Summary of Roy’s Contributions to Machine Vision

Roy has been particularly interested in shape analysis and the sensitive detection of objects in images. These interests fall under the broad headings feature detection and intermediate level analysis. His interest in noise elimination can be broadened to image filtering. Another important aspect has been how to achieve real-time operation, which is necessary in applications including automated visual inspection. His deep involvement in educational aspects has led to three books [19, 29, 42] and numerous chapters and encyclopaedia articles. The five main headings highlighted above are inextricably linked both to each other and to the theory aspects mentioned earlier.

The achievements under the five numeric headings are summarised below, with reference to the 50 most important papers: most of those mentioned are journal publications: conference publications are largely excluded in order to concentrate the discussion.

1. **Image filtering**
2. **Feature detection**
3. **Intermediate level analysis**
4. **Real-time operation**
5. **Automated visual inspection**

- **50 Key Publications on Machine Vision**
- **Special Issues of Journals**
- **Most Important Invited Papers at Conferences**
- **Area Editor of Dictionary**
- **Encyclopaedia Articles and Book Chapters**
- **Food inspection**

1. **Image filtering**

   This programme of work established that:
   - Median filters distort images, producing edge shifts which can be understood on a continuum model [12] and predicted accurately using discrete analysis [38].
   - Trainable noise elimination filters can be produced with negligible edge shift or corner filling [21].
   - Mode filters enhance images as well as eliminating noise – but have to be specially designed to cope with sparsely populated windows [28, 42].
   - Mode filters can be extended to colour, and they show astonishing effectiveness at removing 70% impulse noise [41].
   - The edge shifts produced by mode filters [41] and by the whole family of rank-order filters can be explained quantitatively – a result of key importance for mathematical morphology [33].

   [40] integrates all these discoveries into a solid body of knowledge, covering all the types of filter mentioned above.

2. **Feature detection**

   This programme of work established how to:
   - achieve high accuracy with edge and other detectors [1, 2, 15, 25];
   - determine the effects of occlusion [27] and noise [6];
   - accurately identify valley positions in intensity distributions [22, 44, 47];
   - discriminate motion and even pedestrian behaviour using low-level operations [49, 50];
   - design ideal template masks using a training approach and (optimal) matched filtering [17];
   - optimally position a template to detect features using a new ‘equal area’ rule [26];
   - accurately interpolate between the responses of orientation masks [30];
   - model the Plessey detector’s effectiveness (e.g. its sensitivity to corner angle) [43].

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3. **Intermediate level analysis**

   This programme of work established how to:
   - overcome the effects of incomplete image data using improved inference techniques [42];
   - aid understanding by modelling Hough transform peaks [14];
   - make inference algorithms more general [7], more efficient [4, 36], faster [13, 16], or more accurate [8, 18];
   - increase sensitivity by gradient weighting (the theory starts by considering (optimal) matched filtering) [5].

   [42] covers all these discoveries and integrates them into a coherent body of knowledge.

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4. **Real-time operation**

   This programme of work established how to:
   - systematically speed up vision algorithms by employing 2-stage matching [10], special hardware [23], or selecting cost-efficient combinations of hardware modules using two new cost–speed functions [11];
   - rapidly locate objects using a new sampling strategy representing the lowest computation bounds [24, 34];
   - mimic the saccades of the eye by ‘guided’ sampling, using entropy to determine locations giving the highest gain in information [46, 48].

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5. Automated visual inspection

This programme of work developed the following:

- a variety of techniques for performing 100% inspection of products, including biscuit [3] and X-ray inspection of frozen food packs [42];
- inspection of wheat grains – including detection of insects, ergot, and rodent droppings [35, 37]; the insect detection algorithms employ bar and streak detectors and have wide generic capability;
- means for detecting insect larvae growing inside wheat grains from infra-red images [29].

Professor Davies’s monograph Image Processing for the Food Industry [29], review [39] and invited papers [a-d] sum up much of his work in this area.

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50 Key Publications on Machine Vision


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Special Issues of Journals


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Most Important Invited Papers at Conferences


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Area Editor of Dictionary


Roy managed and edited over 1000 terms in this dictionary.
Encyclopaedia Articles and Book Chapters