# Kansas State's Willie

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**Abstract**

The 1999 robotics team from Kansas State University used a Nomad200 robot from Nomadic Technology, Inc. The software was developed using a subsumption architecture. This architecture allowed easy development and integration of the software. The vision software used simple techniques for object recognition.

## The Team

The Kansas State University team for the AAAI99 Robotics Competition consisted of Tim Beese, Frank Blecha, Jonathon Cameron, and Damon Kuntz pictured left to right in figure 1. Although teams from KSU have competed many times in the AAAI competitions, this was the first competition for all four members of the team, Frank, Jonathon and Damon are May 1999 graduates of KSU with BS degrees in Computer Science. Tim will graduate in December 1999 with a BS in Computer Science. All four were students in the undergraduate software engineering course. Dr. David A Gustafson, the advisor, is a professor in the Computing and Information Science Department at Kansas State University.

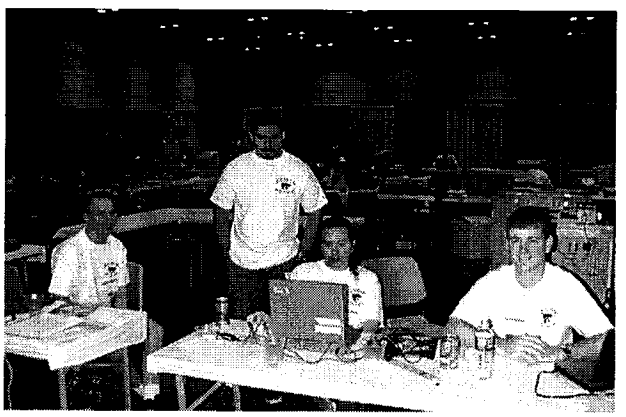

**Figure 1 - Kansas State Robotics Team**

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## The Robot

The Department of Computing and Information Sciences has two Nomad200 robots from Nomadic Technologies, Inc. These robots were funded in part with a grant in 1991 from NSF under Division of Undergraduate Education's ILI Program. The purpose of the grant was to develop a software control lab to give computer science students experience in programming a device that had actual motion and had real-time characteristics. The robots are used mainly in our Software Engineering Projects course which is a required, two-semester sequence at the senior undergraduate level.

The Nomad200 is an autonomous, mobile robot. See figure 2. It is a black cylinder approximately 2 feet in diameter and 3 feet tall which weighs about 200 lbs. It is equipped with three wheels. Onboard the nomad is a pentium computer with a hard drive. The nomad used in the competition is equipped with two rings of 16 sonar sensors. The LINUX operating system is used onboard the robot. The competition software was written in C++.

**Figure 2**

## The Architecture

The team developed the software program from scratch. Although the software from previous competitions was available, the team wanted to develop the software using a subsumption architecture. Figure 3 shows a simplified version of the architecture. Boxes represent behaviors or processes. Most of the behaviors will run as separate threads. The bottom behavior is cruise. This behavior will issue move commands to the motors unless it is subsumed. The circles in figure 3 show the points are which a higher level behavior will subsume (or override) a lower behavior. The next higher level is activated by the sonar thread. This collide behavior will subsume control and avoid collisions.

Other threads run the vision (camera) and sound (mic) routines. The map process maintains an occupancy grid of the area to keep track of areas already explored. These behaviors will direct the motion either toward a possible object or in a search pattern to cover unexplored areas of the competition.

This architecture was easy to understand and easy to implement. The team members built the behaviors separately and integrated the behaviors easily into the complete system. The team did experience difficulty in fine tuning the system at the competition site. In particular,

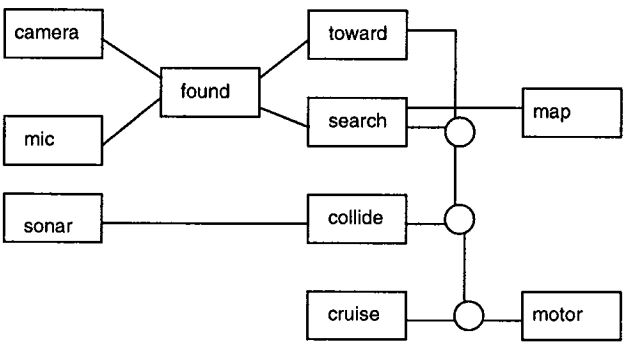


**Figure 3 - subsumption architecture**

since the vision system can only be operated effectively when the robot is stopped, the timing of picture taking is critical. This was difficult to fine tune in this particular implementation.

## Vision

The team built simple vision recognition routines using the Target Jr Vision System (www.targetjr.org). Since the objects to be recognized were simple, an ad hoc approach was used. Each object had an identification scheme based on color, shape or both. Thresholds were identified for the colors and flooding was used to isolate the shape. Simple comparisons of widths of the flooded area were used for identification.

## Conclusion

The team won second place in the scavenger hunt competition. It was a learning experience for all members of the team. Although Willie performed well, there was much room for improvement in both search algorithms and object identification.