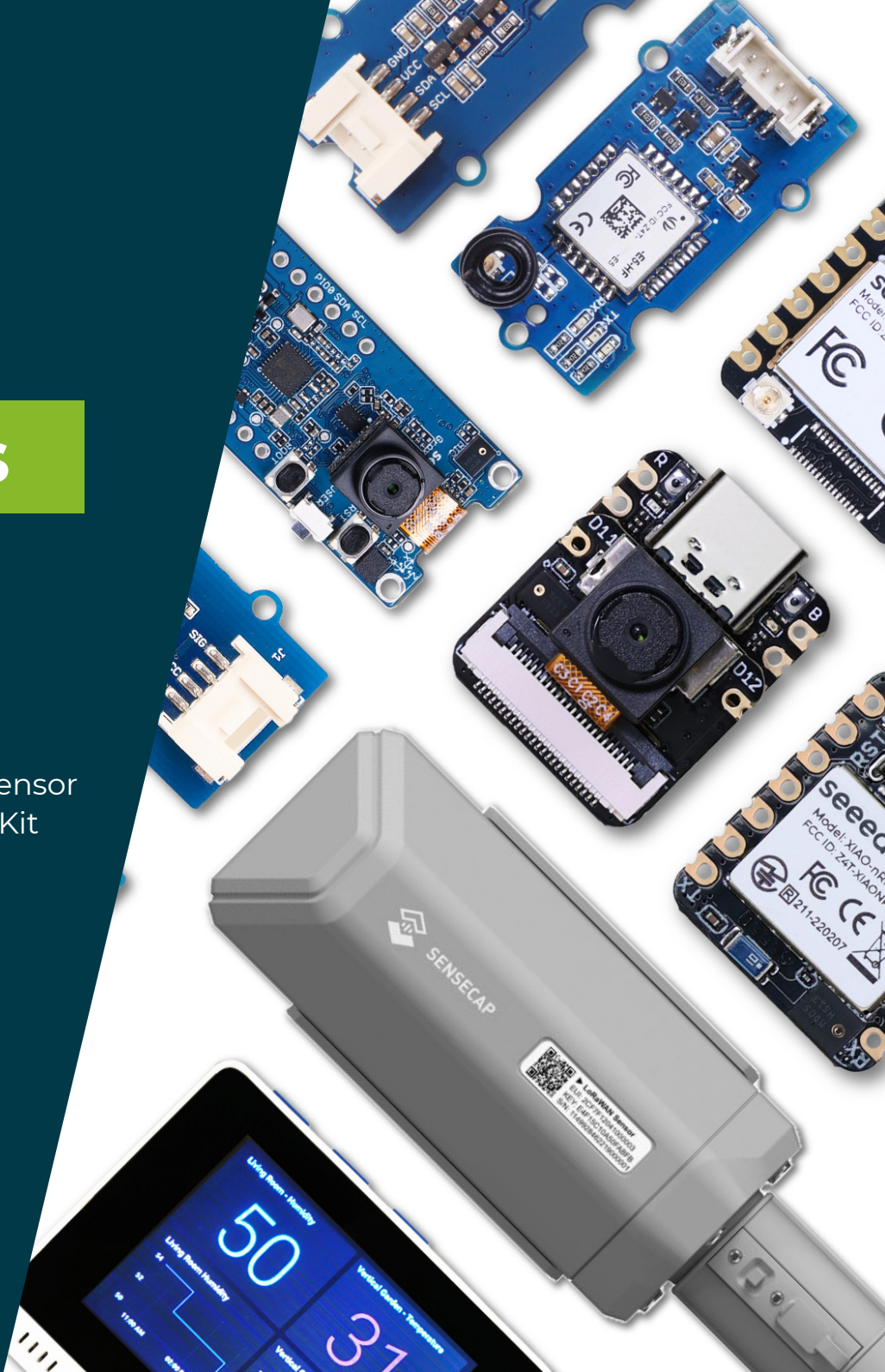
TinyML Case Studies

- Seeed Studio Wio Terminal
- Seeed Studio Grove-Vision AI Module
- Seeed Studio XIAO ESP32S3
- Seeed Studio XIAO ESP32S3 Sense
- Seeed Studio XIAO nRF52840 Sense
- Seeed Studio SenseCAP A1101 - LoRaWAN® Vision AI Sensor
- Seeed Studio SenseCAP K1100 – The Sensor Prototype Kit with LoRa® and AI

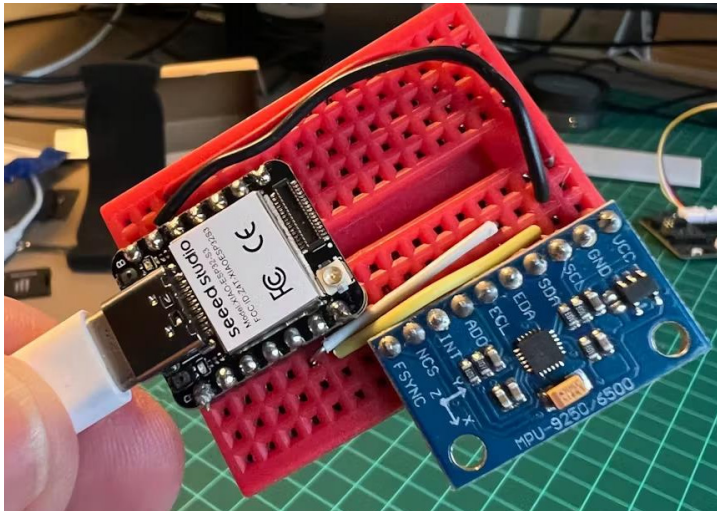
seeed studio



1. Exploring Machine Learning with the New XIAO ESP32S3

Marcelo Rovai showcased his latest project, delving further into the world of machine learning, by introducing the newest member of the XIAO family: the XIAO ESP32S3. In this project, he utilized a low-cost IMU and harnessed the power of Edge Impulse to detect anomalies and classify motion.

Seeed Studio XIAO ESP32S3 leverages 240MHz Xtensa 32-bit LX7 dual-core processor, supporting both WiFi and BLE 5.0 wireless connectivities, allows for deep sleep mode with power consumption as low as 14μA while supporting lithium battery charging management. Ideal for the Internet of Things, Smart Homes, Wireless wearable devices, Robotics, etc.



Seeed's hardwares used in this project:

Seeed Studio XIAO ESP32S3

Softwares used in this project:

ARDUINO

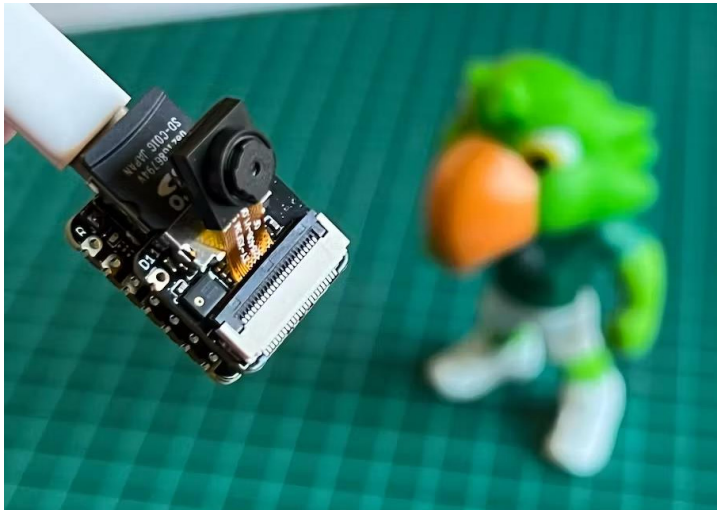
EDGE IMPULSE

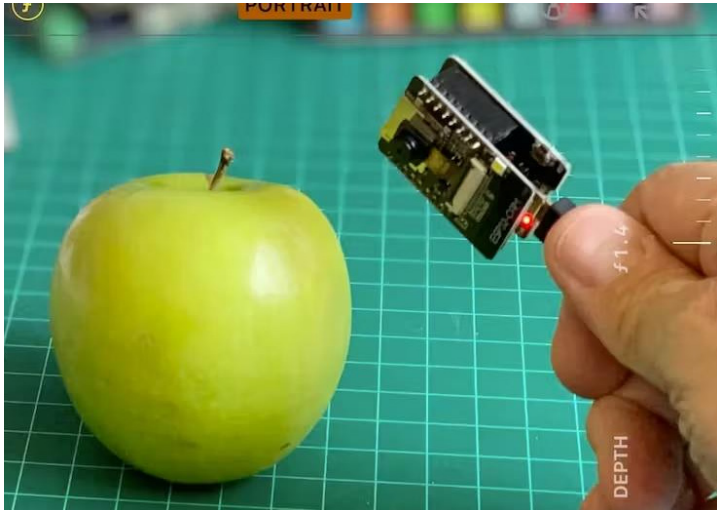
>>Read the full project on Hackster

2. TinyML Made Easy: Image Classification

Marcelo Rovai shared a comprehensive tutorial covering an introduction to Seeed Studio XIAO ESP32S3 Sense and an image classification project where Marcelo demonstrates how to collect Fruits versus Veggies datasets from Kaggle and train a model using Edge Impulse. The trained model is then deployed as an Arduino library in a .zip format and uploaded to the XIAO ESP32S3 Sense, enabling users to classify fruits and vegetables with ease.

Seeed Studio XIAO ESP32S3 Sense integrates a camera sensor, digital microphone, and SD card support. Combining embedded ML computing power and photography capability, this development board can be your great tool to get started with intelligent voice and vision AI.





Seeed's hardwares used in this project:

Seeed Studio XIAO ESP32S3

Softwares used in this project:

ARDUINO

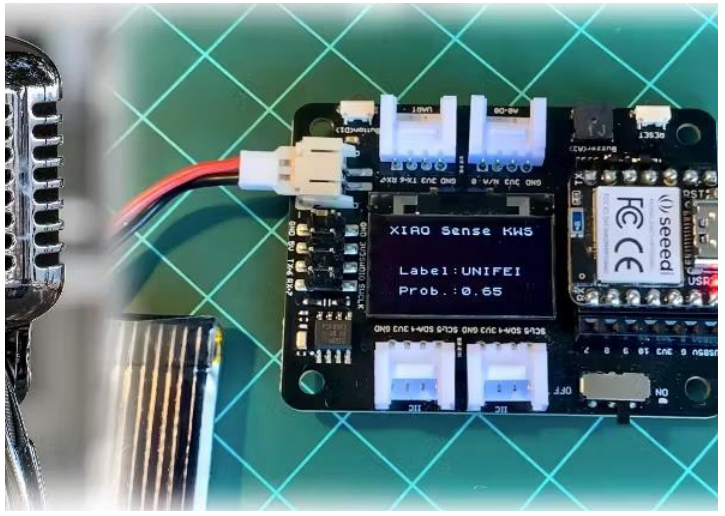
EDGE IMPULSE

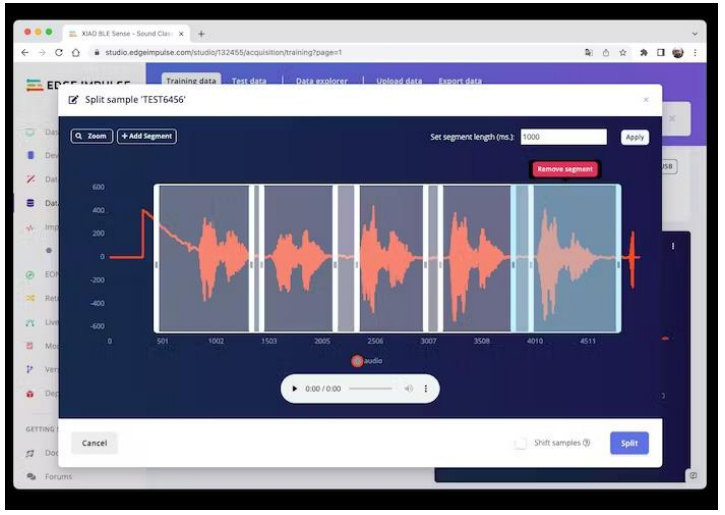
>>Read the full project on Hackster

3. TinyML Made Easy: Sound Classification (KWS)

In this tutorial, Marcelo Rovai used XIAO nRF52840 Sense to classify sound, specifically as "Key Word Spotting" (KWS). KWS is a typical TinyML application and a crucial part of a voice assistant.

The Seeed Studio XIAO nRF52840 Sense is an Arduino-compatible board featuring the Nordic nRF52840 MCU with Bluetooth 5.0 & NFC support. It is an advanced yet compact version of the Seeed Studio XIAO nRF52840, with additional onboard 6-axis IMU and microphone sensors, making it suitable for TinyML AIoT projects that require gesture and voice recognition.





Seeed's hardwares used in this project:

Seeed Studio XIAO nRF52840 Sense
Seeed Studio Expansion Board Base for XIAO

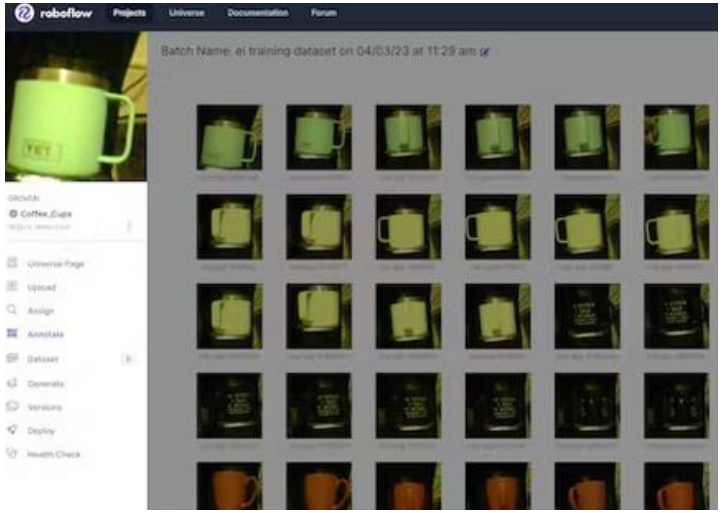
Softwares used in this project:

>>Read the full project on Hackster

4. NMCS: No More Coffee Spills!

Sashrika Das, one of the winners of the “IoT in the Wild Contest 2022” by Seeed Studio, has recently developed a new device. The device, named “NMCS” (No More Coffee Spills), was inspired by her dad’s experience of spilling coffee while brewing it. NMCS aims to prevent such mishaps by checking for the presence of a cup before starting the brewing process.

To achieve this, the device uses the built-in microphone module from the Wio Terminal to detect brewing sounds from the coffee machine. Once brewing is detected, the device uses the Grove-Vision AI Module to check if a cup is present in the machine. If not, the Wio Terminal’s built-in buzzer will beep, alerting the user to place a cup before it is too late.



Seeed’s hardwares used in this project:

Grove-Vision AI Module
Wio Terminal

Softwares used in this project:

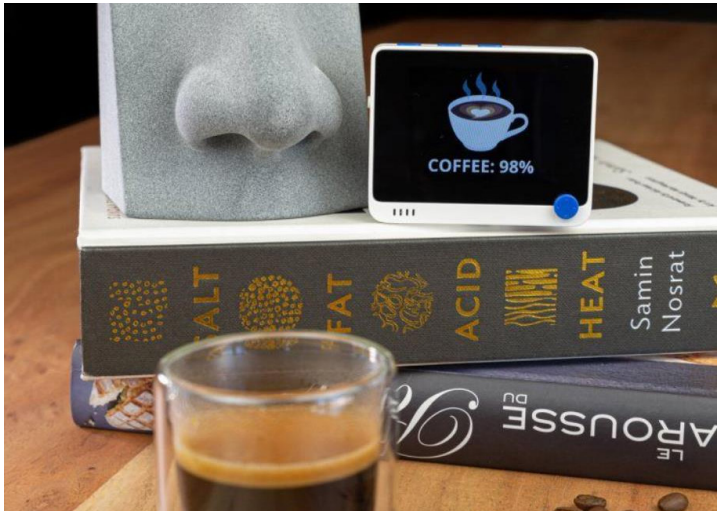
ARDUINO
EDGE IMPULSE
roboflow

>>Read the full project on Hackster

5. Benjamin Cabé' Artificial Nose

Thanks to Benjamin Cabé, now you can follow up the most comprehensive tutorial to build your AI-powered artificial nose that can differenciate coffee, tea, or identify whatever else you train it to smell. The Artificial Nose is powered by the Wio Terminal, Grove Multichannel gas sensor, and a TinyML neural network-based free online tool Edge Impulse.

Since the Wio Terminal is an Azure certified device, not only can the artificial nose sense and tag the scents you want to know in the air, but everything can be analyzed and visualized in real-time through Azure IoT Central. Furthermore, there are endless possibilities for extending the capabilities of the nose, with over 300 Grove modules that are compatible with the Wio Terminal.



Seeed's hardwares used in this project:

Tiny ML powered Artificial Nose Project kit with Wio Terminal

Softwares used in this project:

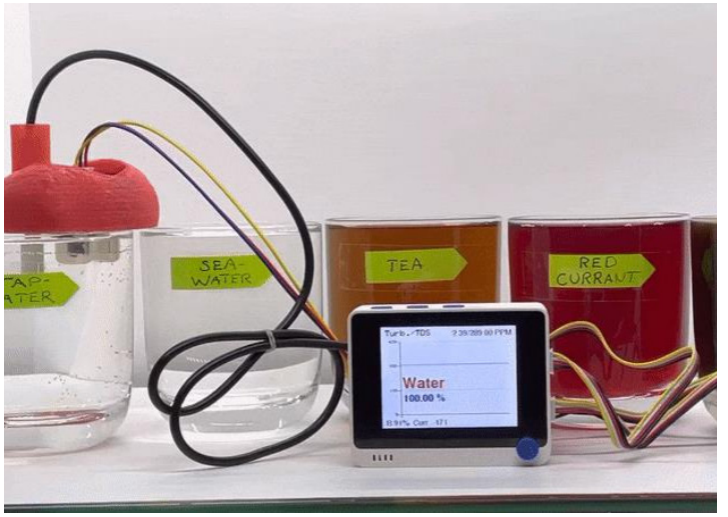
ARDUINO EDGE IMPULSE Azure

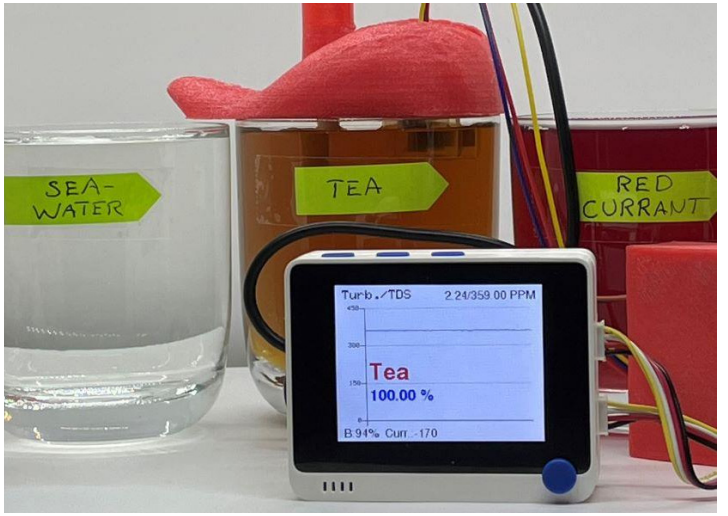
>>Read the full project in this blog

6. Liquid Classification with TinyML

Inspired by Benjamin Cabé's artificial nose, Thomas Vikström has developed an electronic tongue capable of identifying various liquids. This innovation has several potential applications, such as in olfactory training for individuals who have lost their sense of taste and smell, wine testing, and water quality verification.

To gather data from tap and sea water, Thomas used Grove - TDS and Grove - Turbidity Sensors and sent the data to the Wio Terminal for later analysis. After collecting a substantial amount of data, Thomas built and trained a machine learning model using Edge Impulse.





Seeed's hardwares used in this project:

Grove - TDS Sensor/Meter For Water Quality
Wio Terminal

Softwares used in this project:

ARDUINO

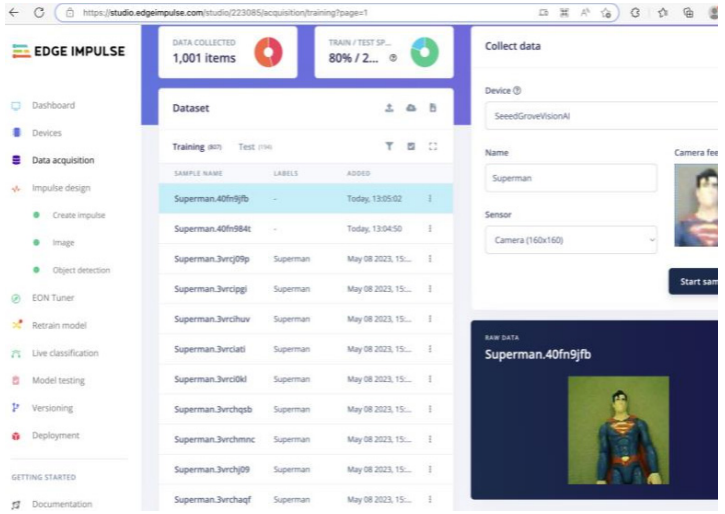
EDGE IMPULSE

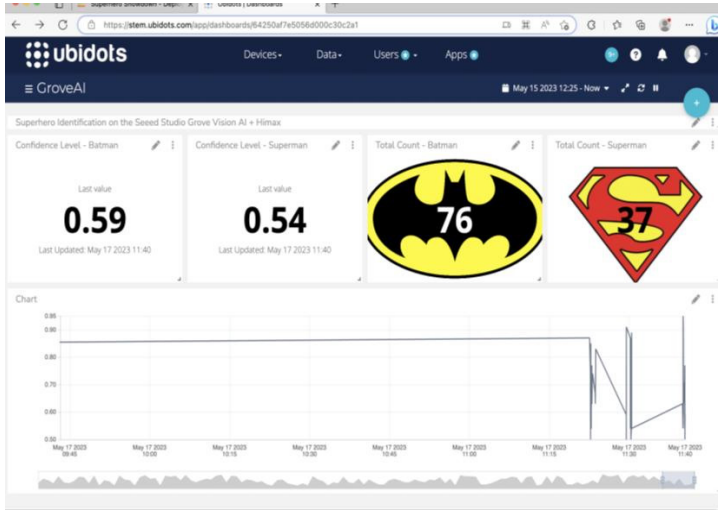
>>Read the full project on Edge Impulse

7. Object Detection and Visualization with the Grove Vision AI Module

David Tischler has recently developed an exciting project using the Grove-Vision AI Module and Edge Impulse. The objective was to create a machine learning model capable of identifying Batman and Superman. After conducting inferencing, the model was deployed onto the module, and the results were sent to a Ubidots cloud dashboard for convenient visualization.

Grove-Vision AI Module is a small TinyML-capable board equipped with an HX6537-A processor and an OV2640 camera, capable of running computer vision models directly on the board. There is also a microphone, accelerometer, and gyroscope, and Arduino library support for simple programming. The board is also fully supported by Edge Impulse, so you can build and deploy machine-learning models with ease.





Seeed's hardwares used in this project:

Grove-Vision AI Module

Softwares used in this project:

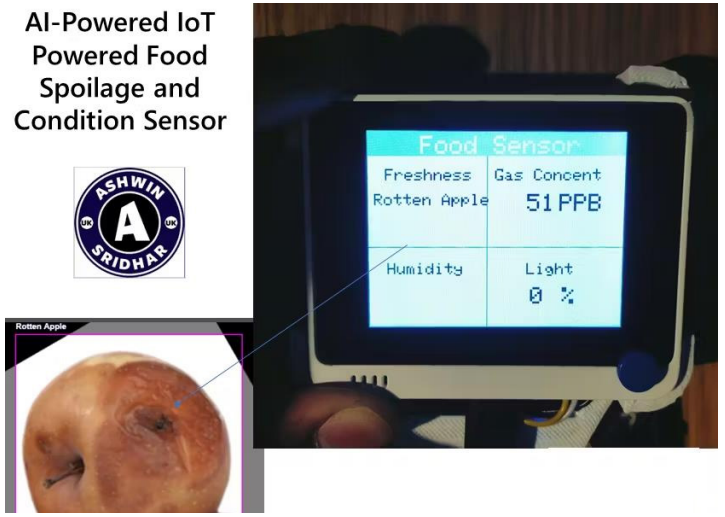
EDGE IMPULSE ubidots

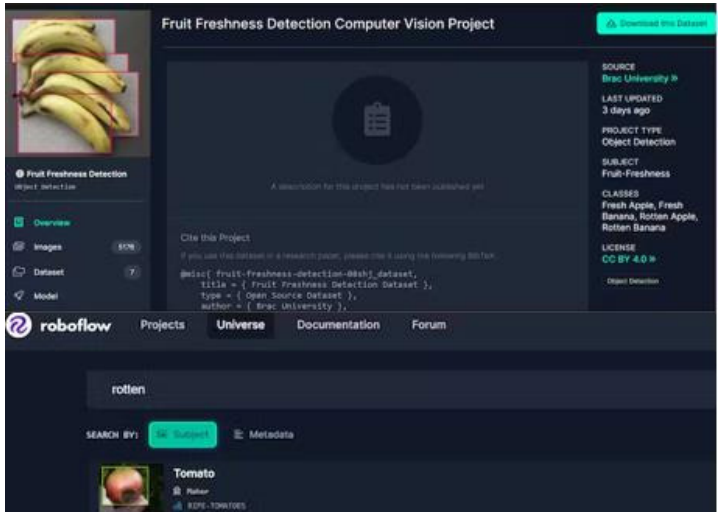
>>Read the full project in this Edge Impulse

8. DeViridi: IoT Food Spoilage Sensor and Monitoring Dashboard

Smallholder farmers and supply chain actors in developing countries lose 15% of income due to food spoilage, which could feed an extra billion people by 2050. This issue is compounded by the struggle to store and detect spoiled foods, resulting in high costs for farmers and processing companies. Agriculture waste also contributes to greenhouse gases, with Kenya alone wasting 50% of post-harvest crops, resulting in edible food loss and significant methane gas emissions.

Ashwin Sridhar developed a smart IoT device that uses AI-based image detection to monitor food storage conditions and detect spoilage early. In addtion, by detecting the gas emitted by different types of food, the device can determine the progress and extent of food spoilage, allowing farmers, suppliers, supermarkets, and households to accurately assess food edibility.





Seeed's hardwares used in this project:

SenseCAP K1100 –The Sensor Prototype Kit with LoRa® and AI

Softwares used in this project:

ARDUINO

AUTODESK® FUSION 360™

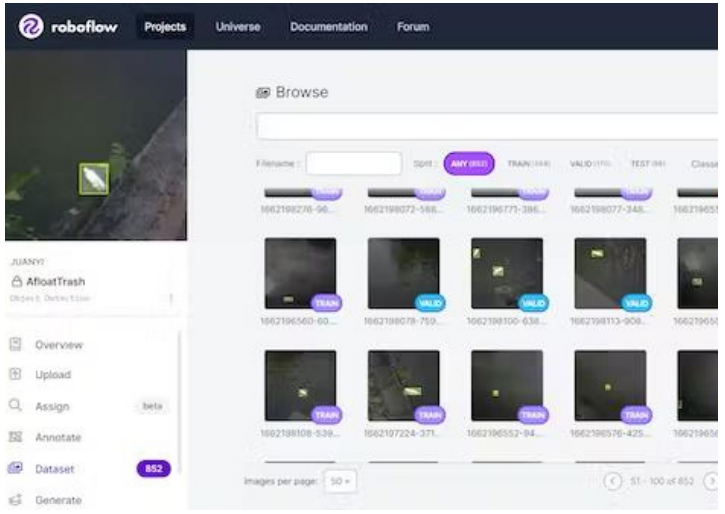
TensorFlow

>>Read the full project on Hackster

9. Plastic Bottle Detector For Lake

There is a misconception among many people that plastic bottles/ containers are biodegradable and can be disposed of in the environment, leading to their inappropriate disposal in rivers, drains, lakes, and oceans. This misconception has resulted in severe environmental pollution and poses a threat to the health and well-being of humans and other living organisms.

JuanYi has developed a device that utilizes vision to identify plastic bottles floating on a lake and sends the collected data to the cloud to minimize the negative impact of trash on the environment. To train the convolutional neural network (CNN), a dataset of plastic bottles is required. Therefore, JuanYi employed the Grove-Vision AI to gather data regularly over several weeks from a nearby park lake.



Seeed's hardwares used in this project:

SenseCAP K1100 – The Sensor Prototype Kit with LoRa® and AI

Softwares used in this project:

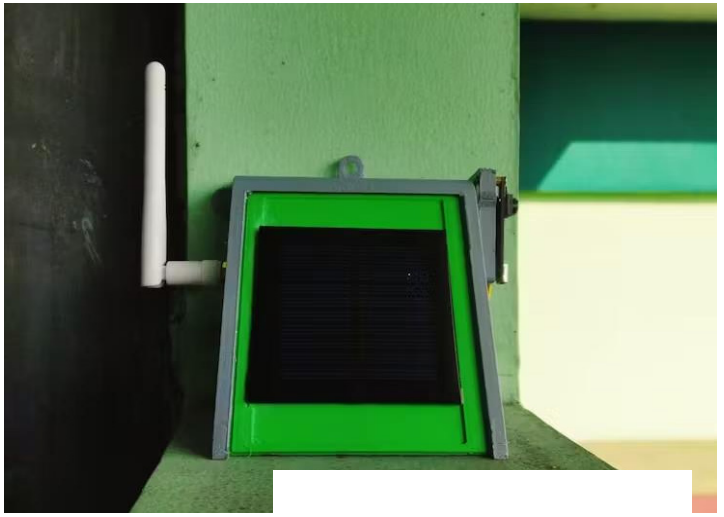
ARDUINO roboflow

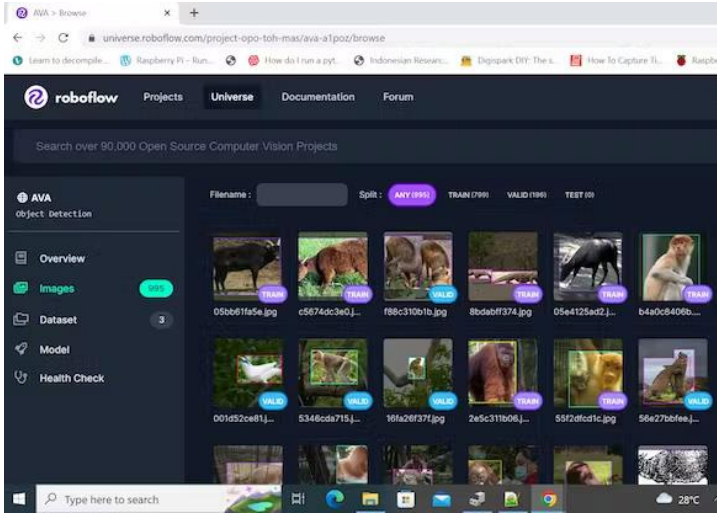
>>Read the full project on Hackster

10. Wildlife Sanctuary Monitor

Indonesia's tropical forests, the third-largest in the world, are home to diverse wildlife, including endangered species. However, conservation efforts face challenges such as illegal hunting and deforestation. The Javan Rhinoceros and orangutan are among those species at risk, with a lack of resources and staff further hindering conservation efforts.

Hendra Kusumah has created a conservation tool that monitors the state of forests and identifies endangered animals as part of efforts to protect them. This project centers on utilizing audio classification to assess the vitality of endangered wildlife, with Grove-Vision AI employed to detect their movements. The device can immediately alert authorities of illegal poaching activities and issue early warnings in the event of wildfire outbreaks to prevent their spread. Moreover, the system can transmit data results wirelessly over long distances and display them on computer dashboards and smartphones.





Seeed's hardwares used in this project:

SenseCAP K1100 – The Sensor Prototype Kit with LoRa® and AI
Seeed Studio XIAO RP2040

Softwares used in this project:

ARDUINO

EDGE IMPULSE

>>Read the full project on Hackster

11. IoT AI-driven Tree Disease Identifier w/ Edge Impulse & MMS

Due to environmental changes and extensive deforestation, trees and plants are becoming increasingly vulnerable to contagious illnesses. This is particularly concerning since trees play a critical role in pollination, and the spread of tree diseases can lead to significant crop yield losses, animal fatalities, widespread infectious epidemics, and even land degradation caused by soil erosion.

To address this issue, Kutluhan Aktar has developed a device that employs Grove-Vision AI to gather images of infected trees, thereby creating a comprehensive dataset. Using Edge Impulse, the models are trained and deployed to identify tree diseases at an early stage. The results are then communicated via MMS, enabling swift action to prevent further spread and harm to forests, farms, and arable lands.

Seeed's hardwares used in this project:

SenseCAP K1100 –The Sensor Prototype Kit with LoRa® and AI
Grove – CO2 & Temperature & Humidity Sensor (SCD30)

Softwares used in this project:

ARDUINO

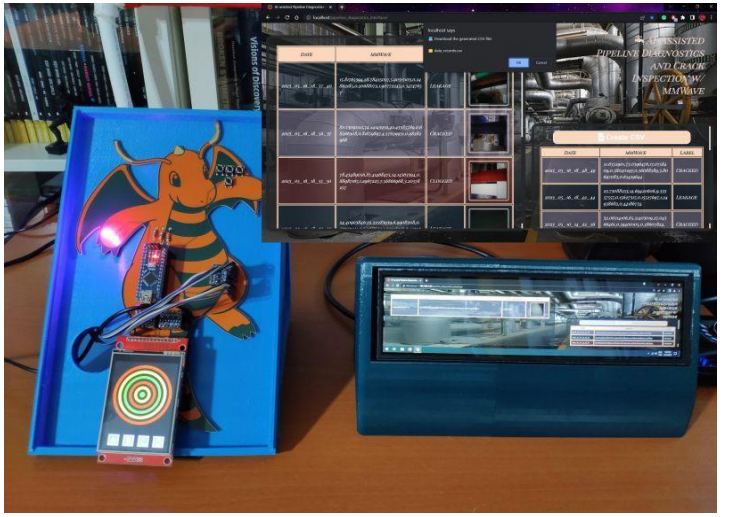
EDGE IMPULSE

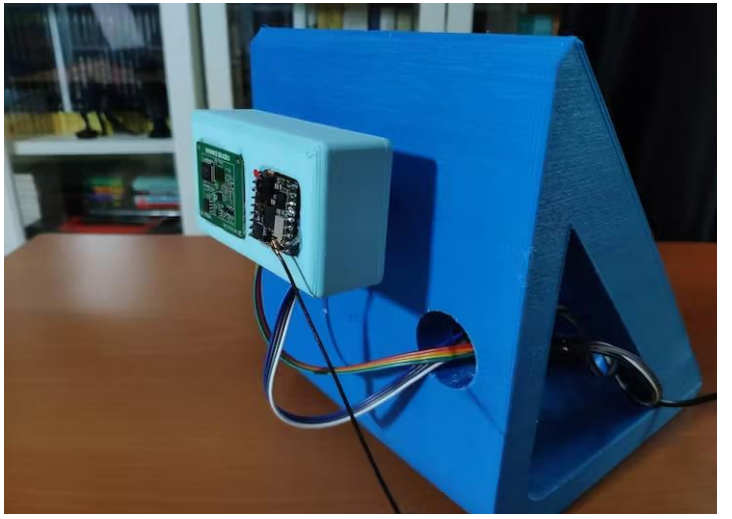
>>Read the full project on Hackster

12. AI-assisted Pipeline Diagnostics and Inspection w/ mmWave

Pipeline maintenance is vital for machine health in automated manufacturing. Stress during operations can cause small pipeline defects. Traditional inspection methods like computer vision, magnetic field measurements, and acoustic detection have limitations and can't be universally applied.

To address this issue, Kutluhan Aktar developed an affordable diagnostic system. This system utilizes an MR60BHA1 60GHz mmWave radar to collect data and extract parameters, trains a neural network model on Edge Impulse to diagnose pipeline defects, and inspect model detection results w/ deformed pipe images on a PHP web application simultaneously.





Seeed's hardwares used in this project:

60GHz mmWave Sensor -Breathing and Heartbeat Module

Softwares used in this project:

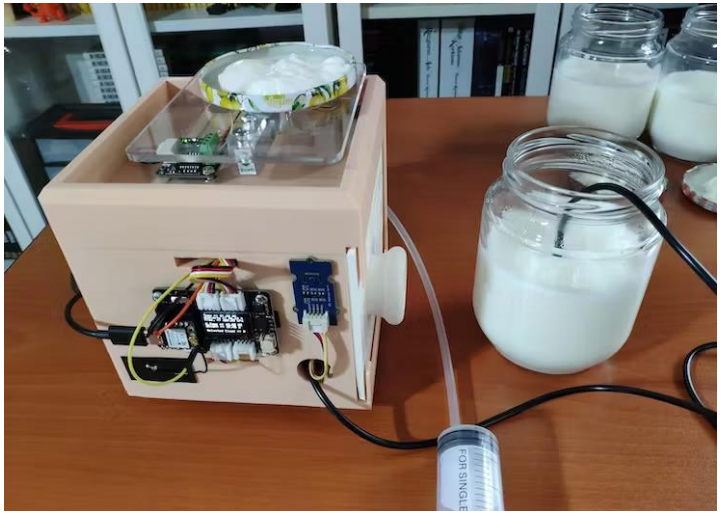
ARDUINO, AUTODESK FUSION 360, EDGE IMPULSE, KiCad, Visual Studio

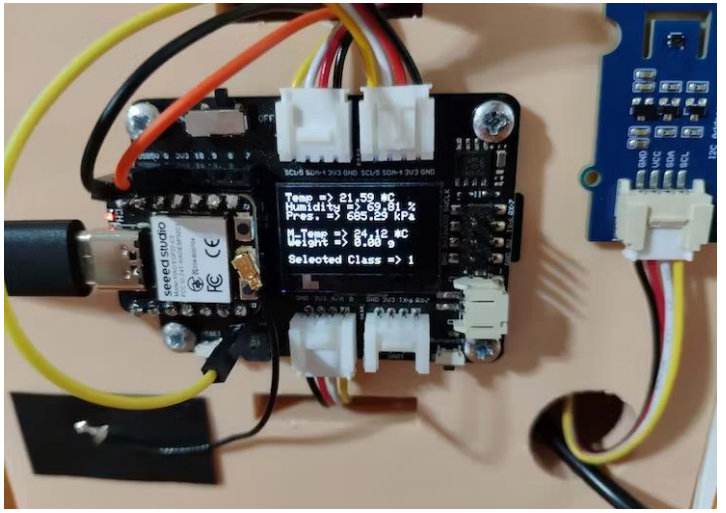
>>Read the full project on Hackster

13. IoT AI-driven Yogurt Processing & Texture Prediction | Blynk

Yogurt is made by fermenting milk with bacteria, and its quality is affected by factors like temperature, humidity, pressure, milk temperature, and the presence of yogurt bacteria. Chemical additives are commonly used, but there's a growing demand for additive-free yogurt.

This project measures key data points using temperature and humidity sensors, as well as pressure sensors, to estimate the consistency level of yogurt. It uses XIAO ESP32C3 to build and train an artificial neural network model, which analyzes the collected data to determine the most suitable environmental conditions for yogurt fermentation.





Seeed's hardwares used in this project:

Seeed Studio XIAO ESP32C3
Seeed Studio Expansion Board Base for XIAO
Grove -Temperature & Humidity Sensor(SHT40)

Softwares used in this project:

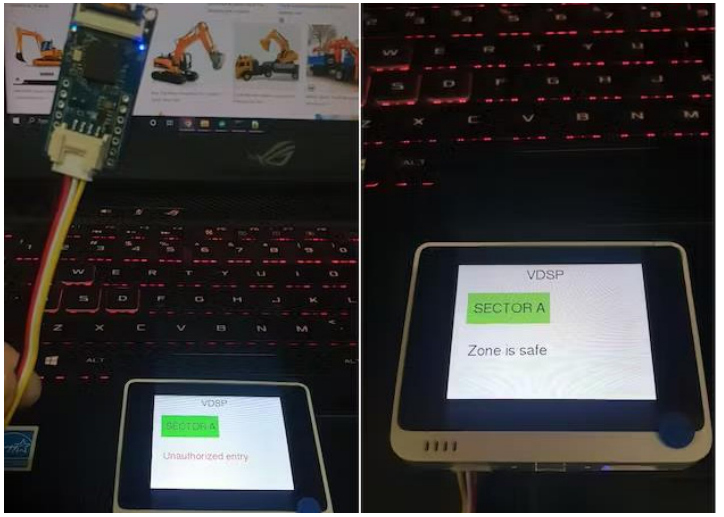
ARDUINO AUTODESK® FUSION 360™ Blynk EDGE IMPULSE

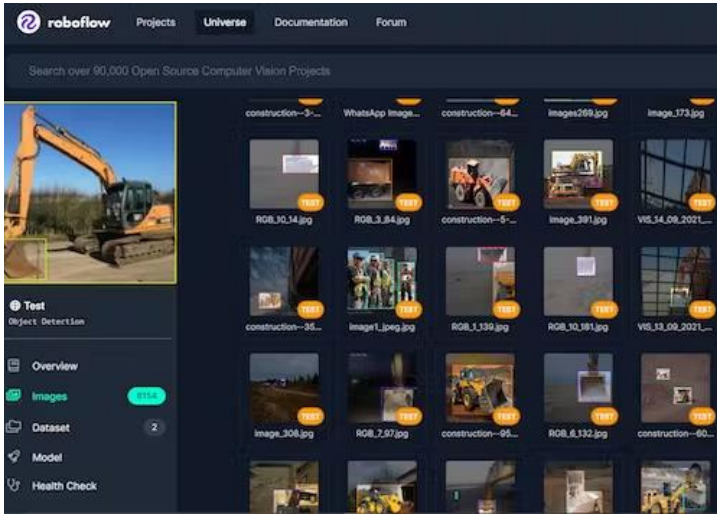
>>Read the full project on Hackster

14. Vision based Sand Depletion Prevention Kit (VSDP)

Sand mining from riverbeds is a major environmental issue, leading to various negative impacts on rivers, including social, environmental, geomorphic, and disastrous impacts. Unchecked sand consumption could increase by 45% in four decades, leading to environmental damage and urban expansion material shortages.

To address this issue, Rahul Khanna D has designed a system that uses Grove sensors to process sensor data, such as VOC, eCO2, soil moisture, temperature, and humidity. This device monitors trespassing humans in the sand depletion region and notifies the server via the gate way. Additionally, the Edge AI model monitors illegal sand mining using the Grove-Vision AI Module. Multiple AI nodes are deployed and connected to the LoRaWAN® gateway, which connects to the Helium Server.





Seeed's hardwares used in this project:

SenseCAP K1100 –The Sensor Prototype Kit with LoRa® and AI

Softwares used in this project:

ARDUINO

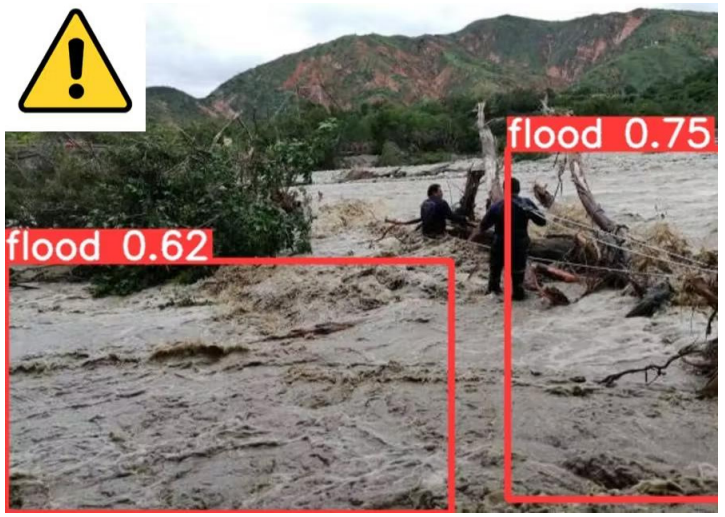
helium

>>Read the full project on Hackster

15. Early Flash Flood Warn System

Floods are a type of natural disaster that can be both common and costly. They are often caused by hurricanes, melting snow, or prolonged periods of rain. Flash floods can occur suddenly when water rapidly rises along a stream or low –lying area.

Jhonattan Fredy Moreno Bernal has created a project to tackle this problem by developing a low-cost system for generating early warnings. By deploying a network of nodes, the system is able to monitor water flows and gather more information to build predictive flood models. The system utilizes a trained model to detect sudden floods and sends an alarm through the Blynk platform via email when a defined detection threshold is exceeded. This helps provide timely alerts for taking preventive measures against floods.



Seeed's hardwares used in this project:

SenseCAP K1100 –The Sensor Prototype Kit with LoRa® and AI

Softwares used in this project:

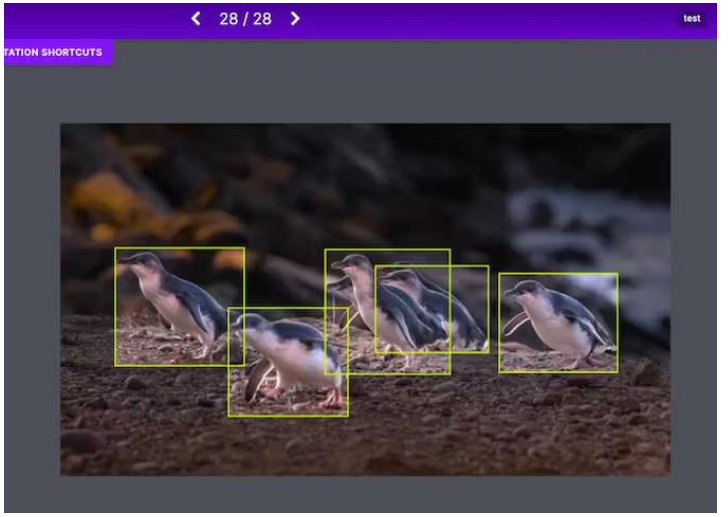
Blynk roboflow

>>Read the full project on Hackster

16. Penguin Counting and Monitoring

Over the past few years, ocean species have been adversely affected by marine pollution and marine heatwaves, leading to starvation and mass deaths. The little blue penguin, also known as “Kororā,” is particularly vulnerable to these conditions, with New Zealand’s Department of Conservation (DOC) categorizing them as “declining/at risk.”

To address this critical issue, Richard Wright has developed a system using the Grove-Vision AI Module to detect, monitor and protect penguins when they come ashore and send the notification via LoRa®. However, this task is quite challenging as penguins typically come ashore at dusk when it is too dark to capture them, but Richard Wright believes that it is a crucial and ongoing endeavor that people must undertake.



Seeed’s hardwares used in this project:

SenseCAP K1100 –The Sensor Prototype Kit with LoRa® and AI
Wio Terminal Chassis
Wio Terminal Chassis –Battery

Softwares used in this project:

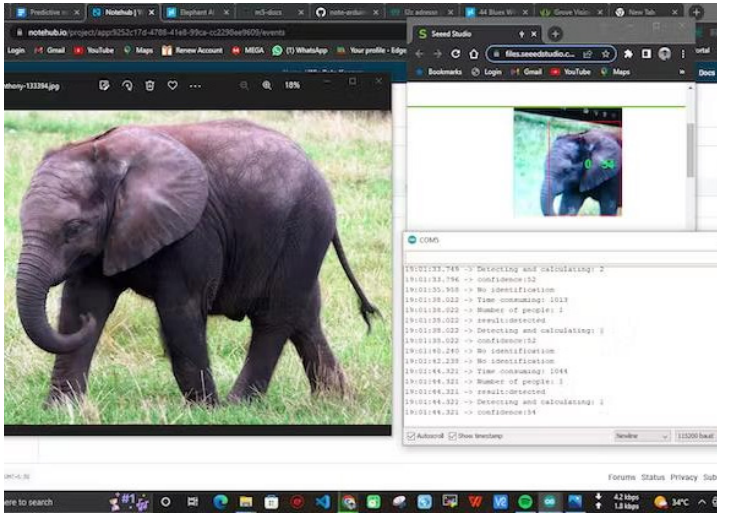
CODE

>>Read the full project on Hackster

17. Gate Keeper –An IoT Based Elephant Detection System

Located in southern India, Ooty is a picturesque hill known for its scenic beauty. However, the frequent entry of elephants into the area often causes panic among the residents. While the sounds of these giant mammals sometimes alert the locals, they usually remain silent, posing a significant risk of human-elephant conflict.

To mitigate this issue, Pradeep Thiruna and his team developed an IoT-based Elephant Detection System using the SenseCAP K1100 – The Sensor Prototype Kit with LoRa® and AI. They integrated the Grove-Vision AI Module to detect and monitor elephant activities and promptly alert the residents via SMS or email.



Seeed's hardwares used in this project:

SenseCAP K1100 –The Sensor Prototype Kit with LoRa® and AI

Softwares used in this project:

ARDUINO Qubitro blues wireless

>>Read the full project on Hackster

18. TinyML Gesture Recognition with SenseCAP A1101 Vision AI

In this project, Yanming demonstrates the process of utilizing the SenseCAP A1101 Sensor. The steps include initiating the sensor, gathering data, annotating and creating a dataset using Roboflow, training a custom gesture detection model with Google Colab and TensorFlow Lite, deploying the AI model, and uploading data to the SenseCAP Cloud platform.

The SenseCAP A1101 LoRaWAN®Vision AI Sensor combines advanced TinyML AI technology with LoRaWAN®long-range transmission capability, making it suitable for efficient and high-performing AI applications in both indoor and outdoor environments. crucial and ongoing endeavor that people must undertake.

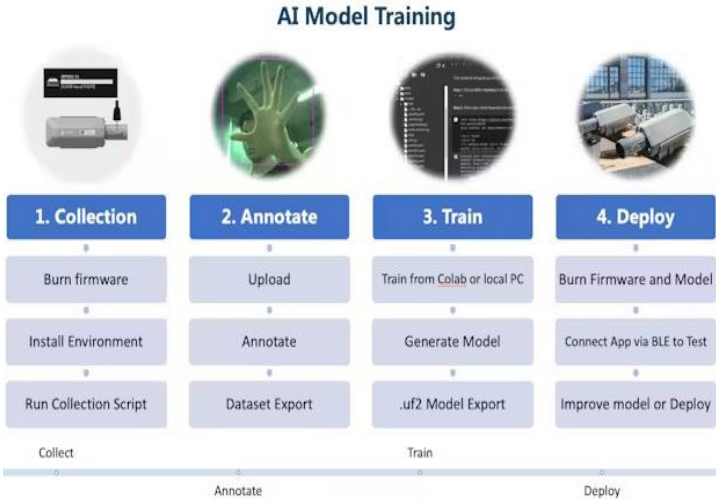
Seeed's hardwares used in this project:

SenseCAP A1101 Vision AI LoRaWAN Sensor
SenseCAP M1 LoRaWAN Indoor Gateway -EU868

Softwares used in this project:

roboflow SENSECAP

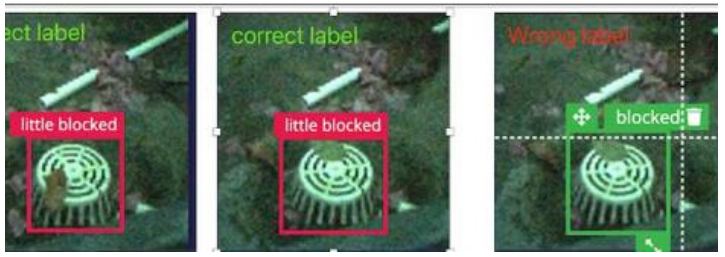
>>Read the full project on Hackster



19. Detect the Drain Blockage with Tiny ML + LoRa®

Shuyang's office has a lovely balcony that resembles a peaceful garden during spring and summer with blooming flowers and plants. However, fallen petals and leaves can quickly accumulate and clog the drain, causing problems.

Shuyang wants to find a way to detect debris accumulation and receive alerts for timely action. To overcome challenges in installing sensors on the balcony and limited knowledge of coding and TinyML, Shuyang used a no-code solution with an outdoor smart image sensor that performs local inference and transmits results with LoRa®. Edge Impulse assisted with model training.



Seeed's hardwares used in this project:

·SenseCAP A1101 –LoRaWAN® Vision AI Sensor

Softwares used in this project:

EDGE IMPULSE

>>Read the full project on Hackster

Useful Links

- **Train and Deploy Your Own AI Model Into Grove -Vision AI Module**
  https://wiki.seeedstudio.com/Train-Deploy-AI-Model-Grove-Vision-AI/
- **HIMAX Yolo-Fastest Person Detection Example For Seeed Grove -Vision AI Module**
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