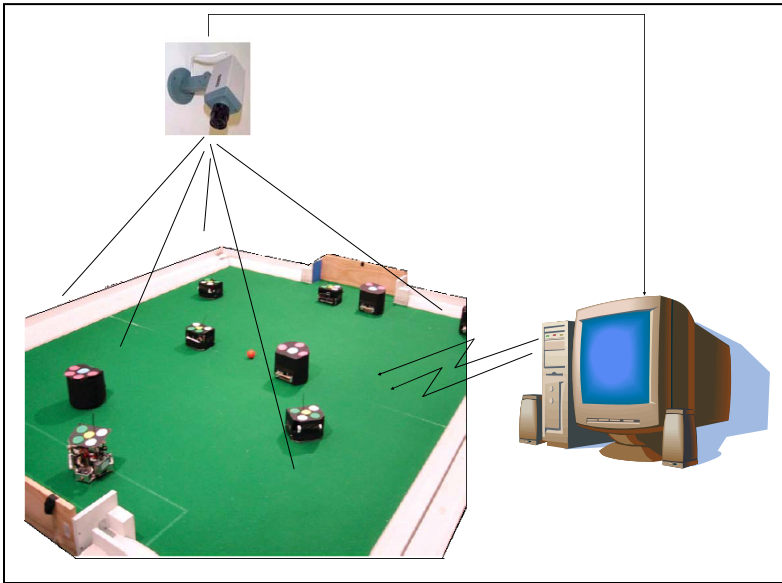


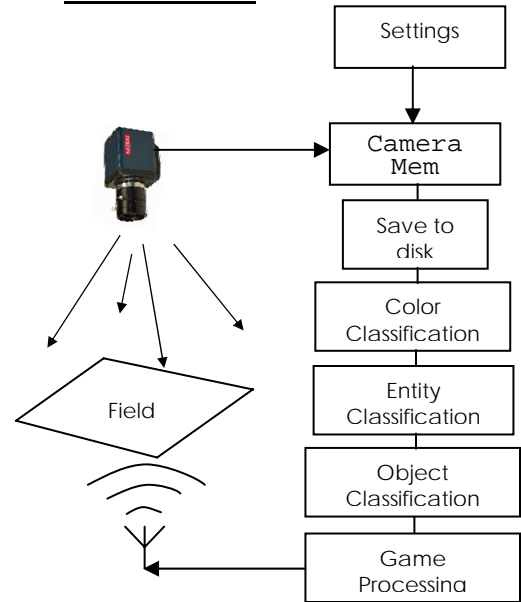
COMPUTER VISION FOR ROBOT SOCCER

Twelve robots play soccer on a field 4m X 5.5m. An overhead camera captures a movie of the event. Each frame of this movie is acquired by a host PC via the USB port. Raw bit map images are vectorised by image processing software and sent to the game strategy software. Game strategy uses Artificial Intelligence techniques to produce move instructions, transmitted via an RF link to each robot, completing a closed loop control system.

GENERAL ARRANGEMENT



PROGRAM FLOW



A human can easily identify the pixels in a camera image(raster) into entities and groups of entities into objects. For a computer, the image needs to be Vectorised. Image Vectorisation can be broadly classified as follows:-

Color Classification - GetColor()

Is the classification of pixels within a range of colors to a single 'pure' color, corresponding to an entity. A Color Classified image contains only those colors that are associated with entities in the image field. Color Classification is performed by specifying a range of color values(slice/segment) for each pure color and then placing each pixel in the image into one of these slices or segments(Color Slicing/Segmentation).

For example Fig 4 shows an image of a green and blue square grabbed by a camera. Entity 'A' is supposed to be pure green and entity 'B' pure blue. Each square represents a pixel. The pixels of entity 'A' fall within a certain range of color values and those of entity 'B' fall within a different range. After Color Classification the pixels are "Segmented" into pure colors as shown in fig 5.

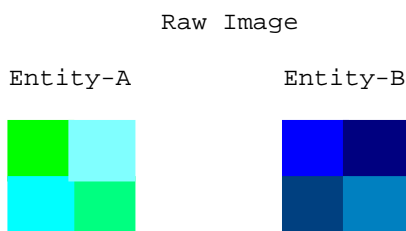


Figure 4

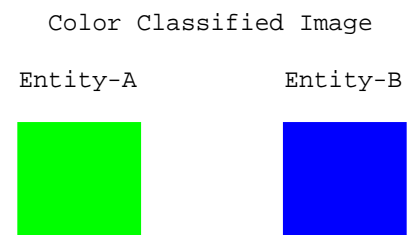


Figure 5

Entity Classification - GetEntity()

Pixels in a Color Classified image(fig 5), are not associated with a particular entity. The program doesn't know for example that the four Green pixels belong to Entity-A and the four Blue ones to Entity-B. The process of associating pixels with an Entity is known as "Entity Classification".

Pixels are classified into Entities by identifying all the connected pixels and providing it the following properties:-

- # Area in Pixels
- # Co-ordinates of Perimeter Pixels
- # Co-ordinates of Center of Gravity
- # Co-ordinates of Extreme Points
- # Color Code
- # Validity

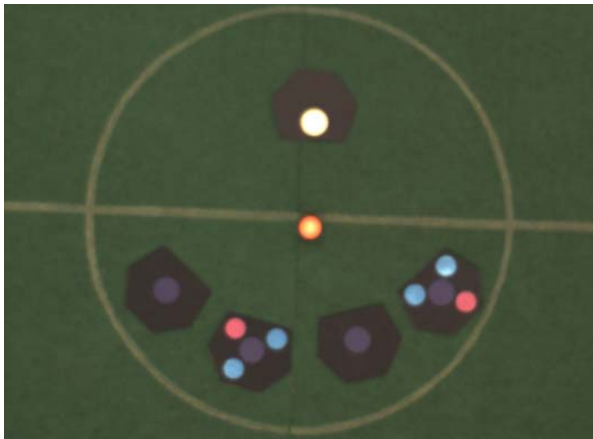


Figure 11.a: Raw image of soccer field w/ robots & ball.

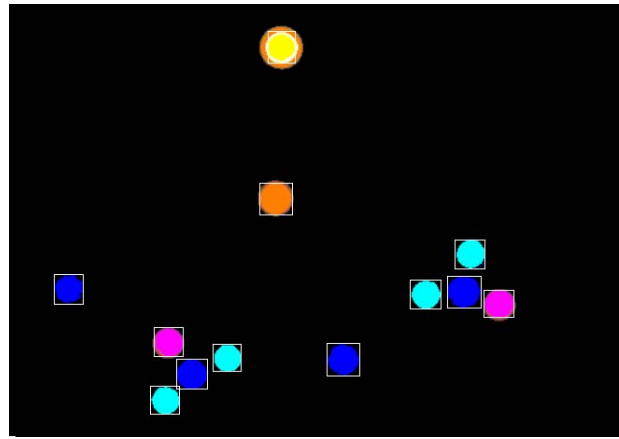
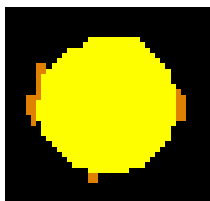


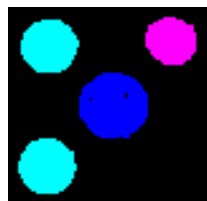
Figure 11.b: Color classified image.

Object Classification - GetObject()

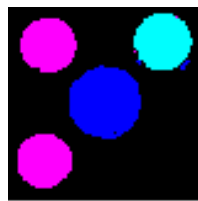
The Entities in an Entity Classified image are grouped into one or more Objects. For example the objects in an Entity Classified Robot Soccer image may be:-



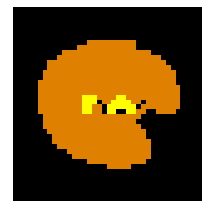
Enemy Robot



Friendly Robot #1



Friendly Robot #6



Ball

An Object has the following properties:-

- # Center of Gravity of Peripheral Entities
- # Center of Gravity of Center Entity
- # Object number