Make Teaching Programming Great Again with TinyML

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Workshop on Widening Access to TinyML Network by Establishing Best Practices in Education

Agenda

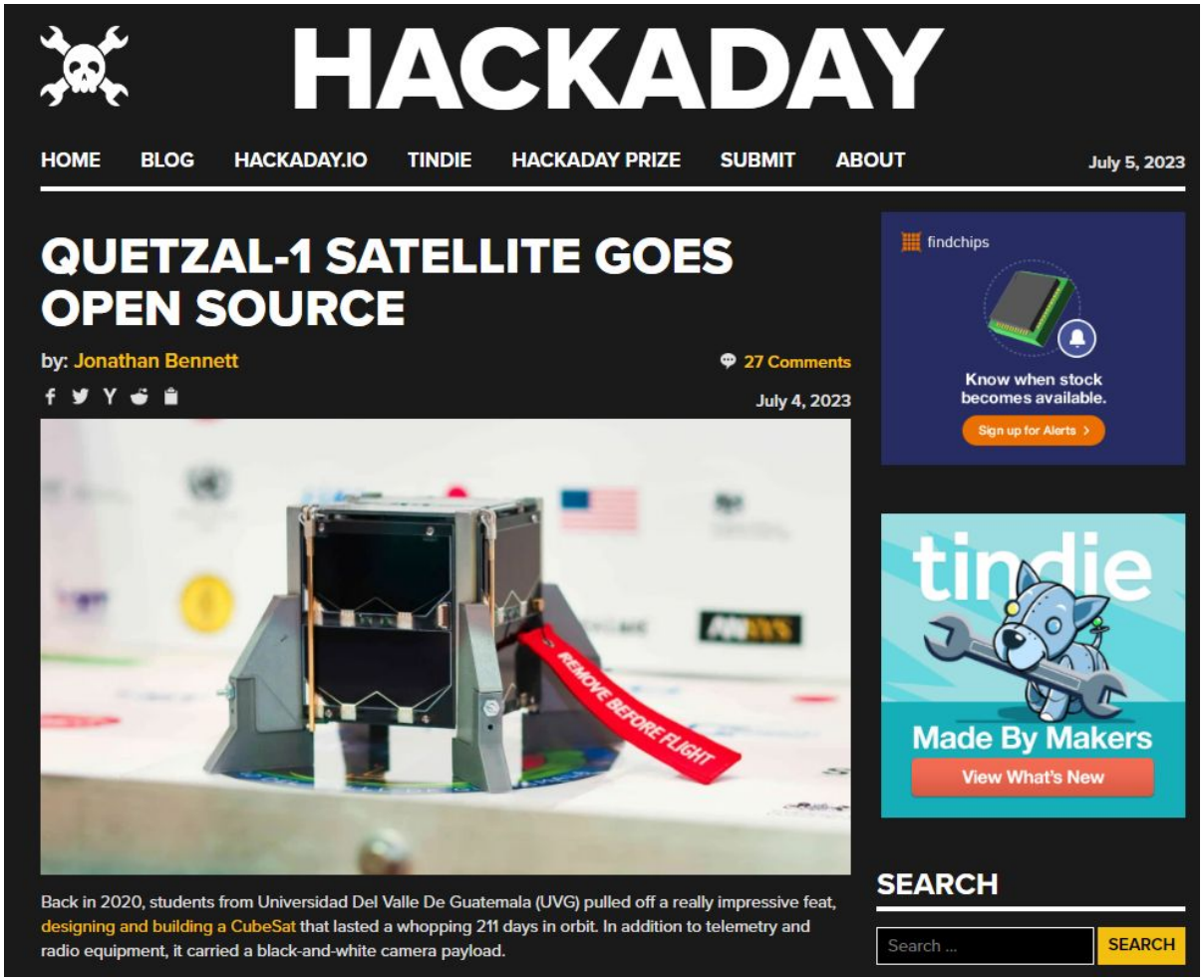
In this presentation I am going to talk about:

- Why TinyML at UVG?
- Anomaly detection
- The course (so far)

About me

Hello, my name is José and I am from Guatemala. I work at Universidad del Valle de Guatemala (UVG) as a lecturer in the Mechanical Engineering Department; I am also involved in the Aerospace Laboratory at UVG. In addition to my work at the university, I'm part of the Arduino team, where I contribute as a content creator for Arduino PRO.

Why TinyML AT UVG?

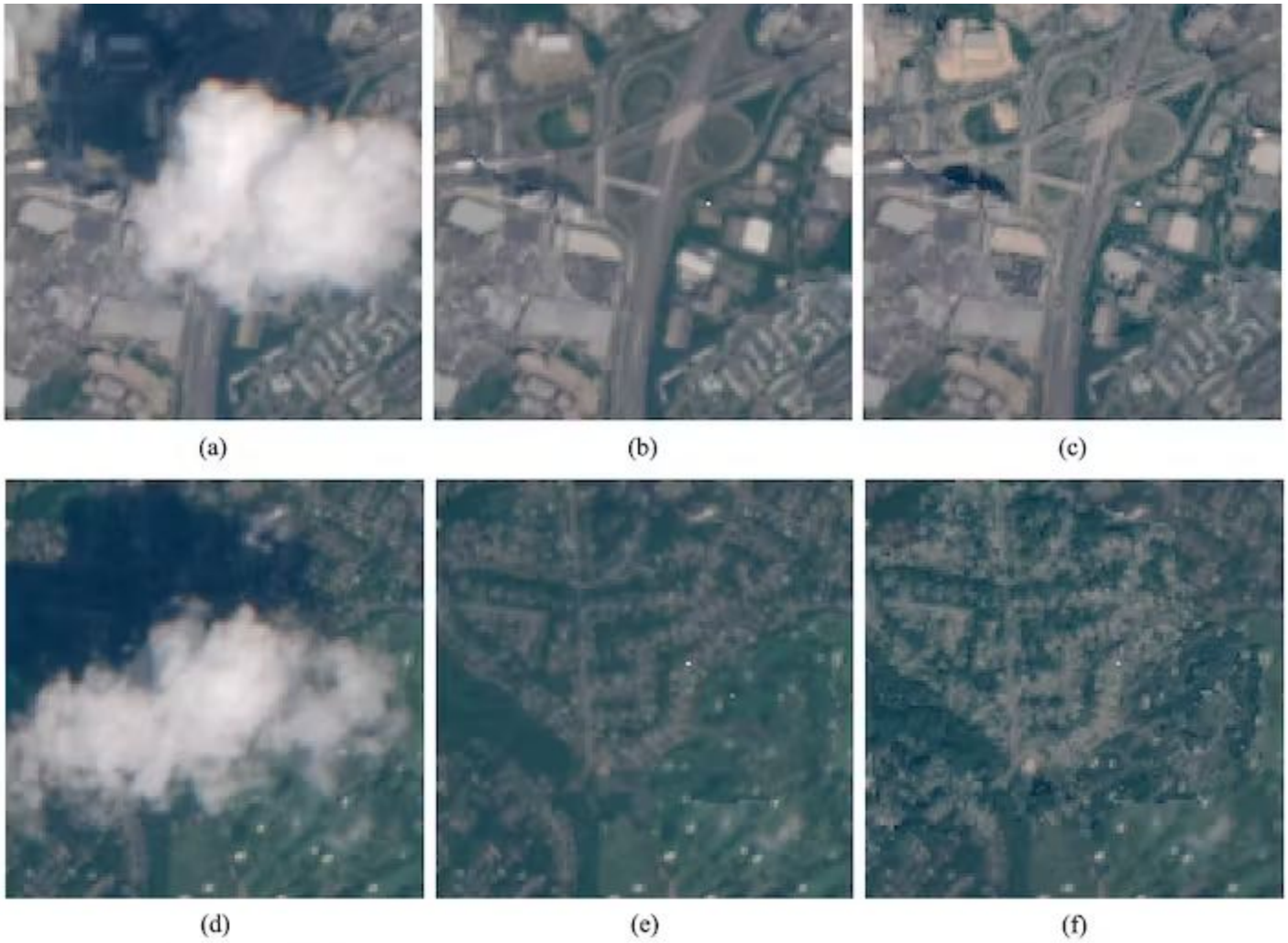


Why TinyML AT UVG? (2)

This is the first picture of Earth taken by a Central American satellite!

But, is it useful?

Why TinyML AT UVG? (3)



Why TinyML AT UVG? (4)

In summary:

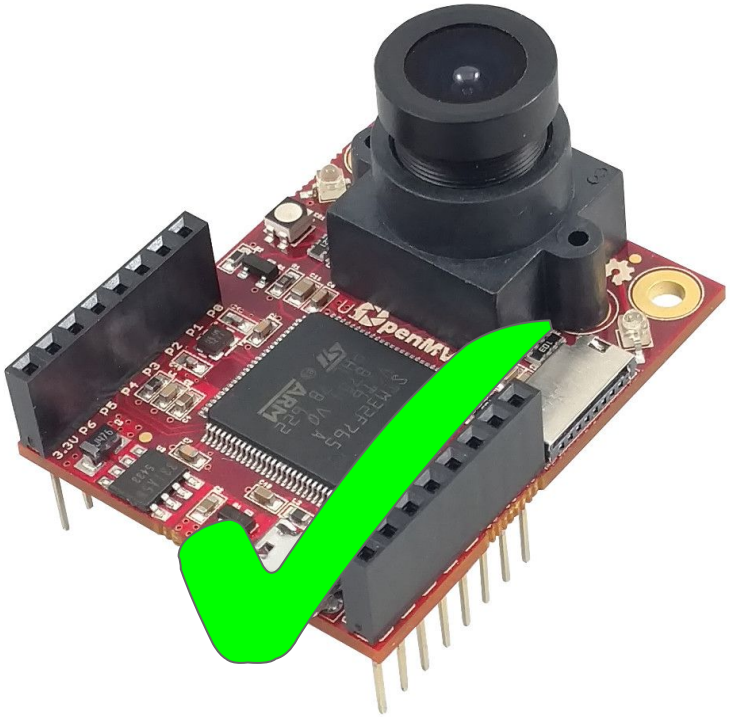
Occluded images of Earth, either through clouds or unidentified objects during the image capture, produce no information about the terrain.

Why TinyML AT UVG? (5)

Why TinyML AT UVG? (6)

Why TinyML AT UVG? (7)

So I have the dataset, I have the software (Arduino and Edge Impulse) and I got the hardware (OpenMV camera). What I didn't had was the most important part: **people**.



Why TinyML AT UVG? (8)

Aerospace Laboratory of UVG is manage by the Mechanical Engineering Department, meaning that most of the students a the laboratory have something in common:

- **THEY HATE PROGRAMMING**

So the question is: **How I can get my students into programming embedded systems and into TinyML FAST but without losing my mind (and them)?**

My bet: a simple introductory course to TinyML based on a simple anomaly detection application

Anomaly Detection

Anomaly detection is the process of **identifying unusual patterns, events, or data points** that deviate significantly from what is considered normal or expected.

Anomaly detection is a crucial and challenging task that has gained importance across various fields, including **finance**, **cybersecurity**, **healthcare** and **industrial equipment monitoring**.

- Most of my students are from Mechanical Engineering, so making something related to it makes it more interesting also (and meaningful for them).

Anomaly Detection (2)

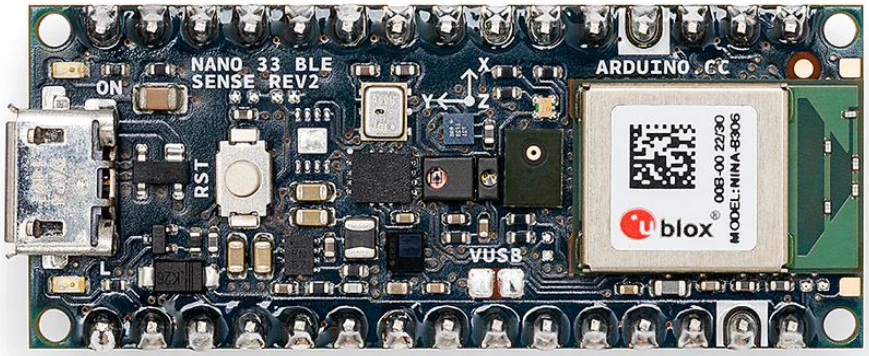
The designed course is focused on developing a **simple anomaly detection application for a fan**.

We use **cheap computer fans** that can be found in any electronics store (or electronics dumpster 😅).

Accelerometer placement in the fan

Anomaly Detection (3)

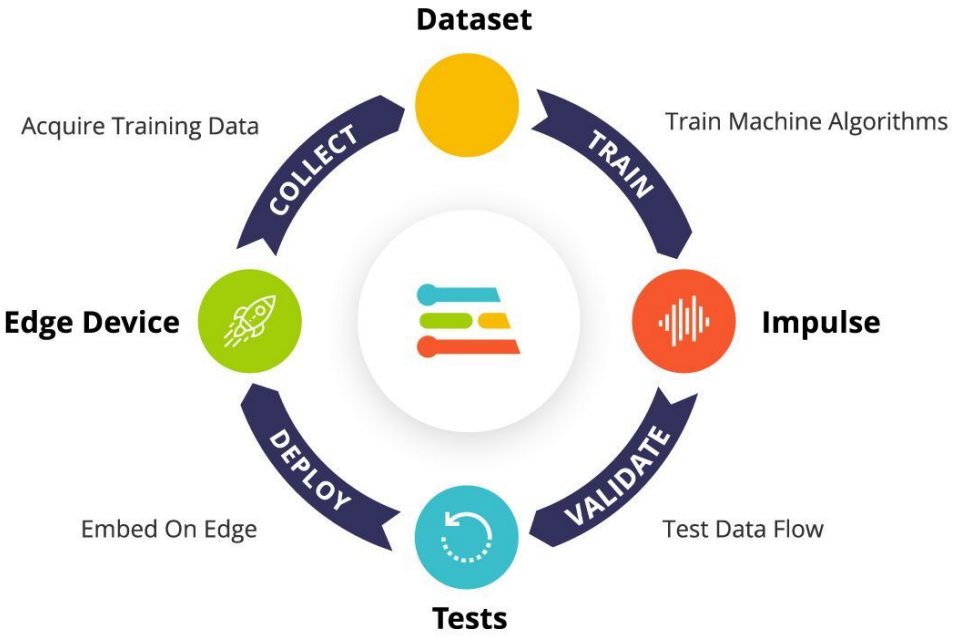
We use a **Nano 33 BLE Sense** for getting the vibration data we need for the model (TinyML kit donated by the TinyML4D network)



Anomaly Detection (4)

We use Edge Impulse for training and deploying the TinyML model to the board.

Alternatively we have been using and making tests also the Fraunhofer AIfES library for Arduino.



The Course

So far, the course is divided into **four main modules** (usually one or two weeks per module depending on the semester):

1. TinyML and anomaly detection basics
2. Getting vibration data from the fan
3. Training the model and testing it with Edge Impulse
4. Deploying the model into the Nano 33 BLE Sense board

The course ends with a live demonstration of the model and a discussion session of the experience.

Note: “The what and the how”

The Course (2)

Students are also encouraged to design a proper enclosure for putting the board into the fan. Most of them use 3D printers, some use laser cutting.

Interesting questions and solutions around this task!

The Course (3)

Some interesting findings from my last course (35 students enrolled):

1. Edge Impulse install process can be frustrating in some computers, even using the Web-based connection.
2. Interesting questions around the accelerometer placement in the fan.
3. Data curation? How? When?
4. How many samples? When is good to stop?
5. How we can scale it from a computer fan to a real industrial fan?
6. Can we make money with this?

The Course (4)

The future of the course:

1. **We are going open-source!**
2. Book publication (in Spanish and open source)
3. Professional update course to be held by the end of the year (money will be used to buy more kits).
4. Image classification course?
5. Alumni working on this for a company

The Course (5)

The future of the course:

1. We are going open-source soon!
2. Open access book publication (publish by the UVG in Spanish)
3. Professional education course (paid)
4. Image classification?
5. Collaboration with industry!

Thank you for your attention

Let’s keep in touch!

- Email: **jabagur@uvg.edu.gt**