Classification of Flying Bats Using Computer Vision Techniques

BMVA/EPSRC Summer School

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Introduction

We are developing computer vision techniques to automatically monitor bat populations, and extract biometric features which will be used to gather important population data. The biometric features will include shape, speed, trajectory features, and wing beat frequency. We will then use classifiers built using Support Vector Machines (SVM) and Neural Networks, to classify bats into species type, male, female, pregnant and young by tracking individual bats in 2D and 3D in low-light using standard cameras

The Department for environment, food and rural affairs (DEFRA) in association with the Bat Conservation Trust (BCT) started a national bat monitoring programme in 1996. Questions that their surveys seek to answer include: Which species are affected by habitat changes? What are bats' hibernation habits? And how many bats at roosting site are females/males, young, pregnant etc.?

Bat populations also roost in buildings, including historic buildings such as churches. This habitation often leads to damage to building fabric and sensitive artefacts. Data about these populations enables the effective management and protection of the buildings they inhabit, and we anticipate that our work will be useful not only to conservationist studying bats, but also to building managers and professional ecologists surveying these buildings.

Approach

Step 1

Bat detection and correspondence was achieved using Grimson & Stauffer background modelling with k = 5 and 4-Neigbour Connected Components

$$\eta(X_t, \mu, \Sigma) = \frac{1}{(2\pi)^{\frac{n}{2}} |\Sigma|^{\frac{1}{2}}} e^{-\frac{1}{2}(X_t-\mu_t)^T \Sigma^{-1}(X_t-\mu_t)}$$

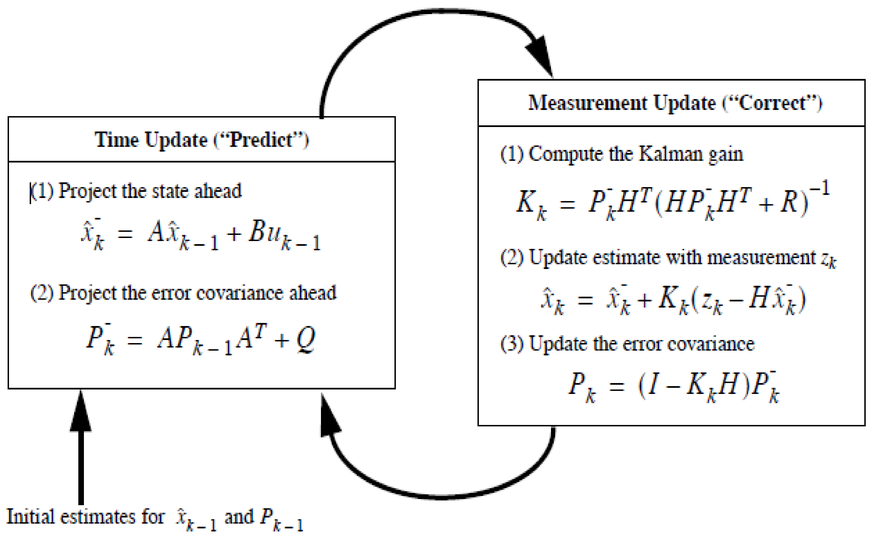
Step 2

$$d(\mathbf{p},\mathbf{q}) = \sqrt{(p_1-q_1)^2 + (p_2-q_2)^2}.$$

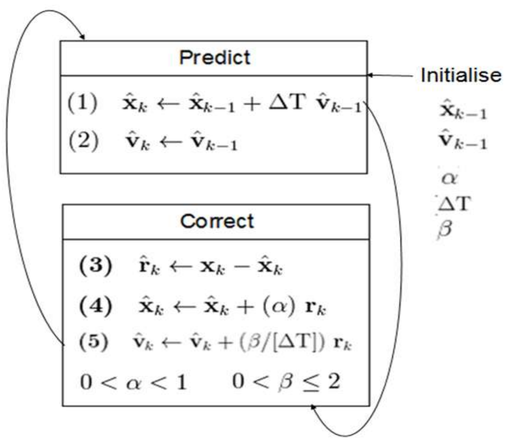
The prediction of bats for tracking was in three parts. The first part used Euclidean distance with simple prediction, using change in x and y.

Step 3

The second part used Kalman filter prediction, the equations are on the diagram on the right



Step 4

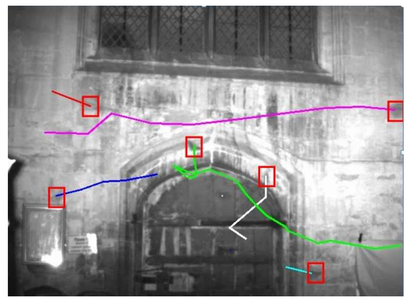


The third part used alpha beta filtering the equations and the steps are in the diagram on the left

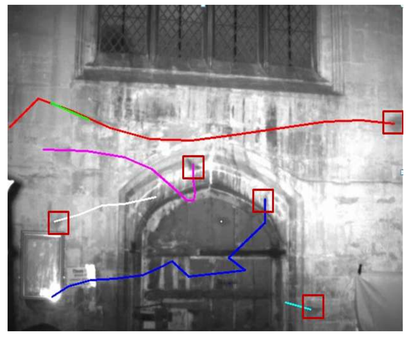
The Outputs from steps 2 to 4 will be averaged to get a better prediction of the bats. This is yet to be implemented

Results

The figure to the left is the results of applying Grimson & Stauffer background modelling algorithm and the 4-Neigbor Connected Components



Bats using data from Holy Trinity Church, Tattershal. The tracking is with only Euclidean distance tracking and **no predictions**



Bats using data from Holy Trinity Church, Tattershal. The tracking is achieved with Euclidean distance tracking and with simple prediction, using change in x and y.

Future Developments

1. Classification of Bats:
   - ✓ nearest neighbour classifiers
   - ✓ support vector machines
   - ✓ neural networks.
2. 2D analysis of wing beat frequency using Fourier Transforms
3. Fitting 3D skeletal model

Collaborators

1. **Lincolnshire Bat Group** , A t**hird party from a residential house** in North Lincolnshire which hosts a maternity roost of Whiskered bats
2. Natural England, University of Bristol and The School of Life Sciences, University of Lincoln.