Can you find someone using a dumb smart watch?

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Smart Devices

Many smart devices a barometer, an accelerometer and a clock.



Often used to track when you get exercise going up/down stairs.

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Idea: Localisation via Air pressure

- Device can tell when you are stationary (accelerometer).
- Form a time series (barometer and clock).
- Match time series to some sort per-location air pressure database.

If this is practical, then air-pressure data tied to a person is potentially sensitive information.

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MÉRA Data

- Met Éireann Re-Analysis (MÉRA) data set,
- Combines modern weather model and historical observations,
- Hourly values from 1981–2015 on \approx 2.5km grid.



MÉRA: Locations

Filtered 258,681 total locations for points in Rol.



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Now have 11,205 locations.

MÉRA: Pressure Variation

How variable are surface pressure values over time/place?



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MÉRA Resolution is 0.25Pa.

Devices: Barometers

- Good enough to spot floor change.
- Some now used for stablising altitude of drones.
- Manual testing shows pretty good (11-13Pa/m).
- Resolution better than 1Pa.
- However different figures given for absolute/relative/noise/...

NB Our met data is historical, so we will simulate barometer. Pick location, pick times, add random noise to MÉRA.

Matching

We observe a hourly time series \hat{P}_t . Match to location?

$$\underset{(\text{lat,long})\in F}{\operatorname{arg\,min}}\sum_{t\in \mathcal{T}} \left(P_t(\text{lat,long}) - \hat{P}_t\right)^2$$

If we think there is systematic error/not at ground level:

$$\underset{\substack{(\text{lat}, \text{long}) \in F}{\delta P}}{\arg \min} \sum_{t \in T} \left(P_t(\text{lat}, \text{long}) - \hat{P}_t - \delta P \right)^2.$$

(Could restrict δP .)

Sample Result

 $\sigma=1.25 {\rm Pa},$ Correcting Systematic Errors.



σ = 1.25 Pa

Conclusion

- Moderately good barometers can be localised.
- Usually need several time points.
- Localisation using air pressure seems feasible.
- Would like to assess barometers and try live.
- How to constrain δP .
- Could factor in other sensors.

Full write up at: https://mural.maynoothuniversity.ie/15359/1/On_the_Feasibility_of_Localising_ Smart Devices using Air Pressure.pdf