[C8] 3D STRUCTURE AND MOTION ESTIMATION

Theme: Detection, Localisation & Tracking Theme

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Abstract

During the proposed project, the problem of estimating the actual 3D motion and structure from sequences of 3D representations will be studied. Specifically, we will study the 3D motion estimation problem from sequences of volumetric data, which is a challenging and important task in many defence applications. An additional objective of the project is the joint 3D structure and motion estimation from sequences of multi-view colour images, an important processing step in modern image processing and computer vision.

Latest work

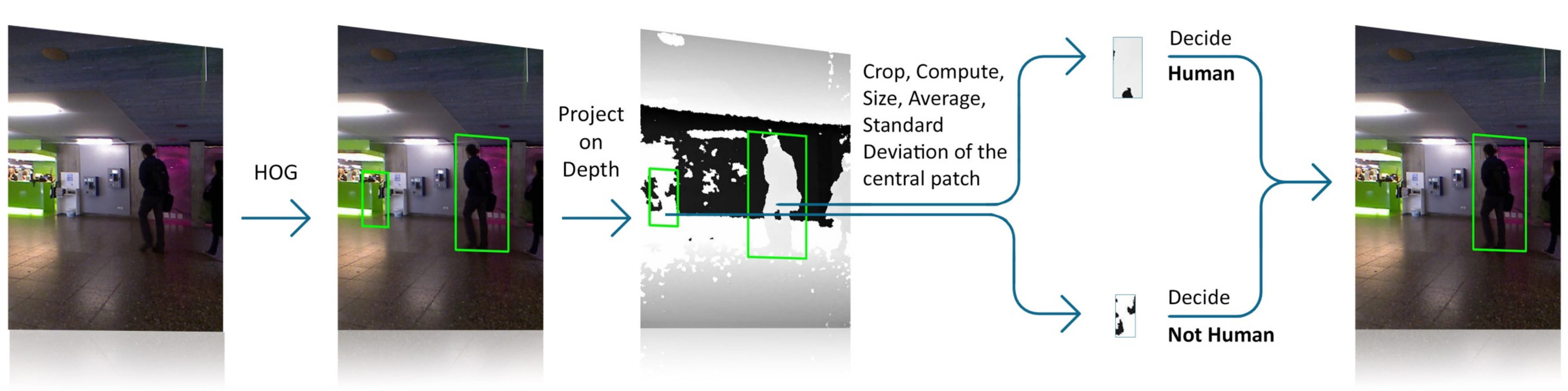
We have recently developed and implemented within project C8, a novel and complete system for human tracking that falls within the recently developed “tracking by detection” class of approaches. The goal is to track people without need of initialisation of their location and to reduce the number of false alarms produced by the existing object detection approaches. We work with Kinect camera and our approach involves using depth information in a novel fashion alongside with the histogram-of-oriented-gradients-type of object detectors. Preliminary results are very encouraging and demonstrate clearly the ability of the proposed system to reduce the number of false alarms without significant increase in the processing time. The near future goal is to track other objects as for example vehicles.

Introduction

Histogram of Oriented Gradients (HOG) is one of the most efficient detectors for humans. It has a high detection rate and is relatively fast. However, HOG exhibits a high false alarm rate that makes it impractical in most of real life scenarios.
Based on that observation and taking into consideration the good detection rate of HOG, we were motivated to attempt incorporating depth information with HOG in order to reduce the produced false alarms.

A representative sample of the output of depth cameras is shown in the figure above. It is clearly illustrated that, as expected, the area within objects‘ boundaries in depth image is of relatively uniform grey shade. Consequently, depth information can be used to distinguish humans from other objects by calculating the local mean and standard deviation in the depth domain.

Generic Diagram of the Proposed Work



The Proposed Algorithm

1. *Read in new frame.*
2. *Pre-process the new frame.*
3. *Apply a HOG window detector to the pre-processed frame.*
4. *If an alarm is fired, go to step 5, otherwise go to step 1.*
5. *Crop the bounding box surrounding the object detected by HOG.*
6. *Compute size, intensity average μ and intensity standard deviation S.D. of the central patch of the cropped part.*

$$\mu = \sum_{i=1}^{M}\sum_{j=1}^{N} p(i,j) \quad ,S.D. = \sqrt{\frac{1}{MN-1}\sum_{i=1}^{M}\sum_{j=1}^{N}(p(i.j)-\mu)^2}$$

7. *Check if S.D. is lower than a pre-specified threshold (determined experimentally).*
8. *Check the consistency of the size with the local mean by using a look up table of local means and corresponding objects’ size.*
9. *If the previous two checks are successful, a human is detected, otherwise the alarm produced by HOG is rejected.*
10. *Check if there are new frames, go to step 1, if not stop.*

Results

Performance of HOG and HOG-Depth

	HOG	HOG-Depth
Rate of detection P_C	0.821	0.803
Rate of false alarms P_{FA}	0.035	0.006
Computational time per frame T_C	1.99 sec	2.07 sec

Conclusions

The HOG-Depth algorithm provides an easy and solution to decrease the number of false alarms red by HOG detector without significant increase in average computational time per frame.

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MINISTRY OF DEFENCE

EPSRC
Engineering and Physical Sciences Research Council

This work was supported by the Engineering and Physical Sciences Research Council (EPSRC) and the MOD University Defence Research Centre on Signal Processing (UDRC).