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Department: Computer Science & Engineering

Name of Research Program: CRA-W/CDC DREU (2009)

## **Research Title:** Region Identification in Unsupervised Adaptive Strategy Framework

**Description:** Motion planning is the problem of finding a collision-free path for a moving object (i.e. Robot) from an initial start state to a final goal state. Unsupervised Adaptive Strategy (UAS) is used to minimize user intervention during the process of motion planning. A combination of the feature-sensitive motion planning framework and the Hybrid PRM planner are utilized by UAS to better automate the question of where and when to apply which planning solution. UAS first applies unsupervised region identification, which partitions a generated roadmap, runs k-means clustering, and determines the optimal number of clusters based on “elbow” criterion, and then UAS applies unsupervised sampler reward assignment, which determines the best sampler for each region and rewards the sampler. The advantages of UAS include simplifying the process of adaptation, requiring minimal user intervention, supporting both topological and sampler adaptation, and it can be applied to any motion planning problem.

In reading the paper on UAS for Constructing PRM's, a few possible research questions became apparent. First, can UAS work well with more complex environments than the current ones? The current environments are simplistic and therefore, do not test the robustness of UAS. I will create more complex environments with different robot types to test whether UAS is capable of handling intricate environments. Second, can different clustering techniques be used, and as a result of using different clustering techniques, do better methods exist to find the optimal number of clusters? Currently k-means is the clustering technique used by UAS; this technique has certain drawbacks, such as requiring initial input of “k”. I will implement and integrate different clustering techniques with the UAS code to find one that will out-perform the current k-means clustering technique. Lastly, is there a way to expand or change the current features used for partitioning? The current features only capture X, Y, and Z positional characteristics of configurations. I will implement and integrate different features with the UAS code to capture more realistic characteristics of configurations.

**Purpose:** Region identification is critical to the Unsupervised Adaptive Strategy Framework because the result of region identification is necessary for unsupervised sampling. Therefore, research in this area of motion planning will help automate the process of choosing and implementing a planner.

**Project Goals and Implications:** At the end of the project, I expect to conclude whether the region identification in UAS has improved since it is critical to the performance of the planner.

**Personal Goals:** My personal goals include: learning more about grad school and about motion planning, robotics, and efficient algorithms

**Approach:** On a daily basis, I plan to do the following things: read information on various clustering techniques, probabilistic roadmaps, configuration features, and motion planning. My research plans are:

- 1) with help from my mentor, implement different clustering techniques by identifying a clustering technique, implementing it in the code, and then evaluating the results
- 2) with help from my mentor, implement different features by identifying new features, running them through the clustering technique, and then evaluating the results
- 3) with help from my mentor, create complex environments with different robot types by defining and identifying a complex environment, implementing it in the code, and then evaluating the results

**Method & Materials:** During the course of my research experience, I will use the following: Parasol Lab computers and software (pimpl code) and Vizmo++, a 3D visualization/authoring tool

**Work Schedule:** 9:00 a.m. – 5:00 p.m., Monday-Friday

**Deliverables and Dates:**

Week 1-2: Background reading on different aspects of motion planning, Website [June 11<sup>th</sup> at 12:00 p.m.], Research Plan [June 11<sup>th</sup> at 12:00 p.m.]

Week 3-4: Implement and evaluate different clustering techniques

Week 5-6: Implement and evaluate new features

Week 7-8: Implement and evaluate complex environments, Research Abstract [July 23<sup>rd</sup> at 12:00 a.m.]

Week 9-10: Research Poster [August 3<sup>rd</sup> at 8:00 a.m.], Final Research Paper/Website [August 5<sup>th</sup> at 12:00 a.m.]