A Fuzzy Controller for Flakey, the Robot

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Abstract

SRI International has a long tradition in the field of qualitative analysis and control of complex systems, starting with the development of the early mobile robot Shakey. More recently, we have developed a fuzzy controller for our new platform, Flakey. Flakey's controller can pursue strategic goals while operating under conditions of uncertainty, incompleteness, and imprecision. This controller includes capabilities for:

- Robust, uncertainty-tolerating goal-directed activity.
- Real-time reactivity to unexpected contingencies (e.g., unknown obstacles).
- Blending of multiple goals (e.g., reaching a position while avoiding static and moving obstacles).

In our approach, detailed in [2, 5], each goal is associated with a function that maps each perceived situation to a measure of desirability of possible actions from the point of view of that goal. The notion of a "control structure," is used for representing and manipulating high-level goals (and the associated desirability functions) in the fuzzy controller. Typical control structures are associated with environment features such as locations to reach, walls, or doorways. Each desirability function induces a particular "behavior"—one obtained by executing the actions with higher desirability. Many behaviors, induced by many simultaneous goals can be smoothly blended together by combining their desirability functions using the inferential procedures of fuzzy logic. The fuzzy controller prefers the actions that best satisfy each behavior. Blending of behaviors is the key to combining goal-oriented activity (e.g., trying to reach a given location) and reactivity (e.g., avoiding obstacles on the way).

Our fuzzy controller can execute a full plan, expressed as a set of control structures [3, 4]. Each control structure in a plan is associated with a fuzzy context of applicability, e.g., a corridor to follow when Flakey is near that corridor, and a door to cross when Flakey is close to that door. Sets of control structures can be generated by traditional AI planning techniques, and hence constitute a valuable link between symbolic reasoning systems and continuous control processes. We have performed experiments where Flakey planned and executed navigation tasks in an unmodified office environment during normal office activity. Thanks to the flexibility of fuzzy rules, Flakey only needs a sparse topological map of its environment, annotated with approximate metric information.

The performance of our fuzzy controller was also demonstrated at the first international robotic competition of the AAAI, held in July 1992 at San Jose, California [1]. Flakey placed second, and gained special recognition for its smooth and reliable reactivity, as exemplified by one judge's comment: "Only robot I felt I could sit or lie down in front of." (He actually did!).

References

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