Robotic Exploration of Water-filled Caves
A proposal for a senior design project in Mechanical Engineering
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In the local area around Tallahassee, most of the regional water flow occurs underground, in natural caves and conduits. This behavior is typical of so-called karst regions, which are widespread, both in the United States (see Figure 1) and elsewhere in the world. It is important to understand this flow, in order to predict the effects of land-use changes and to protect our valuable natural resources, especially springs such as Wakulla Springs.

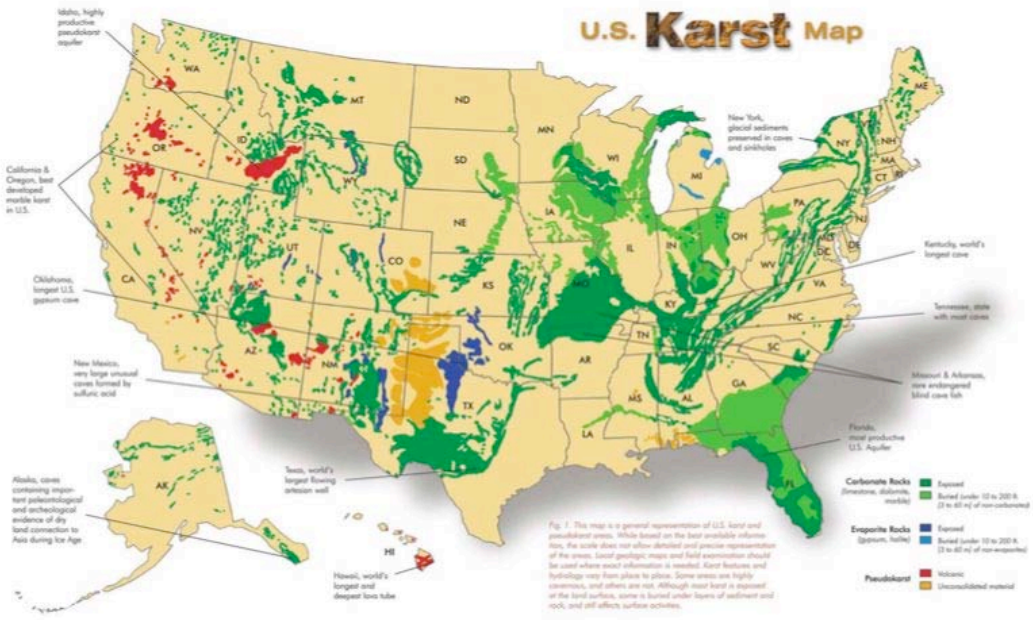

Figure 1. Map of karst regions (shown in green) within the United States

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Some of the caves (those that are large and readily accessible) in our local region have been explored and mapped by divers (most notably those affiliated with the Woodville Karst Plain Project; see Figure 2 and www.gue.com/Projects/WKPP). However, this is a small fraction of the total; the vast majority of caves have yet to be explored. Recent tracing experiments, as well as other observations, provide strong evidence that the cave systems shown in Figure 2 are connected and that many other caves exist throughout the region, extending to the coast at Spring Creek (and other coastal springs such as Shepards Spring, Crays Rise and Bear Creek Spring; see www.tfn.net/springs/) and very likely northward to Tallahassee and beyond (see Figure 3). For example, the episodic draining of Lake Jackson can occur only if there is a well-developed conduit system to accept the water.

Another means of exploration – other than human divers – must be employed if we are to develop a more complete representation of the cave systems that convey water in karstic areas such as ours. This is a proposal to investigate, within the context of a senior design project in Mechanical Engineering, the feasibility of exploring and mapping these water-filled caves using submersible robotic vehicles.

Figure 2. Mapped caves (shown in blue) in the region south of Tallahassee.

The result of the design project should be a report assessing the various options for robotic exploration, the possibility of success (within a stated time frame and budget) and a recommendation how to proceed toward the ultimate goal of cave exploration. Design issues to be considered include the following:

Whether to use a few machines that must be retrieved or use many 'disposable' and cheap robots.
Whether to retrieve the robotic vehicles through the point of entry or send them downstream, to be retrieved at a spring.
Whether the robotic vehicles should be tethered or untethered.
How to maintain reliable communications with the robots.
What information should be recorded by the robots.
The availability of appropriate hardware (platforms, computers, radios) and software.
The costs of the various options.

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Figure 3. Karst features in the Big Bend region of North Florida, including mapped caves (green), rivers (blue), and sinking streams (brown).