A Voyage to Africa by Mr Swift

Geolocation using light levels

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Mr Swift

- Common swift, *Apus apus*. Weight: 40 g
- Equipped with light logger (light sensor, battery, memory, clock). Weight: 2g
- Released on Aug. 5, 2010, found 298 days later

We want to track Mr Swift!
State of the art:

- Compute time for sunrise and sunset
- For each time instance convert to
  - Midday (gives longitude)
  - Day length (gives latitude)
Light levels

Nonlinear filtering solution

- Measurement update at each sunrise and sunset
- Motion model with two modes (stationary and migration mode).
- Solve with a marginalized particle filter.
Contribution

- Light levels localizing animals has been used since the 80’s
- Nonlinear statistical filtering has also been used for a while.
- Not much has been done combining the two.

Contribution:

Using light levels in a statistical filtering framework.
Light intensity data

- Sampling time: 10 minutes.
- Resolution: 6 bits \(2^6 = 64\) values
- Saturated for both low and high values.
Light intensity data

Some problems

- The event will shift several minutes depending on the threshold.
- Will also depend on weather conditions and geographic environment.
Light intensity data

More problems

- If the bird is hidden during sunrise and/or sunset, it might cause missing data.
Sunrise and sunset

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The data

Sunrise and sunset events

This work

Trajectory

Light intensity data
The data

Sunrise and sunset events

Light intensity data

This work

Future work

Trajectory
The likelihood - Summer solstice

Daylight map, 21-Jun-2011 06:00:00

Likelihood, sunrise, 21-Jun-2011 06:00:00
Likelihood, sunset, 21-Jun-2011 18:00:00
The likelihood - Autumn equinox

Daylight map, 21–Sep–2011 06:00:00

Likelihood, sunrise, 21–Sep–2011 06:00:00
Likelihood, sunset, 21–Sep–2011 18:00:00
Measurement update - sunrise.
Time: 05-Aug-2010 03:04:00
Measurement update - sunset.
Time: 05-Aug-2010 19:11:00
Measurement update - sunrise.
Time: 06-Aug-2010 03:09:00
Measurement update - sunset.
Time: 06-Aug-2010 18:47:00
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Animation
The Voyage

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The Voyage

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The estimated mode

0: Stationary mode, 1: Migration mode

08/05 09/23 Sep. Equinox
12/21 Dec. Solstice
03/20 Mar. Equinox
05/29

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Comparison

Latitude

Our solution
Existing solution

09/03 09/13 09/23 10/03

Degree [°]

0 50

−50

09/03 09/13 09/23 10/03

Degree [°]

0 50

−50

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Summary and future work

Summary

- Tracking using light levels
- Measurement update at each sunrise and sunset
- Applied on real world data

Future work

- Do smoothing
- Process light intensity data, handle missing data, false alarms etc.
- Validate on data with ground truth (GPS mounted on heavier birds)