Situation Awareness with The Limited Visual Attention

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Situation awareness (SA) is the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future (Endsley M. 1988). A critical aspect of the situation awareness (SA) problem is that agents must construct an overall view of a dynamically changing world using limited sensor channels. For instance, a (virtual) pilot, who visually tracks the location and direction of several vehicles that he cannot see simultaneously, must shift its visual field of view to scan the environment and to sense the situation involved. We developed the perceptual coordination that helps a virtual pilot efficiently track one or more objects.

Simulation worlds usually offered all information to virtual humans. However, providing all information to the virtual humans not only is unrealistic but can also cause perceptual overload since extracting the pertinent information from the available sensors is challenging and results in unpredictable consequences. In order to reduce perceptual overload, we reduced the amount of input to the perceptual system by limiting a virtual human's visual field. By restricting the visual field, the virtual human needs a way of coordinating the tracking of multiple objects when one or more of the objects are outside the visual field. This calls for a focus of attention and a way of controlling it. For instance, if a virtual human with a limited field of view (e.g., 15 degrees) is tracking two objects, one of which is not currently in view, the agent has to shift its visual attention between the objects, and it has to do it frequently enough to remain sufficiently aware of the situation to avoid disasters (like collisions). A central issue that emerges from shifting visual attention is how long the virtual human can look away from the primary target without losing track of it since there has to be a reasonable prediction of where the object will be located to ease the reacquisition when it is time to shift visual attention back to a target. We have developed a method for predicting a target's future position, and the amount of time the prediction is valid, given the observed motion of the object (e.g. speed, velocity, heading) and the key elements of an environment, which are strategically important terrain features (e.g., hill, mountain, road, river, and lake), surrounding the target.

In our approach, we have focused on learning how to mentally track entities whose behavior will be influenced by key elements of the environment (i.e. maintaining a representation of an object's position when outside the visual field). We implemented the approach on a virtual pilot in a distributed, interactive simulation system called ModSAF. The virtual pilot flies a synthetic helicopter and performs tactical operations with a team of other team pilots. To predict the amount of time the pilot looks away, a neural network is applied since the expected output is how many degrees the object will turn based on the key environment elements surrounding the object and the degree of turning (-35 to 35) of the object is discrete. Given a number of training examples, a neural net learns how the formation of key elements of an environment surrounding a specific target (e.g. tank) affected the movements. In the process of predicting the future positions (e.g. each arrow), the trust factor, which is similar to uncertainty threshold in (Sonu Chopra, 1999), was applied to decrease the degree of trusting the output of the neural network and its value is varied by the task (e.g. battle, reconnaissance).

We found that the method for perceptual coordination we proposed is a way to create more realistic agents since it provides a reasonable time constraint on shifting the visual field. We will extend our approaches by integrating perceptual coordination with organizational and spatial structures (Weixiong Zhang, 1999) that can give a deliberate method of describing spatial relationships between a target and key elements of an environment.

References

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