**Automated Egg Measurement Method**

* Identify egg colour range.
* Do an initial foreground identification using egg colour range
* Compile stats for each object
  + Area
  + Perimeter
  + Circularity
  + Colour
  + Colour distribution
* Filter out background based on colour considerations.
* Apply connected-component labelling algorithm to identify and separate image foreground objects.
* Do an areal analysis using distribution mixtures and estimate the number of eggs, along with the proportion of the sample comprised of single eggs, doublets, triplets, etc…
* Highlight problem or uncertain cases.

Build egg model:

* Egg shape and colour distribution model
* Provide initial placement of models to each egg and cluster
* Fit models to image.
* Extract refined statistics.

**Figures**

**Figure 1**: Basic Egg image

**Figure 2a**: Zoomed-in portion showing eggs and clusters of eggs.

**Figure 2b**: Zoomed-in portion showing eggs and types of debris.

**Figure 3**: Eggs in foreground processed image

**Figure 4:** Mixture analysis with fitted model.

**Figure 5:** Statistical egg model

**Figure 6:** Fitted models to image

**Figure 7:** Problem cases.

**Figure 8:** Summary statistics (histograms of size, colour, etc…)

**Problems of Automated Fecundity Estimation:**

Initial **background characterization**:

* Mixture of percentile-based colour analysis.

Initial characterization of spheres in an image:

* Choose a background pixel and start to expand out, the appearance of a sphere will follow a characteristic curve as it appears, reaches a maximum and disappears again. The amplitude of the curve and length will define the colour and radius of the corresponding sphere.

Object counting problem:

* Label separate objects (those with connected elements) in two dimensions.
* Perform areal analysis to establish size of individual egg, estimate number of eggs in clusters and filter out objects with unsuitable areas, colours and shapes.

Radial symmetry problem:

* Given a set of points (xi, yi) with corresponding values z. Find the point (x0, y0) at which the radial symmetry of the zi around the point is maximized.
* Write ‘gradient’ function to calculate image gradients, with polar coordinate output optional.

Edge detection and gradients:

* Implement Sobel operator in the ‘gradient’ method. Also Sobel-Feldman and Scharr operators.

Sphere modelling problem:

* How do we model spheres with radial symmetry
* How do we model asymmetric spheres?
* How do we reconstruct a 3D spherical surface?

Counting the number of line intersections within a pixel

Calculating the distance(s) between a pixel a line or set of lines.

Egg production graph # egg versus size, coloured by instar or cohort year.

* We need a characterization, per year
  + Female instars or cohorts versus length.
  + Maturity stage
  + Incubation cycle type