Final Project Report
Warehouse and Task Planning

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Abstract—**You should summarize your work here. A good intro with one sentence: e.g. This technology is needed due to . Then how you approached to the problem. What is your contribution/the most valuable part of the work emphasis that. What methodologies you used. How you demonstrated your results. How was the system performance. It should not be too short or too long**

Keywords—*IEEEtran, journal, LaTeX, paper, template.*

I. Introduction

A. Motivation

A smart factory environment is an important aspect of "Industry 4.0" where products can be ordered, produced, sorted, stored in a warehouse and finally delivered to the recipient. The different parts of the scenario are modular and hence the information exchange between the modules is limited.

The goal of our project is to implement a scalable system for cooperative multi-agent task and path planning. The project is used in a warehouse scenario, where robot agents have to store packages into shelves as per the tasks issued. These packages theorotically arrive without any pre-planning and hence the system should be able to accomodate for the unpredictable demand.

To increase efficiency the transportation, multiple robots have to work in parallel in a limited driving space of a warehouse and with co-ordination with the other robots to avoid collisions.

Congestion is another conundrum that this system has to consider. The robots will lose valuable time if they have to wait due to congestion, reducing lower the overall effectiveness of the warehouse system.

This project strives to provide a solution for the problem of assigning packages to the robots, planning the driving paths of the robots and coordinating them. The problem can be split into two separate parts: the task planning and the path planning. Both parts have to incorporate the coordination aspect.

The task planning is concerned with assigning incoming packages to the robots considering the time needed to store the package, energy consumption of the robots and overall optimality as far as possible given that the packages arrive randomly. The technical challenge here is to find an algorithm can assign a package to the best robot under the previously mentioned considerations.

The path planning is concerned with finding and traversing an optimal path for a robot between two points in the known area of indoor warehouse, with consideration of the other moving robots, non-holonomy criteria for optimality reasons and a continuous, non-linear environment. The technical problem is to find an algorithm which plans an optimal path for a robot under the previously mentioned considerations.

B. Problem Defination

A successful implementation of the project will go through following steps:

- The project starts with receiving a package that is to be stored in the warehouse.
- The pick-up point on which the package arrives and the drop-off point, where the package is to be stored, together constitute a task that has to be assigned to a robot. An example of such a task would be to place the package from the input tray to the storage tray.
- The system should accordingly decide a storage tray and assign the task to a suitable robot agent.
- The agent should be able to successfully navigate through the environment using the path and task planner and deliver the package. Thus, finishing the task
- The system must be stable enough to be able to perform multiple tasks concurrently and accomodate for inter-robot interactions.

C. Related Literature

how literature approaches to it (very briefly as we have a related works section)

D. Approach

how was your approach how did you show your results and how was it resulted

Note that these points above should be a summary of everything. With 1-3 sentences each (can change of course), but normally Introduction part takes upto 1,5 pages in the paper format. The trick here is that, you can first write your introduction and copy-paste some parts to the abstract.

II. Related Works

Please inspire from your SDS, but this time make it more elaborated. It should be clear that how the problems you stated was approached in general, and how you approached with a brief paragraph. Which studies were really inspiring to you and in what sense. You should mention those. Do not forget to cite the works, both in introduction and here [1].

III. METHODOLOGY

A. Overview

You should start with describing your project, how you approach the problems state under introduction (now in detail), overall architecture and briefly describing each part of the architecture. Your architecture drawing (with its last version) will be placed here. An example figure is shown in Fig. 1.

B. Main Components of the system

Now that you described the overall architecture, it is time to elaborate more the subparts you set out above. Answer the question of how you implemented each part. What this module involves and the clear methodology followed (e.g. POMDP model is used here inspired from [?] as the robots planner).

1) Path Planner: Short summary of I/O
Gets x from taskplanner
Generates a, b,c
In depth explainations of the component
2) Task Handler:

IV. RESULTS

Think about how you can show your projects performance. This is the most important section that will reflect your entire project, therefore it comes with the most weight on the grading of the Final Report. Therefore, analyze well what your project promises and how you can NUMERICALLY show this. Then, you discuss on the findings. Sub-sections can be created freely. Usually, the common metrics to be used are:

- overall accuracy in estimation (of whatever you are estimating: e.g. human belief, human activity, object type + shape, object pose, comparing the estimated time to store a pkg of a robot and the real time of realization etc). Of course for such analysis you need multiple runs of the system Dont forget to separate the training set from the test set (80
- overall success / precision (of the overall decisions your system makes: e.g. robotA is the most suitable for loading and storing pkg, comparison of the average time a task is realized with or without this component shows the impact of the component.)

If you can show your results on graphics it is a BONUS. If you can show on such graphs that how changing of some parameters of your mehtods/env. conditions/the context in the scenario etc. would affect your systems performance, then you will receive +10 points for your overall document.

As the first step, you start discussing on what sort of results you will show and we will definitely discuss them in the upcoming two weeks. Feel free to suggest and ask anything on that phase (be brave !).

Finally, you will conclude with the discussion of these results you showed/described. Basically answer this question, what these results tell you? Even though they are bad /not significant then you need to comment on why it is how it is. There HAS TO BE A DISCUSSION even though it is short.

You can also criticize your approach and offer better ones if it would lead to better performances. You can also briefly discuss the points to be improved/extended in your system. You will get the GRADES FROM THE DISCUSSION more than the significance or the performance of your results. In the past some groups got the highest grades although their system didnt work well. Your goal is not to build an end product, but to be aware of what you build, a strong code base and discussion points for us to improve on your code. Positive results are of course a plus.

V. CONCLUSION

A brief summary of your system, what was the problem, how you achieved, your objectives, and your methodologies you used very very briefly. Then again very briefly share your finding (the discussion you made). Finally, you will conclude with the possible extensions / changes to improve the performance, basically the future works. You can find more about the templates of IEEE on the internet.

APPENDIX
CLASS DIAGRAM

Here I would like to see your final class diagram. It doesnt require any description (unless it is complicated). It will be sufficient and necessary to mention at least once inside the methodology part that your class diagram is attached as an appendix. Also give figure caption to it.

ACKNOWLEDGMENT

REFERENCES

[1] H. Kopka and P. W. Daly, *A Guide to LATEX*, 3rd ed. Harlow, England: Addison-Wesley, 1999.