

Digital signal processing

Investment opportunities

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- 2 What is digital signal processing?
- 3 Personal portfolio
- 4 Outsourcing opportunities

Safecast: Fukushima Dai-ichi, March 11th 2011



<https://home.bt.com>



<https://file.ejatlas.org>

Safecast: Fukushima Dai-ichi, March 11th 2011 (cont.)



<https://www.tokyohackerspace.jp/assets/images/events/>

image2.jpg



<https://i.imgur.com/wfa34yD.jpg>

Safecast: Fukushima Dai-ichi, March 11th 2011 (cont.)

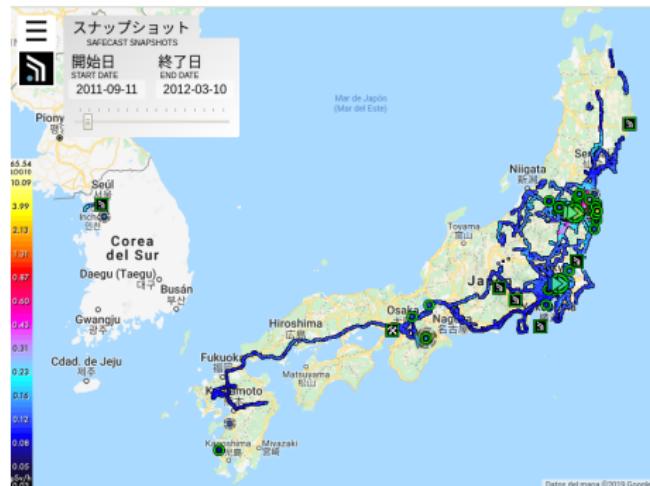


<https://i.imgur.com/EeRcK0K.jpg>

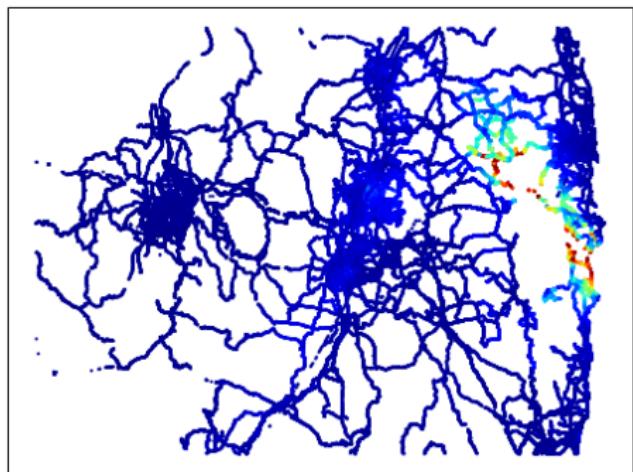


<https://i.imgur.com/FLNtxDZ.jpg>

Safecast: Fukushima Dai-ichi, March 11th 2011 (cont.)

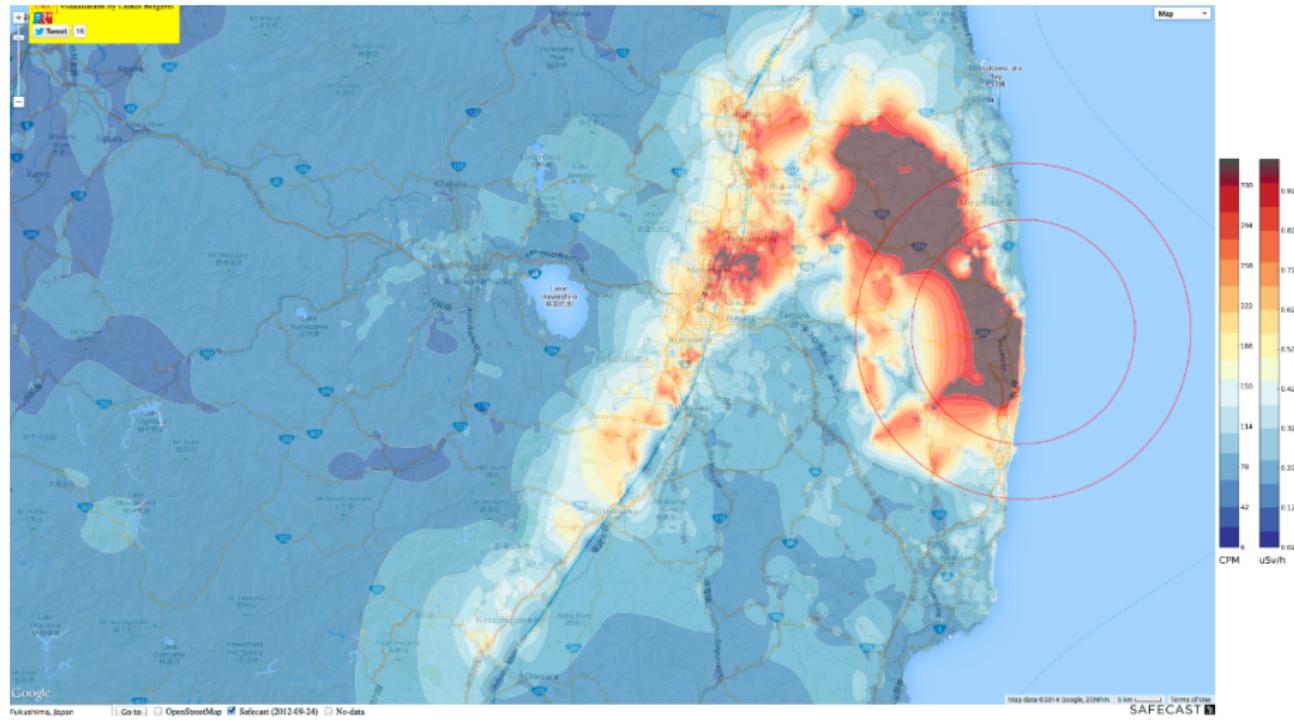


https:
[/safecast.org/tilemap/?y=36.57&x=133.72&z=6&l=14&m=0](https://safecast.org/tilemap/?y=36.57&x=133.72&z=6&l=14&m=0)



https://nbviewer.jupyter.org/github/LCAV/
SignalsOfTheDay/blob/master/Safecast/Safecast.ipynb

Safecast: Fukushima Dai-ichi, March 11th 2011 (cont.)



<https://i.imgur.com/08Aa4KA.png>

Safecast: Fukushima Dai-ichi, March 11th 2011 (cont.)

This project indeed represented a big help, but it was possible only after answering these questions:

- ▶ Is high quality 2D interpolation possible with scattered data?
- ▶ What sampling rate would avoid aliasing in 2D interpolation?
- ▶ If the data is corrupted, can we denoise it?
- ▶ Can we reduce the dimensionality of the data to make easier the training of forecasting models?

Guess what? Safecast members found the answers because they had knowledge in treatment of large amounts of data!

Safecast: Fukushima Dai-ichi, March 11th 2011 (cont.)

CR has natural disasters (earthquakes, landslides, floods and even tsunamis), why aren't those cool things done here?

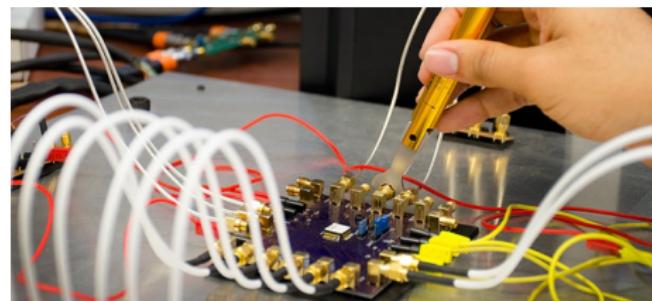
- ▶ It's because Japan is prepared for Industry 4.0

In essence, industry 4.0 describes the trend towards automation and data exchange in manufacturing technologies and processes which include cyber-physical systems (CPS), the internet of things (IoT), industrial internet of things (IIoT)[2], cloud computing [3][4][5][6], cognitive computing and artificial intelligence. - Wikipedia

DSP Investment opportunity

But Costa Rica has knowledge to handle large amounts of data...

- ▶ The ITCR offers specializations on data science and digital signal processing (DSP)
- ▶ At least 5 companies in CR have started to use this knowledge years ago
- ▶ What about you?



https://www.tec.ac.cr/en/system/files/media/img/main/maestria_electronica-min.jpg

DSP Investment opportunity (cont.)

Think on this:

- ▶ CR cannot compete with the massive chinese, indian and bulgarian workforce on SW/HW
- ▶ We need to find market niches that require strong mathematical knowledge
- ▶ DSP is an example of that niche, plus it has a high impact given its enormous applicability



<https://youtu.be/c55f1VYrqug>

DSP Investment opportunity (cont.)

Why DSP and not data science? How are them related to big data?

- ▶ Data processing consists in two stages that overlaps:
 - Data acquisition and preprocessing (cleaning): **a DSP job**
 - Data modeling and forecasting: **a data science job**

If you put a data scientist to clean data using a classifier, guess what...
the model becomes heavy and vulnerable to overfitting/learning paralysis.

Made on Costa Rica

Real time processing of sensor data for agricultural meteorological stations:

- ▶ Lantern Technologies CR, Microsoft, IICA - Aug. 2019
- ▶ Sensors supported by mobile app: soil humidity, temperature, rain, light, dew, wind speed and direction



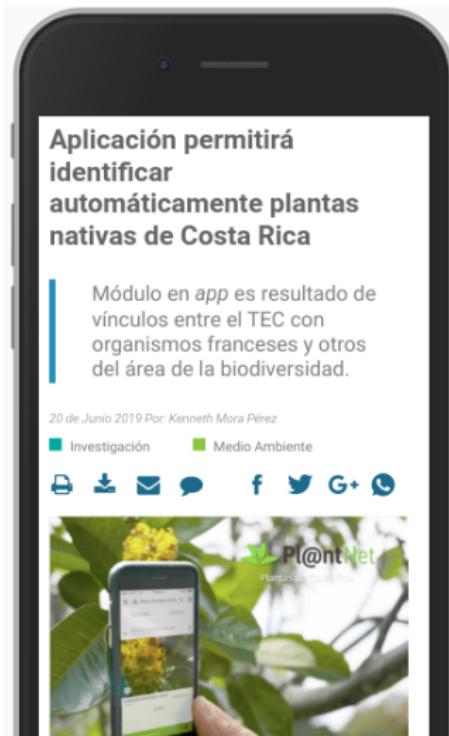
San José, 21 ago (elmundo.cr) – Microsoft, Lantern Technologies y el Instituto

<https://www.elmundo.cr/mundo/>

Made on Costa Rica (cont.)

Flora recognition using computer vision algorithms:

- ▶ France Tech Institute for CS (INRIA), TEC of Costa Rica - Jun. 2019
- ▶ Pl@ntNet mobile app that uses deep learning and DSP algorithms for image enhancement



<https://www.tec.ac.cr/hoyeneltec/2019/06/20/>

Made on Costa Rica (cont.)

Fishing certification using an embedded device attachable to boats:

- ▶ XYZ CR - Jan. 2019
- ▶ <https://www.remoraxyz.com/>



<https://www.nacion.com/tecnologia/innovaciones/empresa-tica-capaz-de-rastrear-origen-de-los-pes>

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What is digital signal processing?

DSP refers to the treatment of signals by digital means:

- ▶ Signals are measurable phenomena (physical or man-made)
- ▶ Digital stands for “the use of computers”
- ▶ Treatment can be several things, from analysis to synthesis

What is digital signal processing? (cont.)

Some examples of signals:

- ▶ Audio and video
- ▶ Biological signals (e.g. ECG, EEG, glucose levels)
- ▶ Smartphone sensor data (e.g. accelerometer, gyroscope, compass)
- ▶ Environmental (e.g. electromagnetic radiation, temperature, water level, humidity)
- ▶ Server response time, financial signals (e.g exchange rates), etc...

What is digital signal processing? (cont.)

DSP fill the gap of converting analog data to the digital world without any loss of information:

- ▶ Analog-to-digital (A/D) and digital-to-analog converters
- ▶ Sampling, interpolation, quantization
- ▶ Digital and analog circuitry

Note: Data scientists do not know how to do this.

What is digital signal processing? (cont.)

Pre-processing treatment for signals:

- ▶ Reconstruction of missing data and compression
- ▶ Noise cancellation or enhancement of components
- ▶ Fusion of multiple sensor data
- ▶ Dimensionality reduction
- ▶ Bandwidth optimization

Note: Data scientists might have an idea of know to how to do this, but they lack of the background to use the numerical tools (see next slide)

What is digital signal processing? (cont.)

What special knowledge do DSP engineers have?

Transforms: Fourier/Laplace/Z/Wavelet/PCA transforms

Signal operations: autocorrelation, convolution, modulation (AM, FM, PAM, QAM, ADSL), etc...

Filter design: FIR, IIR, adaptive (Kalman, Wiener, LMS, RLS), LPF, HPF, BPF, all-pass filter, comb and notch filters

Statistics: stochastic processes, Wiener-Kinchin, etc..

What is digital signal processing? (cont.)

How can a DSP engineer serve in your organization?

- ▶ Helping your **mobile developers** to clean sensor data and perform data fusion
- ▶ Helping your **data scientists** to reduce data dimensionality to improve their models
- ▶ Helping your **programmers** to perform computer vision and speech recognition tasks
- ▶ Helping your **quality assurance engineers** to do RPA and calculation of audio/video quality metrics

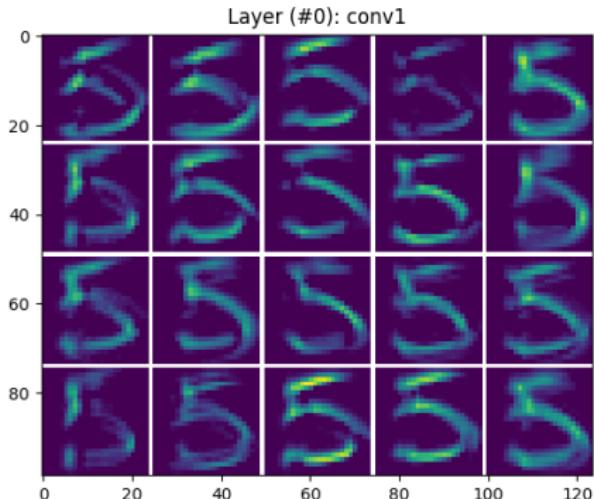
What is digital signal processing? (cont.)

With knowledge on psychoacoustics you can even perform:

- ▶ Speech processing / synthesis (TTS)
- ▶ Music information retrieval
- ▶ Audio compression
- ▶ Beamforming
- ▶ Echo cancellation
- ▶ Auralization for virtual reality
- ▶ Audio/video codecs evaluation, WebRTC (ITU-T, PESQ, POLQA)

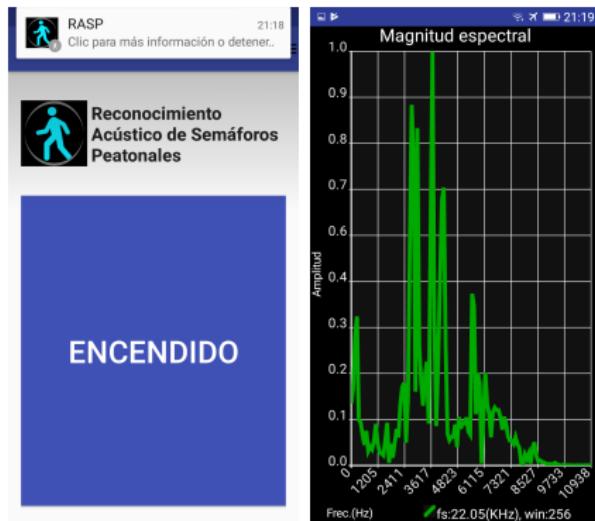
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Personal portfolio



J. Fonseca and L. Jimenez, Reconocimiento de dígitos escritos a mano usando aprendizaje profundo.

URL: <https://tinyurl.com/y58tnck4>



S. Ruiz, J. Fonseca and A. Camacho, Reconocimiento automático de semáforos peatonales (RASP), Android app.
URL: <https://play.google.com/store/apps/details?id=>

Personal portfolio (cont.)

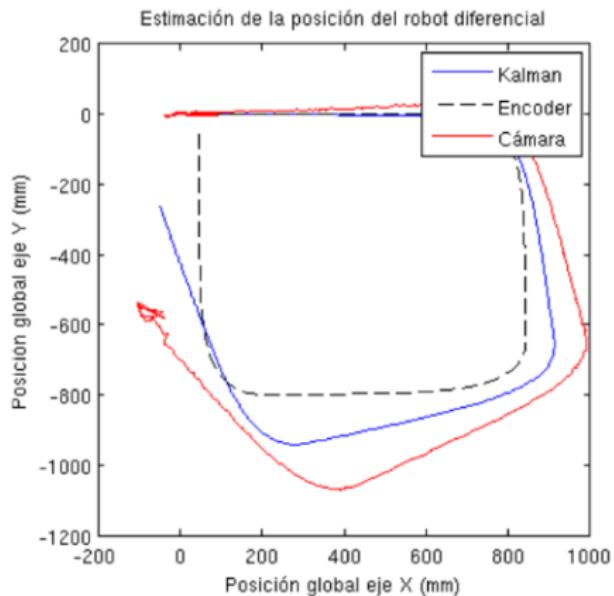


L. Jimenez, J. Fonseca. Pose estimation for a chessboard

(<https://www.youtube.com/watch?v=uHkUAkP3xYY>), and

Players detection using Meanshift

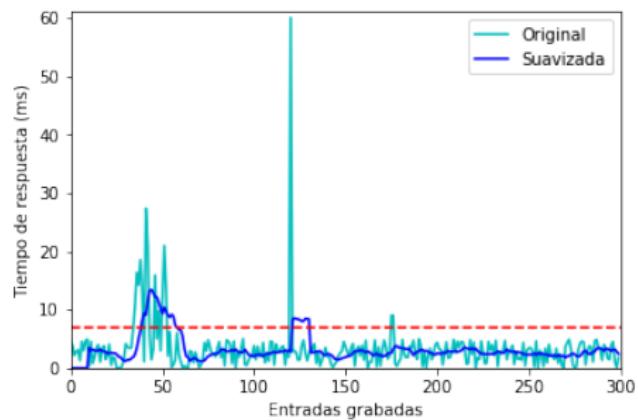
(<https://www.youtube.com/watch?v=d71rjkHQj6o>).



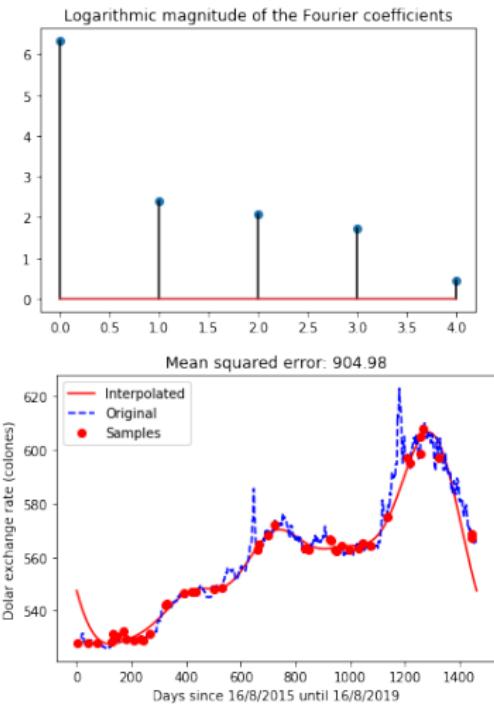
J. Fonseca, Kalman filter for encoder, gyroscope, and compass

sensor fusion.

Personal portfolio (cont.)



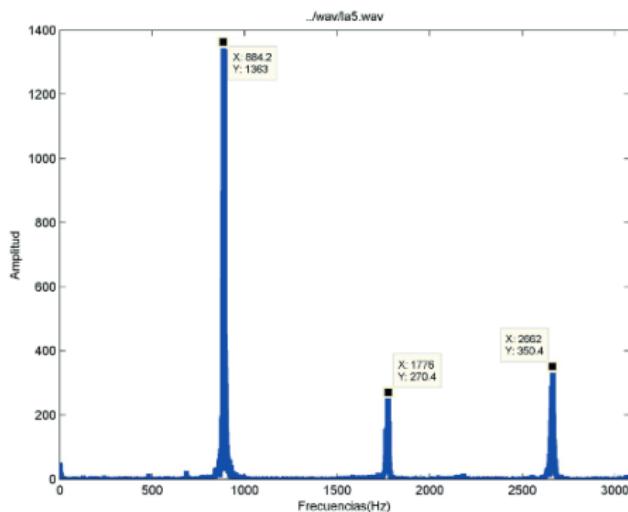
J. Fonseca, Media móvil para la emisión de alertas tempranas: el día en el que falló el sistema de facturación electrónica en Costa Rica. URL: https://juanfonsecasolis.github.io/blog/JFonseca_suavizadoTraficoServidorWeb.html.



J. Fonseca, Band limited interpolation for daily reference rates.

URL: <https://juanfonsecasolis.github.io/blog/>

Personal portfolio (cont.)



J. Fonseca, Automatic pitch recognition in a computer game interface.

URL: <https://doi.org/10.15517/ri.v25i1.11751>.

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Outsourcing opportunities

IEEE DSP job board: [https://signalprocessingociety.org/
professional-development/jobs-signal-processing](https://signalprocessingociety.org/professional-development/jobs-signal-processing)

Acoustical Society of America job board:

<https://acousticalsociety.org/jobs/>

Requirements:

- ▶ BS/MS EE, CS with knowledge on DSP
- ▶ Python, Matlab, Git, Tensorflow, C/C++
- ▶ Good English