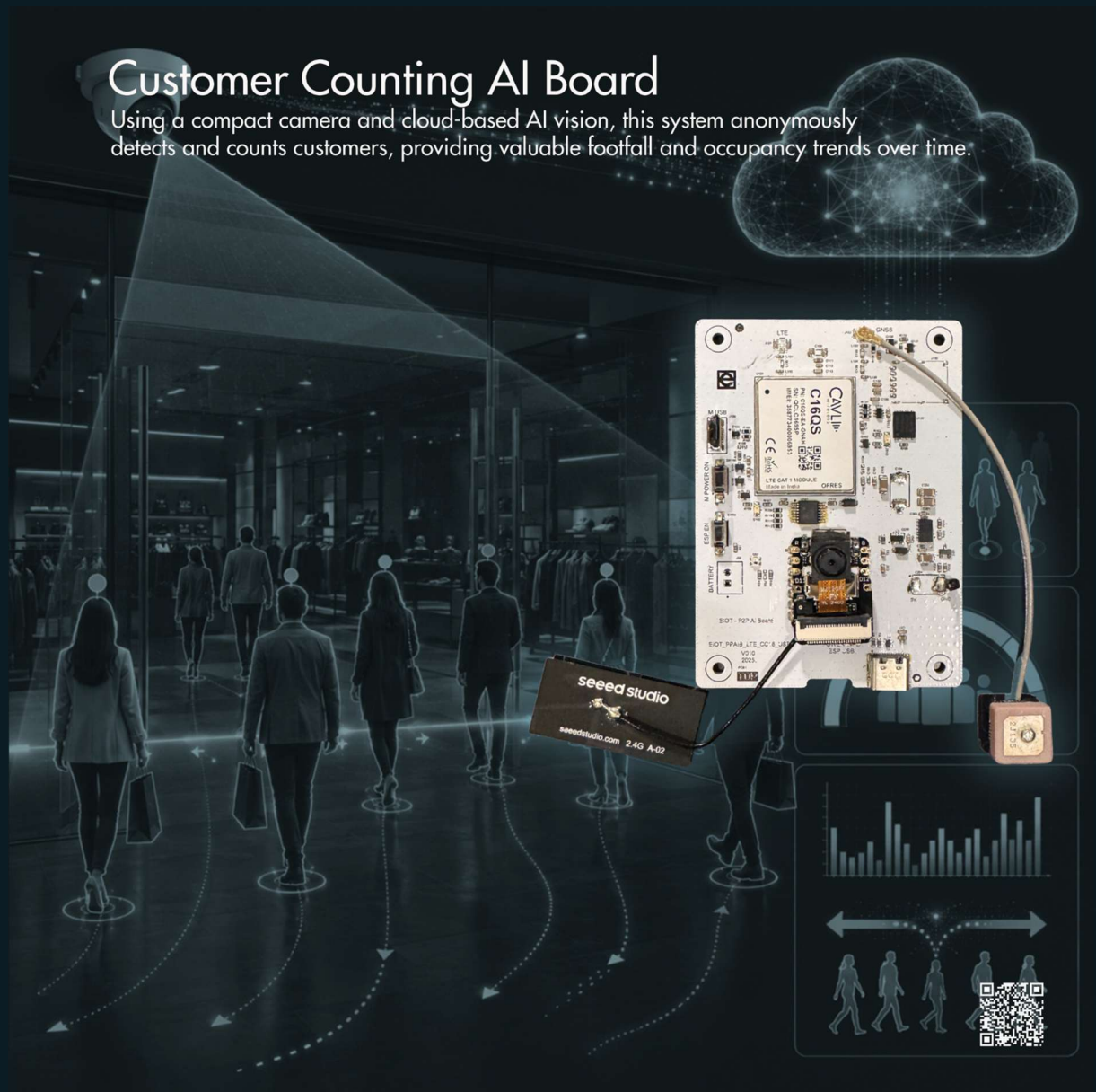




Customer Counting AI Board

The E-IOT AI camera board combines an ESP32 controller, a compact camera and Wi-Fi or cellular connectivity to support image-based monitoring. It offers limited Edge AI capability for simple, optimized tasks such as reading legacy utility-meter displays, while more demanding applications—including customer and traffic counting—use Cloud AI. Selected images are uploaded for analysis, and compact JSON results return the information needed by the application.

Products shown

- **E-IOT AI camera board** — An integrated platform combining image capture, local processing and connectivity for image-based IoT applications.
- **ESP32 camera subsystem** — Captures images and runs the application firmware, with sufficient resources for selected lightweight AI models.
- **Cavli cellular modem** — Provides the mobile-network connection for installations without suitable Wi-Fi access. The intended connectivity concept supports LTE Cat 1 bis; the illustrated prototype carries a C16QS-labelled module.
- **External antenna assemblies** — The image shows a 2.4 GHz antenna and a GNSS patch antenna. Positioning functionality depends on the assembled hardware and firmware.

Product features and operation

Two approaches to AI processing

The platform supports two distinct processing approaches: limited local inference on the ESP32 and cloud-based analysis through an Internet connection.

For a small, well-defined task, the ESP32 can process an image locally using an appropriately optimized model. When the application requires more demanding object detection or scene interpretation, the board captures and uploads a frame to a cloud service that performs the analysis.

This division allows the same hardware concept to serve both lightweight Edge AI applications and connected Cloud AI demonstrations.

Limited Edge AI for legacy meter reading

The ESP32 has limited processing power and memory compared with dedicated AI accelerators or high-performance single-board computers. Its local AI capability is therefore best suited to compact models operating under controlled conditions.

One example is reading the mechanical digit display of a legacy utility meter. With a fixed camera position, suitable lighting and a model adapted to the display, the device can identify the visible digits and convert them into a numerical reading.

The resulting value can then be transmitted to the E-IOT Cloud without uploading every image. This provides a retrofit approach to remote meter reading without modifying the

meter's internal electronics. Recognition quality depends on image clarity, reflections, digit alignment and partially rotated digits.

Cloud AI for customer and traffic counting

For customer counting and traffic analysis, the proposed solution uses Cloud AI. The ESP32 captures a frame and uploads it through Wi-Fi or the cellular connection to a configured analysis service.

The cloud model examines the image and returns a structured result containing selected information, such as the number of people or counts of cars, vans, trucks, buses and bicycles. The board does not need to run the larger vision model locally.

A single frame provides a snapshot of the visible scene. Measuring cumulative footfall, entry and exit direction or traffic flow requires repeated observations and suitable tracking logic to avoid counting the same subject multiple times.

Compact JSON results

The cloud response contains the data required by the application rather than a lengthy image description. For example, a traffic-analysis response could take the following form:

```
{  
  "people": 6,  
  "vehicles": {  
    "cars": 8,  
    "vans": 2,  
    "trucks": 1,  
    "buses": 0,  
    "bicycles": 3  
  }  
}
```

The result structure can be adapted to the use case. For retail analysis, it may contain a total customer count and, where appropriate, optional model-estimated appearance categories. Any male/female appearance classification is an uncertain visual estimate, not a determination of a person's gender, and should allow an unknown category.

Returning compact JSON simplifies integration with dashboards, databases and automation rules. The uploaded image remains the main contributor to data traffic.

Wi-Fi and cellular image transfer

Wi-Fi provides connectivity where a suitable local network is available. LTE Cat 1 bis provides an alternative for independent installations where Wi-Fi access is unavailable or impractical.

These connections support periodic image uploads, with the capture interval and image compression selected according to the application. Actual upload time depends on image size, signal quality and available network capacity.

The cloud-assisted approach requires connectivity when analysis is requested. Local meter-reading inference can operate without an active Internet connection, with reporting handled separately by the firmware.

E-IOT integration and data handling

The extracted measurements and counts can be forwarded to the E-IOT Cloud for visualization, historical logging and comparison over time. This supports applications ranging from meter-consumption trends to observed customer occupancy and traffic composition.

The application can be designed to retain aggregate results rather than images. However, returning only counts does not automatically make the complete process anonymous: image upload, processing and retention must also be configured accordingly.

Typical applications

- Optical reading of mechanical utility-meter displays using lightweight Edge AI.
- Cloud-assisted customer counting and occupancy observation.
- Vehicle detection and classification for smart-city demonstrations.
- Periodic monitoring of parking areas and loading zones.
- Retail activity analysis based on aggregate counts.
- Image-based E-IOT proof-of-concept development.