Making sense of the wild

Eric Pan
CEO
seeed studio
How it started since 2008

From possibilities to productivities

How it’s going 2022
Community driven, Industry oriented

Global Developer Communities

Collaborative Innovation

Integration

Edge Computing
Computing Modules
Edge Computing Devices

IoT Network
Communication Modules
IoT Communication Devices

Smart Sensor
Sensor Modules
Smart Sensor Devices

Services
Instruments
Prototypes

Engineering Kits
Tools and Accessories

Solution

Traditional Industries

Digital Economy

Emerging Technologies

Software
Scientific Research Achievements
New Materials

Chips
Algorithms
Accessories

seeed studio
Open technology for the rest of us.

Make Sense of the Wild

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Making Sense
Open Hardware Sensor system
Sensor + TinyML

Multi Gas Sensor + Embedded AI = Smart Nose

Alcohol classification using the Artificial Nose
Smart Nose for Real Problems
Liquid Classification with TinyML

TDS (Total Dissolved Solids) sensor + Turbidity Sensor + Wio Terminal + Embedded AI = Smart Tongue
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 KT100 – The Sensor Prototype Kit with LoRa® and AI
The true frontier of IoT

%99 of planetary surface

The wild
Off grid
Far away
Reckless

%1 of planetary surface
Civilized
Center of digital world
Crowded

[ Cloud ]
Established
Omnipotent

[ Edge ]
On premise
Interdependent

[ Prototype ]
Grove system
TinyML ready

[ Objects ]
Vision
Sound
Vibration

Air Temp&Humidity: 4.80 °C
Air Humidity: 14.38 %RH
Light Intensity: 5290.0 Lux
Barometric: 81360.0 Pa
Wind Speed: 12.5 m/s
Wind Direction: 20° (N)
Rain: 1.6 mm/hour
PM2.5: 5.3 μg/m³
PM10: 7.6 μg/m³

[ Soil ]
Lightness
Temperature
EC

Air Temp&Humidity: 24.80 °C
Air Humidity: 34.38 %RH
Light Intensity: 5290.0 Lux
Barometric: 101360.0 Pa
Wind Speed: 1.1 m/s
Wind Direction: 30° (N)
Rain: 0.6 mm/hour
PM2.5: 12.0 μg/m³
PM10: 17.0 μg/m³

Tigers spotted
Drought
Caution wildlife

404 connected
53 connected

Calm and eating

www.seeed.cc
Making Sense
Of the Wild
Operation Igloo White
1973
Acoustic Seismic Intrusion Detector
‘T-1151’ Dog Doo Transmitter
A huge failed IoT piloting project:

**Investment:**

1 billion dollars annually

• $30 million orbit reconnaissance aircraft for signal transmission.
• $20 million command post
• Deploying four $10 million worth of fighter jets
• $40 million worth of sensors
• Huge system and personnel maintenance costs

**Results:**

5000$ and

• Elimination of $5000 worth of trucks and several combat units
• Significant collateral damage to civilians
50 years later…
What’s different today?

- Millions of Long range communication infrastructure
- Millions of Cheap sensor with embedded AI
- Millions of makers all over the world
Low power long range networks

Coverage > 10KM

Thing centric infra
coverage < 1KM

People centric infra

Water

Cameras

Air

Location

Temperature & Humidity

Meteorology

Alarm

Others

LoRaWAN

Gateway

ITU

LoRaWAN

4G/5G

WIFI

Ethernet

Over 1M Helium hotspots ready for long range IoT
LoRaWAN Network rapid growing (Helium & TTN)
pervasive LoRaWAN infrastructure

by operators

web3 infra >1,000,000 hotspots

private

hijack consumers > 10,000,000 hotspots
SenseCAP S210x Sensors

SenseCAP S210x series sensors offer long-distance data acquisition via LoRaWAN®. With IP66 enclosure rating, the sensors can operate in extremely low and high temperature zones (-40°C to +85°C). Their built-in, 19Ah high capacity battery, S210x series can operate in harsh, outdoor environments up to 10 years with a range of up to 10km. To add, the built-in Bluetooth made them easy to be configured and deployed, that together reduces field deployment costs. Moreover, users can get data in just a few steps, and with open Cloud API, they are easy to be integrated.
SenseCAP S2100 LoRaWAN® DTU
LoRaWAN Data Logger

SKU 114992872

Overview
SenseCAP S2100 Data Logger can connect to Modbus-RTU RS485/Analog Input/GPIO sensors and transmit data from sensors to the LoRaWAN® network. It is specifically optimized for OTA with built-in Bluetooth, which enables quick setup and update. It can be battery-powered or connected to a 12V external power supply. With the help of S2110 sensor builder, S2100 Data Logger is able to connect to Seeed Studio’s wide range of Grove Sensors, which will make it the ideal solution for developing, fast prototyping, and small deployment for DIY Industrial level LoRaWAN® Sensors.
Build your own sensors
Or use light sensor by default

https://github.com/Seeed-Studio/Seeed_Arduino_S2110

Modbus Register Table

<table>
<thead>
<tr>
<th>Grove Sensor Name</th>
<th>Register Name</th>
<th>Register Address (Hexadecimal)</th>
<th>Register Address (Decimal)</th>
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<tr>
<td>Grove - CO2 &amp; Temperature &amp; Humidity Sensor (SCD41)</td>
<td>Temperature</td>
<td>0x0004</td>
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<td>Humidity</td>
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<td>CO2</td>
<td>0x0008</td>
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<td>Grove - Light Sensor v1.2</td>
<td>Light</td>
<td>0x000A</td>
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<td>Grove - Flame Sensor</td>
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<td>0x000C</td>
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<td>Grove - Oxygen Sensor (MIX8410)</td>
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<td>0x000E</td>
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<td></td>
<td>Light Intensity</td>
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<td>Grove - Sunlight sensor (SI1151)</td>
<td>Visible Light</td>
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<td>UV</td>
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<td>Grove Temperature and Barometer Sensor (BMP280)</td>
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<td>Atmospheric Pressure</td>
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<td>Height</td>
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<td>Air Quality(VOC)</td>
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<td>CO</td>
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<td>0x002C</td>
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<td>Grove - Turbidity Sensor Meter V1.0</td>
<td>Turbidity</td>
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<td>Grove - TDS Sensor</td>
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<tr>
<td>Grove - Ultrasonic Ranger</td>
<td>Distance</td>
<td>0x0032</td>
<td>50</td>
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Perfect combination between TinyML and LoRaWAN
Panda Sensor: Detection and Tracking in Sichuan, China

It is a vision-based tracking system deployed in "Laohegou Nature Reserve", so as to monitor wild pandas in Sichuan Province, China. Through combining Computer Vision AI and LoRaWAN technology, the system alerts when it detects and tracks pandas in the wild to help the conservation of the beloved creatures.

Wild panda monitoring has been traditionally done manually by rangers, which was difficult, time-consuming, and inefficient. Through this digitalized system, the rangers can monitor illegal activities (such as poaching and invasion), that can help protect animals from various risks in wildlife habitats. The application of real-time monitoring and intelligent identification technology can not only reduce human interference to the conservation areas, but also shorten the distance between pandas and the outside world.
SenseCAP A1101

LoRaWAN Vision AI Sensor

- Ultra-low power AI chipsets
- Built-in AI inference
- Long Range transmission
- Up to 10 years battery life
- IP66 protection
- Designed for wild deployments

Train at Edge Impulse
Deploy and verify
Remote sensing with APP

79$ MSRP
All in one TinyML sensor

**Seeed Studio XIAO ESP32S3 Sense**
Ultra-small ESP32-S3 development board with OV2640 camera

**HIGH-PERFORMANCE**
240MHz Xtensa 32-bit LX7 dual-core processor

**MEMORY**
8MB PSRAM + 8MB FLASH

**MULTI-FUNCTIONAL**
Microphone/SD card slot/Detachable OV2640

**WIRELESS**
2.4GHz WiFi and BLE 5

**TINYML-SUPPORTED**
Image Processing/Speech Recognition

Xiao = 小 (xiǎo) = Tiny
SenseCraft: No Code & No IoT

1 Sense
   Built in & Add on

2 Process
   Data Handling & Machine Learning

3 Uplink
   Network Connectivity

-Tech4All: no node needed to overcome barrier to build AIoT projects;

-Open & Inclusive: supports various open source hardware platforms

Open Source on GitHub: https://github.com/Seeed-Studio/SenseCraft
Perception system for real world data

Smart Sensors - Collect data -

Long range network - Coordinate data -

Edge computing - Process and store data -
Making Sense Of the Wild
With the community
IoT2wild Contest

Winner Announcement:
IoT Into the Wild Contest for Sustainable Planet 2022

October 11th, 2022
16:15P.M.-7:00P.M.
Pacific Standard Time

Website: https://www.hackster.io/contests/iotinthewild
Winner announced at Hackster Impact Summit on October 11, 2022

- Early Detection of Harmful Algae Bloom
- Early flash flood warn system
- Wild Animal Tracker
- MonChan
- Black Soldier Fly Farming

Make Sense of the Wild

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Smart Lake - Early Detection of Algae Bloom

By, Sashrika Das & Mithun Das

Project Description
Using data from different sensors and ML on the edge, this device can detect early sign of algae bloom and notify authorities or citizens.

Highlights
- Multi-model sensing
- Edge AI for inference
- Long-range, low-power monitoring
- Full stack open source

Keywords: Climate Crisis Prevention/Mitigation, LoRaWAN, Blockchain, AWS
AgroLoRa

By, EdOliver & Victor Altamirano

Keywords: Precision Farming, LoRaWAN, Helium, AWS

Project Description
Automated irrigation and crop health monitoring device for local and urban farming, developed on the basis of SenseCAP K1100 Kit, while performing predictive agriculture analytics via Helium network.

Highlights
- All-in-one, inexpensive precision farming solution
- Predictive analysis
- Long-range, low-power monitoring
- Full stack open source

Sustainability Topic

76% Agriculture

Prototype

Key Info to Monitor

Scan to Know More
IoT AI-Driven Tree Disease Identifier w/ Edge Impulse & MMS

By, Kutluhan Aktar

Keywords: Tree Disease, Edge Impulse, MMS

Project Description
Tree disease identifier using SenseCAP K1100 Kit, Wio Terminal, and Grove sensors (CO2, temperature, humidity sensors) to collect data from trees infected with different types of plant diseases, and then uses Edge Impulse to train the object detection model with machine learning, and finally, receives the detection results and early warning notifications through MMS.

Highlights
- Web application in PHP to save the transferred detection results (images)
- Long-range, low-power monitoring
- Full stack open source

Sustainability Topic

Key Info to Monitor

Prototype

Scan to Know More
Weather Balloon "Mining" Using Blockchain and IoT

By, Nicolas Lopez  
Keywords: Climate Crisis Prevention, LoRaWAN, TTN, Node-RED

Project Description
Floating balloon to measure meteorological data 32,000 feet above West Africa, using a Grove sensor (air temperature, humidity, barometer sensor). Helium’s LoRaWAN network was used to transfer the collected environmental data, after which Node-RED (no-coding platform) was used to process weather observations and authentication checks.

Highlights
- 25 launches of weather balloons with students in Africa and the USA
- Long-range, low-power monitoring
- Full stack open source

Sustainability Topic
NATURAL DISASTERS
- tornado, volcano, earthquake, tsunami
- drought, avalanche, dust storm, forest fire
- thunderstorm, snowstorm, hurricane, windstorm
- hailstorm, flood, sandstorm, sinkhole

Key Info to Monitor
- Sun, Rain, Temperature

Prototype

System Diagram

Scan to Know More
Project Description
Wildlife movement and behavior tracking device for endangered species to research about their biology, using Wio Terminal, Grove - Long Range 868MHz, and Arduino IDE. Used for field monitoring in mapping out and monitoring the animal’s movement patterns, trajectories, nests, and natural environmental habitats in real-time.

Highlights
- Latest status quo of the wildlife and their natural habitats
- Long-range, low-power monitoring
- Full stack open source

Keywords: Wildlife Conservation, Biodiversity, LoRaWAN, Arduino IDE
MonSand: Monitoring Illegal Sand Mining

By, Raunak Singh

**Project Description**
A device that detects illegal sand mining activities in the oceans and river banks, by using Wio Terminal, SenseCAP K1100 Kit, Grove Lora E5, after which the collected data is sent to Helium Console, and then the monitoring outcome analysis will be directly shown on Google Sheets to send SNS to relevant authorities, either government agencies or NGOs.

**Highlights**
- Embedded system to map out illegal sand mining sites
- Long-range, low-power monitoring
- Full stack open source

**Keywords:** Illegal Sand Mining, Marine Conservation, LoRaWAN, Helium

**Prototype**

**Sustainability Topic**

**System Diagram**

**Key Info to Monitor**

Scan to Know More
XIAO Empowers TinyML in Academy

Ready-To-Use XIAO Course: Big Power, Small Board - Mastering Arduino and TinyML

This course uses a project-based approach and hands-on practice to teach students how to create projects with Seeed Studio XIAO, from simple LED lighting to TinyML projects. Community-made project cases are also included to inspire students to explore the technological possibilities of XIAO.
The new XIAO ESP32S3 development board is an ideal fit for TinyML education and projects in developing countries due to its affordability, high quality, and ease of setup and use.

--- Quote from Prof. Marcelo Rovai
TinyML Case Studies

IoT AI-driven Yogurt Processing & Texture Prediction by Kutluhan Aktar

Background
Yogurt's 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.

Solution
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.
A Pet Activity Tracker using XIAO BLE Sense & Edge Impulse

**Background**
Why should humans have all fitness trackers? Our pets deserve more to stay active. We love our pets and we want the best for our pets: good health, deep sleep, nutritious food—essentially, all the things that ensure a long, happy life together.

**Solution: A Low-Cost and Flexible Fitness Tracker Especially for Pets**
This tracker only includes an XIAO nRF52840 Sense, a rechargeable battery, and a case on the hardware side. Mithun Das trained a TinyML model to make the pet's activity recognizable and identifiable and designed an accompanying mobile app connected to the device over Bluetooth and a microcontroller sends prediction data every minute. Data is stored on mobile local storage and plotted on graphs to provide meaningful insight.
Unify the AI sensor standards and create more

Based on various digital transformation scenarios, we continue to develop smart devices that integrate the latest technologies, and work closely with developers and industry experts to provide software and hardware solutions for vertical industries at multiple levels.
bridge between science and practice

(4) Silt Pressure

\[ P_{silt} = \frac{1}{2} \gamma_{silt} \theta_{silt} \theta_{silt} \alpha \]

neglected, if considered after time a part of the dam

(5) Wave Pressure

\[ P_{wave} = \frac{1}{2} \left( \frac{5}{2} \gamma_w h_w \right)^2 \]

= \frac{1}{2} \left( \gamma_w h_w \right)^2 \]

= 2000 \gamma_w h_w \]

= 2h_w \gamma_w \]

\[ P_w = \text{wave force} \]

\[ h_w = \text{wave height} \]

\[ = 0.032 \sqrt{V} + 0.063 - 0.211 \sqrt{F} \]

\[ = 0.032 \sqrt{V} \]

\[ (F \geq 50 \text{ km}) \]

\[ V = \text{wave speed (km/h), } F = \text{straight length (km)} \]

(6) Ice Pressure

\[ P_{ice} = 0.5 \gamma_{ice} \theta_{ice} \theta_{ice} l/m^2 \]

= 25 - 150 \gamma_{ice} \theta_{ice} l/m^2

\[ \theta_{ice} = \text{depth of ice layer} \]
From data to GPT insights

SUSTAINABLE AGRICULTURE

- Soil Salinity Management
- Post Harvest Losses Management
- Livestock Management
- Water and Irrigation Management
- Energy Management
- Erosion Management
- Integrated Pests Management
- Pasturelands Management
- Nutrients and Soil Fertility Management
- Wetlands Management
- Fisheries and Aquaculture Management

AI answers are provided for reference only. Please use them with caution as SenseCAP cannot be held responsible for any consequences resulting from the use of AI services.

Crop or Animal *

Input the crop or animal

Location *

Input Location

Time *

1 Month 6 Months 1 Year

Measurements (up to 5) *

Send

Environmental Data analysis:
The average soil temperature of 26.49°C in Sichuan is suitable for strawberry cultivation. However, further analysis is needed to provide more specific advice.

Planting/Breeding advice:
For strawberry cultivation, it is recommended to select suitable cultivars that can tolerate high temperatures and have good heat resistance. Proper irrigation management is also crucial to maintain soil moisture and temperature. It is suggested to use mulching to conserve soil moisture and reduce soil temperature. Additionally, providing partial shade to the plants during the hottest part of the day can help to mitigate heat stress.

Pest control:
The specific environmental data provided does not give enough information to provide specific pest control recommendations. However, it is recommended to monitor for common pests that affect strawberries, such as spider mites, aphids, and thrips, and use appropriate control measures if necessary.
Commercialized Research Project: Carbon Monitoring System with Institute of Atmospheric Physics, Chinese Academy of Science

**Monitoring**
- Ground: Network of ground compact weather stations
- Air: Drones, Aircraft
- Space: Carbon Satellite: TanSat, GOSAT2, OCO3

**Simulation**
- Atmospheric Transport: WRF-CO2
- Ground Carbon Sources and Sinks: VEGAS/TRENDY
- Model Assimilation: LETKF-C, CarbonTracker

**Industry**
- Emission reduction policy in the making
- Construction of carbon emission accounting model
- Standard reference for comprehensive atmospheric control
- Building a comprehensive information platform
- Research and historical data sources

Data Collection with reliable and high-precision monitoring weather station from Seeed (Co2 monitoring with the accuracy of 1% in ppm)

Modeling Assimilation System: Data Processing and Analysis

High Resolution Simulation of Carbon Sources and Sinks in Beijing-Tianjin-Heibei City Cluster

According to the system, the average CO2 concentration of Beijing’s roads decreased by 40~60ppm

Make Sense of the Wild
Train local solution makers with confidence

**seeed studio**

**Digital Transformation 101**
Build your first perception system in 8 hours
The Fab Lab Network is a global community of makers, located in 90+ countries with 1,500+ Fab Labs. They share tools and knowledge to democratize technical invention and foster innovation.
FabXIAO

XIAO is the Designated Official Teaching Tool Recommended by Prof. Neil Gershenfeld, the Founder of the Global Network of Fab Labs.