Introduction:

The aim of the project is to enable autonomous mapping of dangerous or hostile territory. This could be done with a single powerful robot or multiple simple robots. A single robot is susceptible to failure or destruction, and would take a large amount of time to map large areas. A swarm of robots, using intelligent interaction, could significantly reduce the time required to map a given area, and the failure rate of the mission would be lower since it would not depend on a single robot [1]. The final product of this project would be one of the members of such a swarm.

Current Research:

Autonomous mapping is a topic that has been under research for the past few years, especially as an application of robot teams. However, while various technologies and software algorithms to enhance such an endeavor have been developed, a robot swarm for mapping is not yet commercially available. The commercial applications of such a project are vast, as are its possible uses to military.

The ability to map out a building held by enemy soldiers would be desirable to any military organization. The swarm could also be used to map unexplored mines and caves, landmine-covered fields, and various other dangerous areas. Since the individual members of the swarm would be dispensable both in terms of cost and functionality, there are very few limitations as to where the swarm could be used, though different types of terrain may require modifications to the individual robots.

It was decided by group members that the robot used would be either a pre-made kit with an overriding command microcontroller or a toy buggy converted into a robot. The latter option would give us more flexibility but would require more time. The robot would
communicate via wireless with a central system, which would give it commands on how to proceed based on currently available data. The mapping software of the central system could be later modified to include several robots and command them simultaneously.

Having microcontrollers on each robot is not necessary if they are taking commands from a central system, but it offers many advantages [2]. The programmability of the microcontroller makes the individual robot truly autonomous, and not just a remote-driven car. Given the possibility that a central system might not be available in hostile territory, it is necessary that the robots be able to function independently, with the central command only adding to the functionality and efficiency of the team. Microcontrollers also allow for easy upgrades to all the robots via software modifications, as well as flexibility in the physical systems used.

The type of microcontroller used is very important in determining the functionality and abilities of the robot. There are a wide variety of microcontrollers available, but only a few are suitable for robotics:

- The PIC series [3] microcontrollers are inexpensive, which is important since we don't want individual robots to cost much. The PIC microcontrollers have almost all the features that a microcontroller can provide, but they are limited in terms of memory and I/O pins.

- The Atmega AVR series of microcontrollers is relatively expensive, but includes chips with 35 I/O pins and a free C compiler. Also, it is available on a board with many other accessories such as LCDs and light sensors which might save us the time of assembling a board ourselves. [4]

- A few microcontrollers programmable in BASIC which do not justify their higher prices and are primarily for people who cannot or do not wish to program in C or assembly. [4] Just the facts, don't editorialize
The microcontroller most suitable to our needs can be decided only once we have quantitatively assessed our requirements, and this would depend heavily on whether we use a toy buggy or a pre-made kit. A buggy would require a more complex microcontroller that can control the buggy as well as calculate the overall direction it must take, while pre-made kits have an in-built control processor and only need a processor to direct the controls. Multiple PIC chips could also be used to drive the buggy, which would eliminate the cost advantage but would prevent the programming from getting complex.

The advantage of PIC microcontrollers is also the familiarity of several group members with the PIC16 and PIC18 series which are discussed in a Georgia Tech course on embedded microcontrollers. Extensive instructions on the use of the PIC18F452 are available in the course book [5]. Also, the resources of the Embedded Microcontroller Lab used for the aforementioned course may also be available for programming the chip. Using PIC chips would therefore save not only money but also the time and effort required in learning how to use a new microprocessor.

Conclusion:
The project will involve the merging of several fields in electrical and computer engineering. While robot swarms and autonomous mapping are fields that have been researched previously, they have not yet been combined in a commercially viable manner. Secure wireless communications will need to be used, and mapping algorithms to maximize efficiency of the swarm will need to be developed. A physical structure suitable for this purpose will have to be built, and the microcontroller for it programmed so as to enable members of the swarm to be autonomous. At the same time, economic factors will have to be considered to make the swarm commercially competitive.
Sources:


