Control of UAV for Indoors Inspection

Grupo de Instrumentación y Control

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$$P(demofailure) \sim 1 - \exp(-talktime)$$

Regional Workshop on the use of Wireless Sensor Networks and UAV for Radiation Measurement

A little bit of personal history...

Fukushima (2011) + Student looking for a masters thesis

UAV for radiation inspection

Complex problem, can be tackled at different levels …

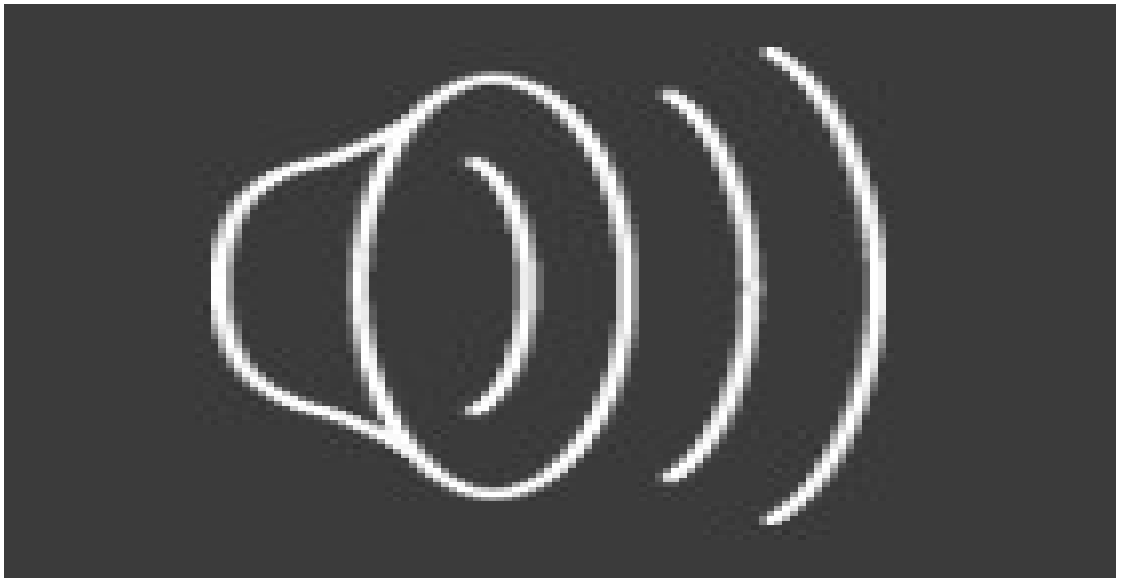
Not much info in Argentina at the time ➡ Started at the low level to get the KNOW HOW

Low level means... build from scratch :)

- Indoors trials evolve into indoors flying

  Not the same to drop electronics from 1m than from 50m

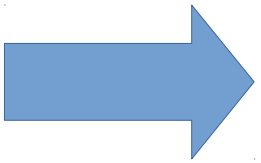
  (It will happen if your playing with the control laws all the time)



Indoors flying is challenging!

Not harder than outdoors, just different...

- No wind
- Low distances
- Objects!
- Precision



PERCEPTION

Complex! You split it...

+ Know were you are
+ Know what is there
+ Understanding

Perception sensors for indoors

- ~~GPS~~ → *Doesn't work indoors*
- Radio, WSN → *Doesn't give structure*
- LIDAR → *Expensive!*
- RGBD → *Fails on outdoors*
- VISION → *Computationally expensive*
  - + Monocular
  - + Stereo

State of The Art Monocular Visual Slam Systems

- ORB-SLAM - Sparse Feature Based

  Raúl Mur-Artal, J. M. M. Montiel and Juan D. Tardós. ORB-SLAM: A Versatile and Accurate Monocular SLAM System. IEEE Transactions on Robotics, vol. 31, no. 5, pp. 1147-1163, 2015

- DTAM – Dense, Direct

  Newcombe, R. A., Lovegrove, S. J., & Davison, A. J. (2011, November). DTAM: Dense tracking and mapping in real-time. In Computer Vision (ICCV), 2011 IEEE International Conference on (pp. 2320-2327). IEEE.

- LSD-SLAM – Semidense, Direct

  Engel, J., Schöps, T., & Cremers, D. (2014). LSD-SLAM: Large-scale direct monocular SLAM. In Computer Vision–ECCV 2014 (pp. 834-849). Springer International Publishing.

- SVO – Mixed

  Forster, C., Pizzoli, M., & Scaramuzza, D. (2014, May). SVO: Fast semi-direct monocular visual odometry. In Robotics and Automation (ICRA), 2014 IEEE

  International Conference on (pp. 15-22). IEEE.

And from the south of South America...

Realtime Edge Based Visual Odometry for a Monocular Camera (REBVO)

WHY EDGES?

- Fast and “easy” to find.
- Still features, but provide semidense information, that could be used to OA
- Can be tracked and mapped very efficiently

Juan Jose Tarrio, Sol Pedre; The IEEE International Conference on Computer Vision (ICCV), 2015, pp. 702-710

On GITHUB soon!

RUNS 25FPS on ARM!

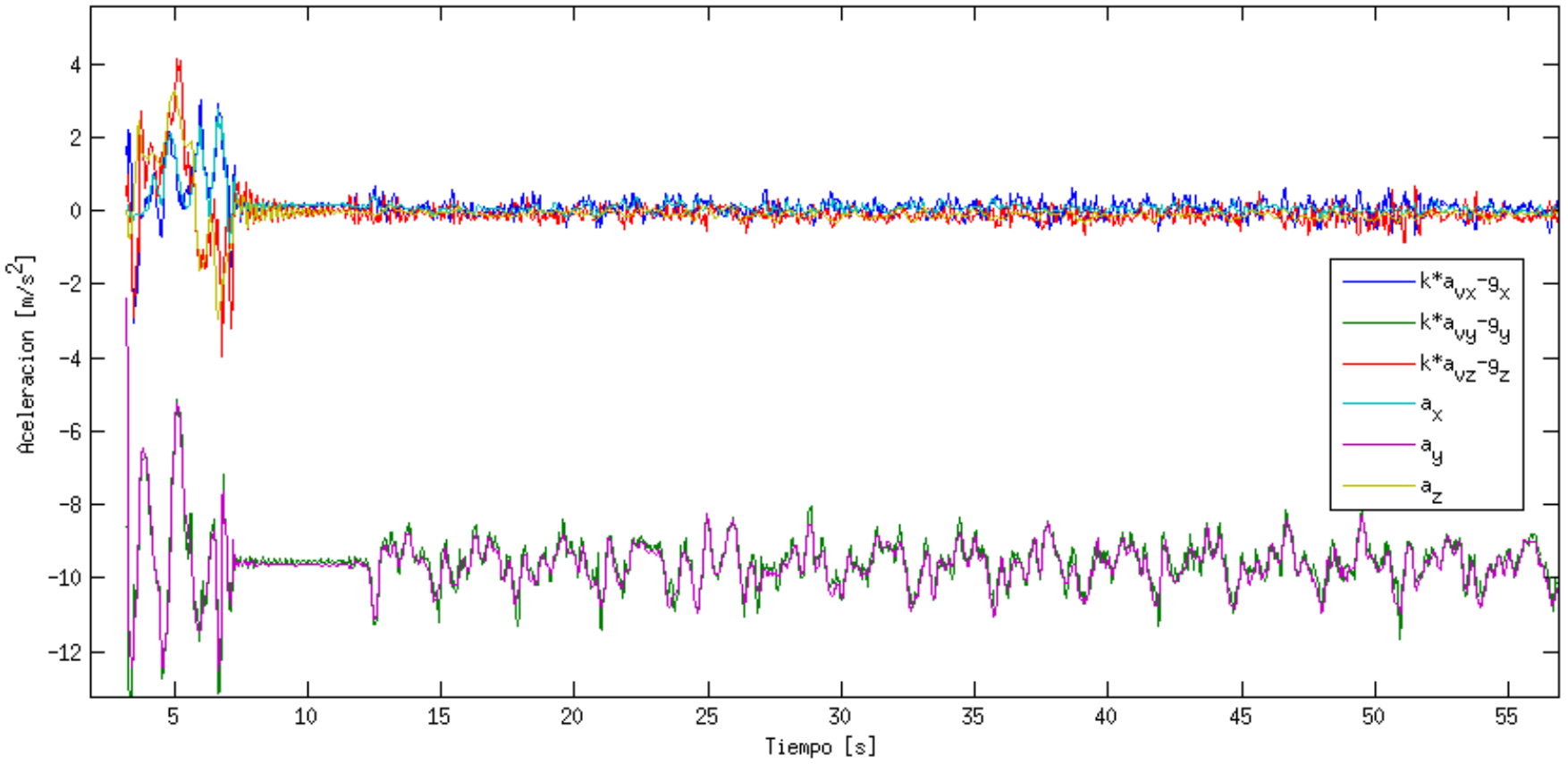
Not a SLAM system... yet

What REBVO does is...

- **Detects edges in the image.** The set of edge belonging points is called and EdgeMap.
- **Tracks Translation and Rotation** by “fitting” the previous EdgeMap into the new one.
- **Uses the motion to improve the depth measures** in an EKF stile scheme.

Mixing with an IMU

- **Gyroscope provides rotation.** Initialization not an issue.
- **Accelerometer provides linear acceleration.** Can be used to estimate scale.



Communication

Challenge: use the 128KBit radio to tele-operate.

Idea: compress edge data and send only the edgemap.

Only 2 frames per seconds on low bandwidth radio.

Idea 2: Transmit edgemap at 1HZ and navigation data at frame-rate (25HZ). Use this information to “predict” edges movement.

So finally... the UAV!

Designed to use a minimal set of sensors: only camera, gyroscope and accelerometer for control.