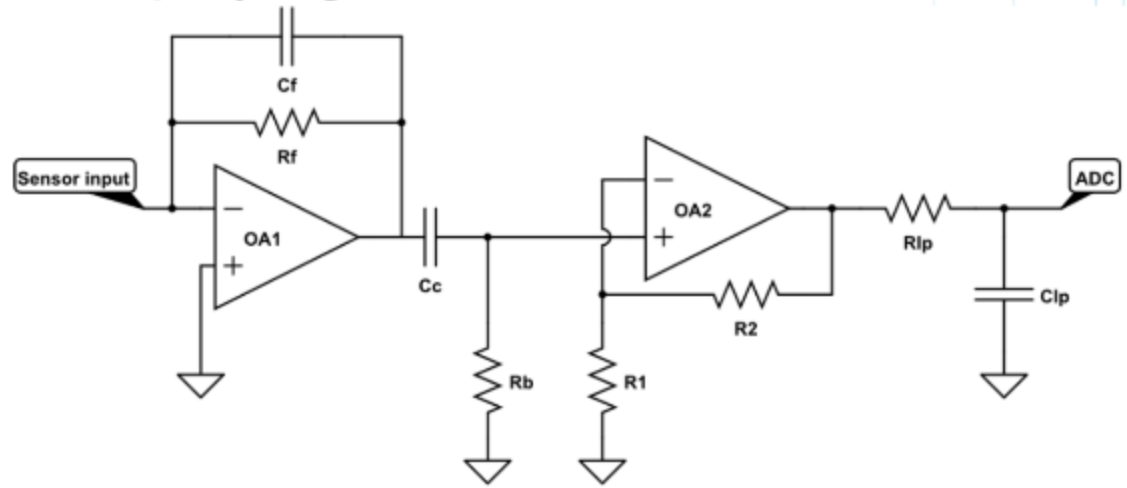
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Design of a Piezoelectric MEMS Microphone

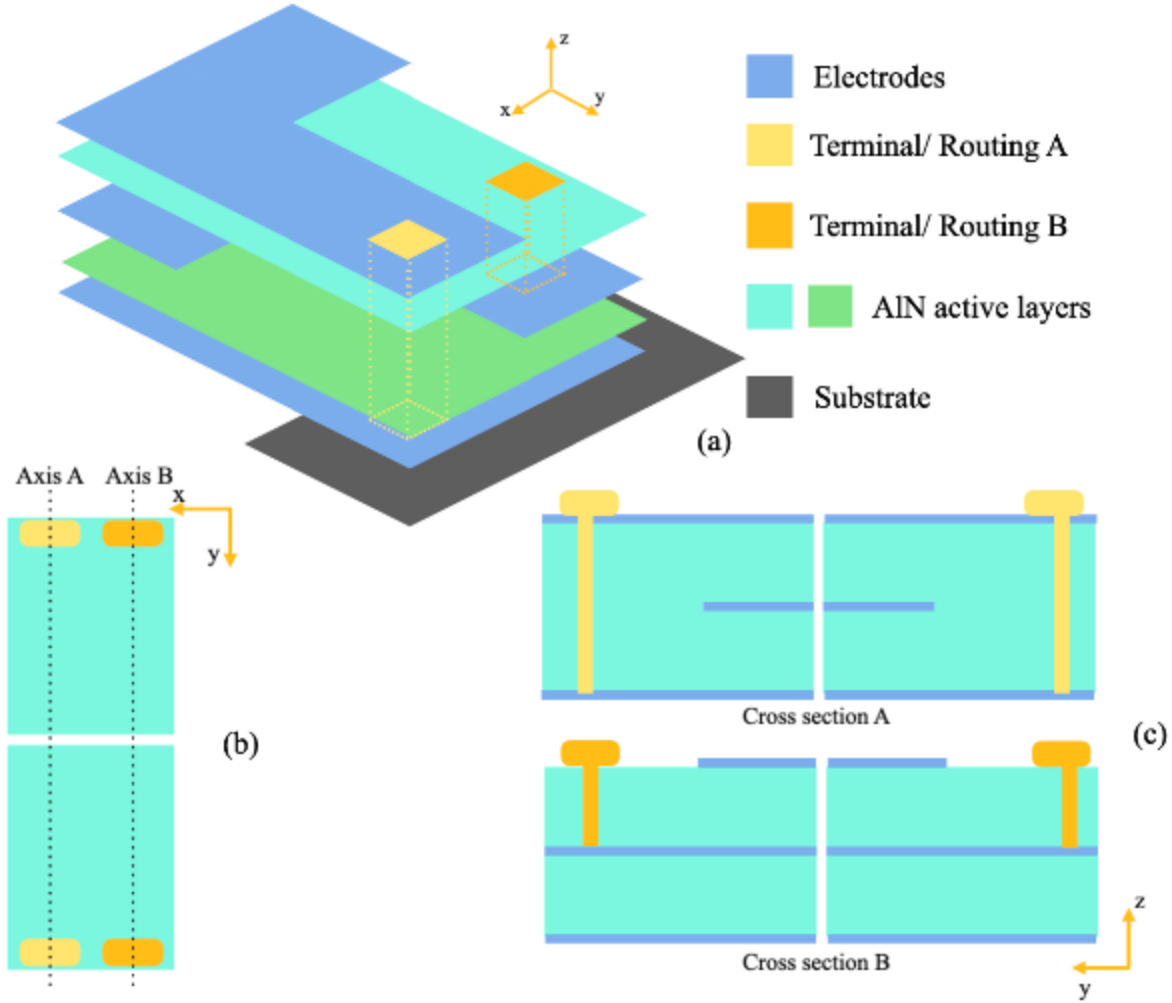
Device and Readout circuit



- Applied Piezoelectric cantilevers as sensor beams.
- Beams are connected in series for sensitivity concerns.
- Transfer to voltage signals, remove out-of-band signals by filter and amplifying.

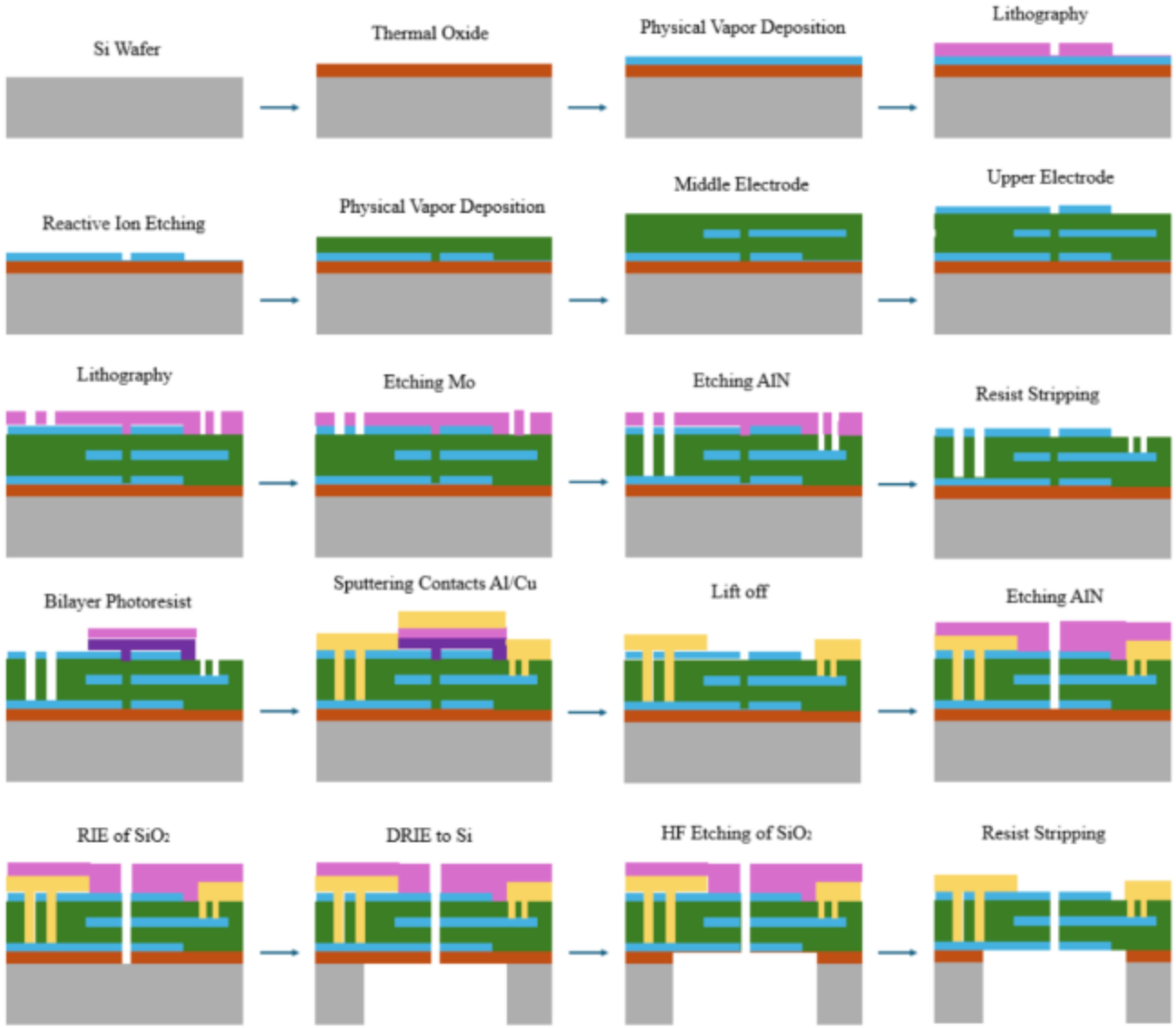


Sensor Unit/Beam Design



- Bimorph structure for better sensitivity and SNR
- Reverse electric field adding up opposite strains on surfaces.
- Connection-oriented electrode patterning

Sensor Fabrication

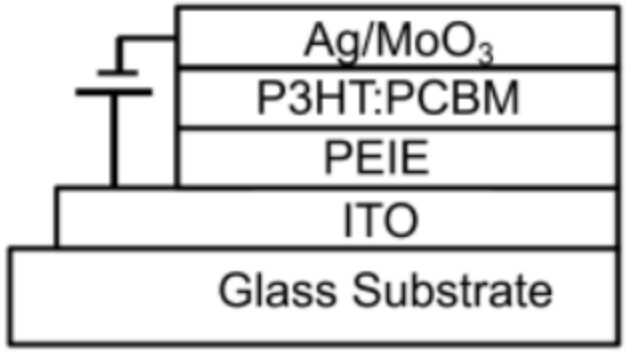


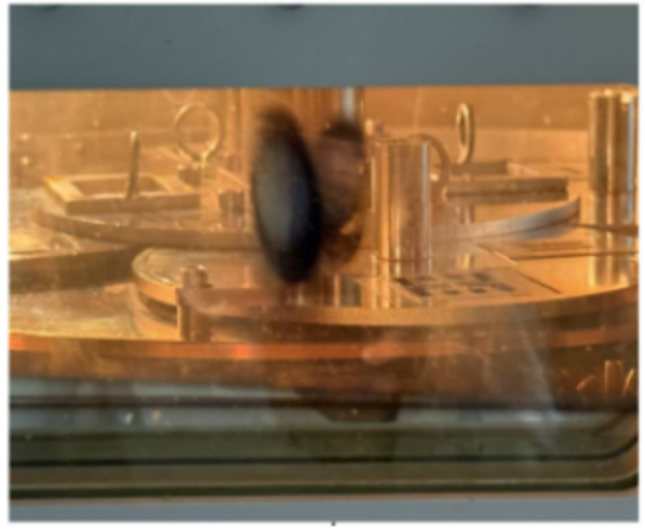


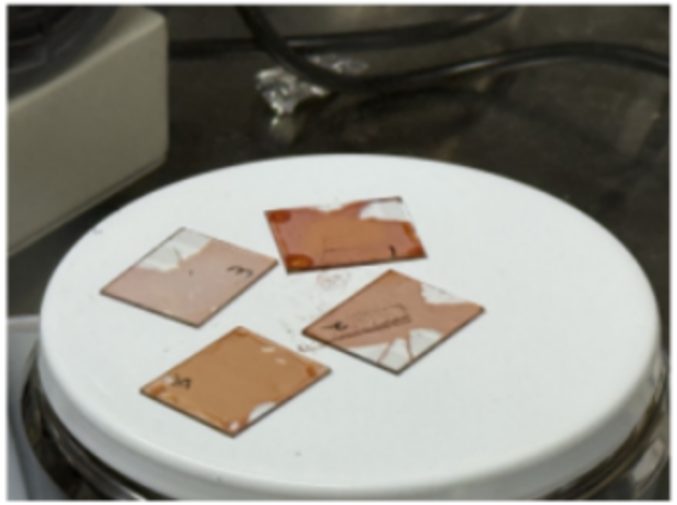
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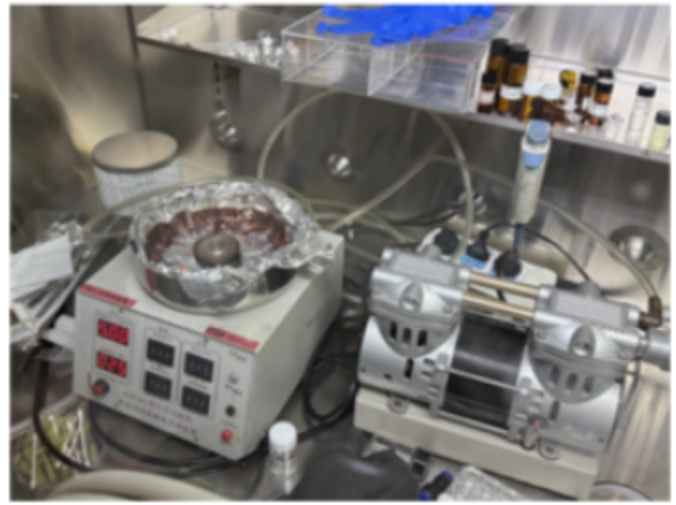
Organic Photovotaic Cell Fabrication and Characterization

Device Structure and Fabrication





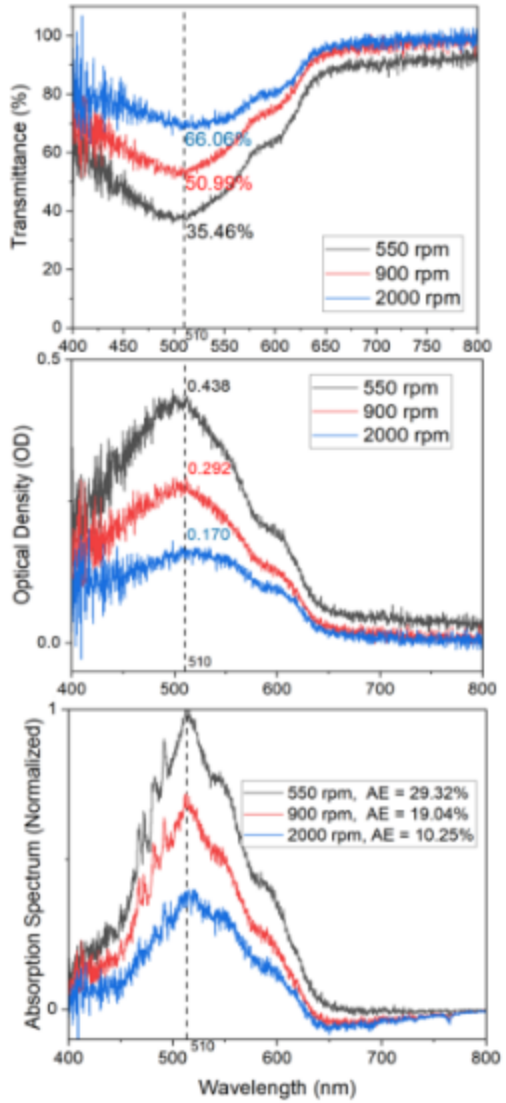


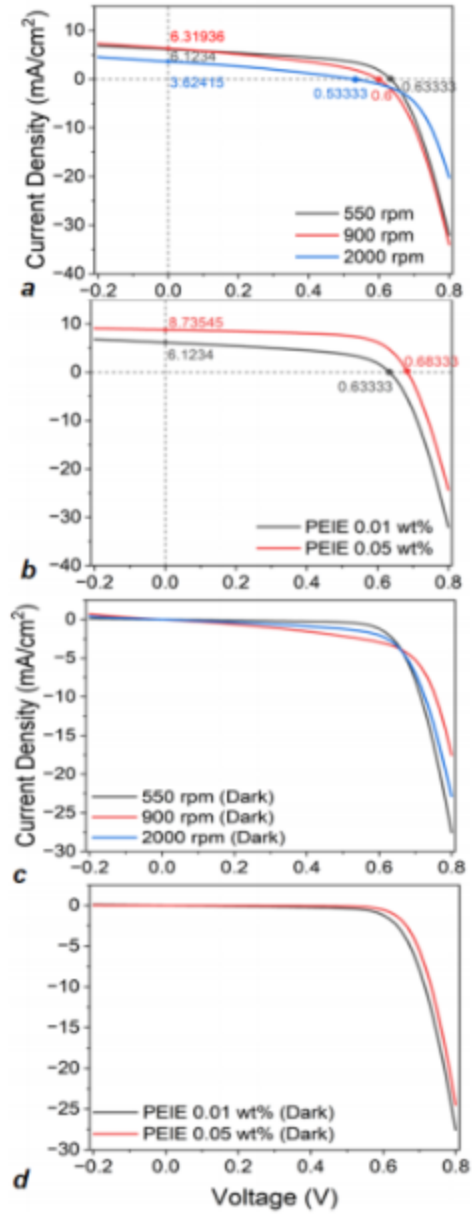


- Spin coating active layer, hole injection layer and hole transport layer.
- Evaporation of electrode
- Samples of different active layer thickness

Characterization







Compared devices with different active layer thicknesses and PEIE conditions:

- Absorption Efficiency
- J–V characterization.