Real-time Automated Concurrent Visual Tracking of Many Animals and Subsequent Behavioural Compilation

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One of our major research focus areas is real-time visual tracking and monitoring of moving and static objects in a video sequence. In particular we are interested in (1) object localization (also referred to as the focus of attention) which involves identifying the object of interest, (2) tracking the object using a model of the object which was initiated in step 1, and (3) understanding the accumulation of movements of the object over time (i.e., behaviour). The objects of interest for the purpose of this proposal are pigs. Automatically monitoring pigs via a non-invasively placed camera in their pens is interesting because the pigs are monitored in their natural habitat. It is also hypothesized that general health, quality and pig happiness can be monitored via real-time computer vision techniques. An alarm can alert a custodian of any unusual behavioural patterns. Certain behaviours that can be monitored include social interaction, dunging, feeding, etc. With the continual consultation of animal behaviour experts, the objective of this project is to design and demonstrate computer vision techniques to acquire this information. In particular, the emphasis is placed on developing fast and robust tracking techniques in order to produce the traces necessary for behavioural analysis. The benefits to the pork industry of the potential resulting tools are methods of assuring pork quality. Public perception of how animals are treated is important in the net sales of pork products. Automatic monitoring provides an effective way of assuring the pork producers and all parties in the pork processing industry that desired quality levels are achieved. The delivery of the information is via annotated streamed data across the Internet. The annotation of the streamed video data provides information on distance travelled with the intent of providing more detailed annotation in the future.

Visual tracking involves modelling the object of interest and keeping track of its position and orientation through time. Issues include tracker recovery from error and preventing the tracker from jumping to other pigs. Investigations include a probabilistic framework and the maintenance of multiple hypotheses for the tracker. Currently we have had some modest success with a simple blob tracker: we have been able to demonstrate tracking pigs at about 10 to 15 Hz, however, the tracker tends to drift off the target eventually. We have only experimented with a single pig but our initial tests indicate that we can probably track at least 10 pigs simultaneously. Some unknowns include determining how quickly the pigs move and the type of motions, including quick jerky movements. Our preliminary investigations revealed that a blob tracker is insufficient for producing accurate traces. Pig tracking chiefly relies on gray-scale tracking because colour and texture do not really provide any additional information. We have also found that local histograms of pigs in a scene can drastically vary depending on where the pig is situated in the pen (i.e., due to lighting conditions). This is why we hypothesize that tackling a middle ground tracker will be sufficient for pig tracking; exploiting the simplicity of a blob tracker but also including additional information (e.g., shape) that will be essential for adequate robustness for tracking. Addressing robustness is necessary because the pig’s appearance may change due to: (1) change in form (e.g., body twists); (2) illumination change (i.e., we do not want to modify the environment at all and certain parts of the pen may have different illumination properties); (3) specular reflections; and (4) systematic changes (e.g., occlusion, disocclusion). Tracking issues include: (1) tracking many pigs simultaneously; (2) eliminating or minimizing tracker drift; (3) differentiating pigs from each other; (4) developing a multiple hypothesis model for the application; to name a few.

In order to currently initiate the tracker, the operator manually point-and-clicks to the pig’s location. Alternatively, automated attentional localization techniques that we have explored include ones based on symmetry and motion information. The motion method uses accumulated optical flow to segment moving from stationary pigs. Symmetry information is used to localize stationary pigs. Our intent is for these localization techniques to automatically seed the tracker.

The demonstration will include on-line localization based on symmetry and motion information of pigs in a video stream as well as preliminary tracking results.