Multimodal Communication for Wayfinding: Airports as a Case Study

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People have to find their ways through cities, through buildings, along streets and highways, using public transportation, etc. In order to do so, they have to be provided with adequate wayfinding information, which is communicated to them from different sources and through different modes of communication. The analysis of such interplay is important if one wants to simulate human wayfinding in a cognitively plausible way. Such simulation of wayfinding tasks helps to determine where people face wayfinding difficulties, why they face them, and how wayfinding information and the design of wayfinding environments have to be changed in order to communicate better to the user.

In this work we use an agent-based approach to simulate multimodal communication of wayfinding information within a computer system. In general, an agent can be anything that can perceive its environment through sensors and act upon that environment through effectors (Russell and Norvig 1995). In our case we simulate a cognizing agent finding its way through an airport based on information communicated to it via different modes. The restriction to the well-defined microworld of an airport reduces the enormous complexity of modeling the world and users' intentions. It therefore makes it possible to investigate the different modes of communication in detail. In order to do so, we develop a formal model, which fixes the meaning of the conceptual process model for wayfinding. The formal model is represented in a functional language and it is therefore possible to check its consistency and simulate test cases (such as finding the way from the check-in counter to gate C54) (Raubal and Worboys 1999).

The cognizing wayfinding agent is based on three modules that deal with perception, decision, and action. A cognitive schema (Neisser 1976) internal to the agent guides these processes. It includes information about the task and the goal, and a minimum of wayfinding strategies and commonsense knowledge necessary for the agent to perform the task. Most of the wayfinding information in an airport is communicated visually, either through signs, screens, and maps, or through architectural features. Arthur and Passini (1992) termed this "environmental communication" and argued that the built environment and its parts should function as a communication device. In our agent-based simulation we use the concept of affordances to describe the kinds of knowledge that agents derive from the world by means of visual perception. Affordances (Gibson 1979) are possibilities for action with reference to the agent. Information (such as from signs) is necessary for the agent to decide upon which affordances to utilize. The task description from the cognitive schema directs visual perception in such a way that the agent samples only task-relevant information and affordances.

Auditory sources are another important aspect for communicating wayfinding information in an airport. Such sources are non-cognizing objects of the environment, such as loudspeakers,

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or other cognizing agents, such as passengers or employees of the airport. The auditory mode of communication plays an especially important role during emergency situations when directions for passengers are given through speakers, and also for blind people who need to receive information through channels other than visual perception. We model communication with other cognizing agents within a multi-agent framework (Weiss 1999), focusing on the direct exchange of information based on the idea of spatial communication with maps. Here, information is communicated from a map-making agent who explores the environment and collects information, which he uses to construct a map of the area, and a map-using agent who acquires this map to gain knowledge, which he uses to navigate in this environment (Frank 2000).

As an example for the integration of multimodal communication of wayfinding information, we further investigate location based navigation services using mobile phones. Agents can be given information through textual instructions on the client display, through verbal instructions, or via symbols and digital maps. The mode(s) of presenting wayfinding instructions depend(s) on the agent profile (e.g., handicapped vs. non-handicapped) and the task. Finding one's way in an airport uses a different set of cognitive abilities than navigating through a city. The presentation of wayfinding information depends also on the user interface of the client device. Well-designed user interfaces facilitate human-computer interaction, i.e., the communication process between user and computer.

Future work with an agent-based approach to simulate multimodal communication of wayfinding information will also have to include vestibular, tactile, and proprioceptive sources of information. Furthermore, the results of our simulation method have to be compared to the performance of human subjects in the real world.

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