PAC-MANIFESTUS

progress report for EECS 467 project A3

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Abstract – This document serves as a review of progress made toward the completion of project A3. The document will examine deviations from the original proposal, progress made, current challenges, and assessment of remaining tasks.

I. Introduction

In order to fulfill the requirements of project A3, we are constructing a maze environment in which three MAE-Bots will be placed, allowing users to play the arcade classic, PAC-MAN, in the physical world. This project will involve a variety of the skills learned in this class including path finding, motion control, sensor integration, localization, and decision algorithms. The physical maze will be constructed with foam-core walls attached to a wooden base. Three Mae-Bots will placed within the maze. One bot will be user controlled and represent pac-man, the remaining two bots will operate autonomously and represent ghosts attempting to capture pac-man.

II. Deviations from original proposal

After contemplation of our original plans and consultations with our GSI, several components of our original designs were altered or abandoned. The largest changes came to our proposed localization scheme. We had originally intended to place colored circles atop the Mae-Bot lidars, and colored tape along the top edge of the maze walls. We would then use an overhead camera and blob detection to draw the map and track the location of each bot. This information would be used to manage the game state as well as to provide localization and motion control feedback to the individual bots.

This scheme was discouraged by the GSIs due to several potential problems that could arise at the design expo, such as variable lighting conditions, potentially impermanent camera positioning, and camera occlusion. These problems would wreak havoc with our system, and developing methods robust enough to counter them is likely unrealistic given our time restraints.

In concert with the proposed blob detection methods mentioned above, was the assumption that we would somehow monitor the maze at run-time and represent it as an occupancy grid. This was determined to be unnecessarily complex as valid paths through the maze could be represented in a much simpler manner, such as an undirected graph. This change should make path planning much more straight forward and dramatically reduce the memory and time requirements associated with the map.

A final change to our initial proposal concerns manual control of the bot representing pac-man. It was initially conceived that pac-man would be fully manual, allowing the operator to drive the bot as they wished. It was later decided that this would not only add undesirable difficulty to using our design, but would allow the operator to take such troublesome action as crashing the bot into walls or other bots.

It was decided that user input would be limited to Up, Down, Left, and Right commands similar to the actual arcade game. Pac-man would then use those inputs to make appropriate

and legal movements within the maze. This approach both simplifies control and allows us to reuse motion commands between the manual and autonomous bots.

III. Progress Made

Thus far we have thoroughly analyzed the concerns mentioned above, come to feasible design decisions addressing those concerns, and have begun work on several aspects of the implementation.

The most significant design changes we have made concern the map representation and localization methods. For the map we have chosen to use a hard-coded undirected map of two-dimensional coordinates. This is both a lightweight data structure, and one that lends itself to easy path planning via Dykstra's algorithm. Work has begun on this, and we are experimenting with different node representations to achieve the required data in the most straight forward manner.

For localization we have abandoned the use of cameras altogether to avoid the potential pitfalls previously mentioned. We will instead use line following sensors in concert with lidar to maintain localization. We will will be installing black tape on the floor of our maze representing valid paths of travel. Using the line sensors, we will control motion such that the robot can nominally be assumed to be on a valid path. Then using the fore and aft measurements of the lidar system, we can determine how far along a given edge a bot is.

As stated above, we have decided to use a simplified motion control system for the bots, in which they may only move in the four cardinal directions. Work has begun on this front as the basic movement functions have been written.

IV. Current challenges and remaining tasks

The largest challenge faced at present is that of controlling the motion of the Mae-Bots. The two difficult aspects are tuning the line following algorithm, and achieving accurate turning motions. Perfecting line following will simply require more time, as different parameters need to be explored and the effects of these parameters analyzed. The issue of accurate turning seems to be remedied by a firmware update on the bots wherein their feedback frequency is increased from 20Hz to 100Hz. I have not yet had an opportunity to work with the updated bots, but am informed that they provide a vast improvement that should abate our motion control difficulties.

With the updated bots, we anticipate being finished with motion control and map representation this week. Our attention will then turn to localization. This should not take too long as we are implementing a simplified version of what was used in project A1. The final tasks will then be writing the two ghost AIs and writing a game driver. The high level algorithms for the ghosts are already in place and are ready for implementation once navigation and localization are finished. The game controller should be simple to implement as it will simply receive pose messages from the three bots and determine whether the game is active or finished. Although a bit behind where I would like to be at this point, we have a clear vision for what needs to be done and, I believe, enough time to do it.