

# Reading the road shape

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We have built a mobile robot, Beobot, which has an on-board "Beowulf" cluster with its parallel processing ability for real time vision processing. To utilize the distinct feature of Beobot as a test bed of neuromorphic vision algorithm, in this paper, we suggest a framework model for vision-guided Beobot navigation system in an outdoor environment (an athletic running track at USC). The model comprises two phases: the extraction of feasible features from incoming visual information, and the exploitation of the achieved features. In the feature extraction phase, the model adapts the properties of the earliest visual neuronal tuning mechanism, specifically for orientation tuning, as shown in the early biological visual processing. Using Centre-surround differences and spatial competition with preprocessing of Gabor-wavelet convolution, the model can get abstracted orientation features. The feature exploitation phase uses Linear Discriminant Analysis (LDA), for two reasons. One reason is that LDA reduces the data dimensions significantly, like Principal Component Analysis, and so it releases the burden of massive data processing in the real-time system. Another reason is, through the data dimension reduction, LDA can provide class separability and decision boundaries. Our two-phase approach, where one might consider the exploitation of the achieved features as an identifying procedure with respect to the nature of the selected features, is inspired from the known segregation between dorsal (Where) and ventral (What) visual processing in the primate brain. Thus, the feature extraction phase mimics "Where" processing while the exploitation phase mimics "What" processing. Additionally as shown in the biological vision processing, the separate treatment of divided phase system can provide a good method for fast visual information processing through selective attention model, e.g. visual attention model of Itti and Koch (Computational Modeling of Visual Attention, Nat. Rev Neurosci, Vol 2, 3:194-203, 2001.), as a comparable future work to the holistic image frame treatment of this paper.

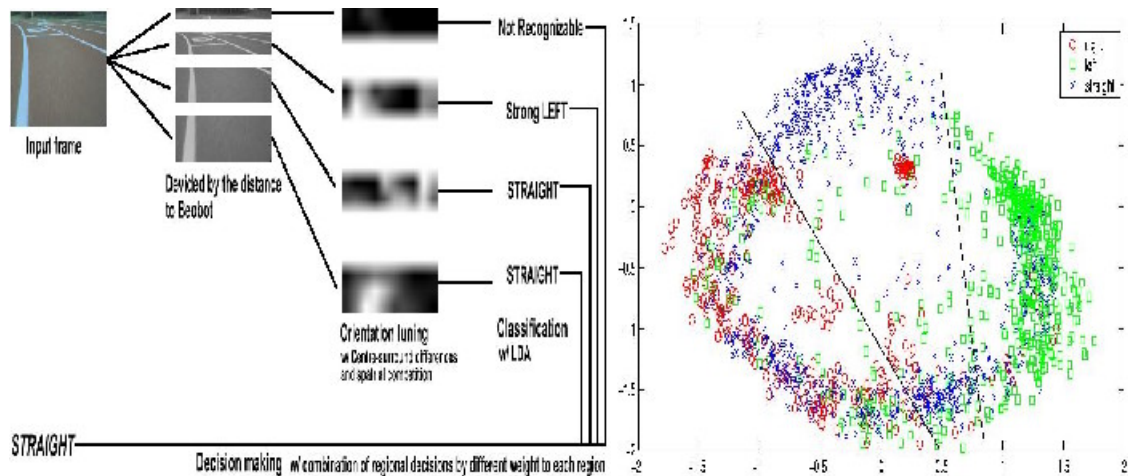


Figure. The overall model and its processing (Left) and LDA for road feature classification (Right): the direction transforms smoothly from 'left turn', red dots, to 'right turn', green dots. Blue dots symbolize 'straight'.

The results of the model are quite promising for Beobot driving and decision making. The model shows considerable robustness of distracters, guide lines and track numbers on the track, as well as the agile performance for massive incoming visual streams. However, the model still requires finer tuning for more accurate driving decision, which is also inherited from the innate problem of visual information, such as if we define 'slight left' with 12 degree tilted lines, then, should we have to say 'straight' for 10 degree tilted lines?



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