BMVC91

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Foreword

Lewis Carroll once wrote a story about a king who wanted a very accurate map of his kingdom. The king had a pathologically fastidious eye for detail and consequently decided that the map was to be produced at a scale of 1:1. The scribes dutifully set to and, in time, the map was made. The map carried details of every tree, every rock and every blade of grass throughout the entire land. The problem occurred when they tried to use it. First of all, the map was extraordinarily difficult to open out and line up with the countryside. Its sheer bulk meant that it took whole armies to carry it and a great host of bureaucrats and technicians to maintain the information. Such was the detail of the map that as soon as the wind blew strongly, whole sections needed to be redrawn. What was worse was that all the farmers protested because the map completely cut out the light from the sun and all the crops died. Eventually the howls of protest became so strong that the king was forced to take action. He did away with the old paper copy and decided to use the kingdom itself as the map. All lived happily ever after.

There are, at least, two morals to this tale. First, you are almost certainly doomed to failure if you do not get the representation of the problem right. Second, it is important that the representation uses a level of precision appropriate for the tasks required of the system – and no more. Nowhere are these requirements more important to get right than in computer vision. The fact that sophisticated, human-style, machine vision seems to be both highly complex and appears to have a seemingly boundless appetite for computing resources means that we must pay great attention to finding good (i.e. simple) representations in our machines. We must also think hard about the tasks that we want vision to solve and so be guided into selecting appropriate data-types and levels of precision that meet the system requirements. We should also try to avoid any unnecessary duplication of information or the computation of symbols that we later discover to be superfluous to our needs. Were we to follow these guidelines when building sophisticated vision systems we might be led to the following conclusions:

1. Do not perform edge detection on the input images. Signal matching problems such as stereo and motion correspondence can be solved without the use of edges and, in any case, you need to keep the gray-level information if you intend to compute shading or colour information. If you only keep the edges you are guilty of throwing away the baby with the bath water whilst if you try to keep the original image and its edge map(s) you are guilty of over representation. When we appreciate that there is no substantive evidence that biological systems perform edge detection, the justification for any such technique looks a bit thin.

2. Foveate your representations. When seeking the holy grail of the minimal representation, there is much we can learn from biological systems. Visual data seems to be log-scaled on almost every dimension. Both intensity and eccentricity are thus scaled so producing the representational appearance of being at the centre of a foveal magnification bubble in which most of our sensitivities and resolutions decrease away from the point of fixation. Many researchers produce high resolution results over the entire field of view of the camera and when asked about foveal/pyramidal representations simply say that this could be "bolted on" afterwards if you wanted the process to go faster. However, such an approach may well miss the point. Those researchers who have explored the use of such data structures have realised that many problems that might originally have needed to be algorithmically coded, now simply drop out of the system as a natural property of the representation. Polar tessellations produce rotation and size invariance as well as a "time-to-impact" computation which is a linear pixel count. Further, resolution pyramids naturally facilitate all the "octave based" algorithms as well as introducing a massive saving in computational effort.

3. Be qualitative. If you can achieve your task using qualitative representations, do not go through all the added difficulty of scaling the data to make it quantitative. For example, if relative gray-values are output from a real-time stereo system then you do not need to scale them to perform hand-eye control, vergence, motion segmentation or tracking providing the stereo system provides signals within the control loop of the system. Such an observation may suggest that whilst a few trinocular systems quantitatively lumber around some research laboratories, nature seems to suggest that two eyes are quite sufficient.

Returning to Lewis Carroll the king's final solution was to do away with the model altogether. Such Brooksian ideas might go down well in parts of MIT but as soon as any sophisticated problems need to be tackled, the need for models becomes clear. Whilst the pioneering ideas of Kenneth Craik[1] are as true today as they were when first conceived, todays pressing problem is now to discover the minimal representation to facilitate the process.

Having been granted the opportunity to offload some accumulated prejudices, some things need to be said about BMVC'91. The familiar joke about stage five of a successful project (i.e. "praise and honours for the non-participants"), hangs guiltily over my head. The real work behind organising the conference and collaboration with Springer-Verlag was carried out by Jon Ritchie, Tanya Oliver, Irene Brebner and David Wilson. As a somewhat bemused bystander to the event I appreciate that they, at least, have done much to make this a useful, representative and well organised summary of British machine vision research for 1991.

Peter Mowforth
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29th July 1991

[1] Craik, the Cambridge psychologist, was the first to argue strongly that perception is a model in the brain.

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