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Contents

Index

Abstract

abstract abstract

Keywords: Keywords

Introduction

General introduction

In the latest year robot has become a more and more prominent part of the work force, becoming more present in most sector of the industries. Robot were particularly important in the manifacturing industry as repeated movement and task could be automated, increasing productivity and the safety of the workers, that worked with big macinery [1]. Industrial robot are big, and can be dangerous to human working cloes to it, that is why during the last years [2] cobot has been introduced. Cobot are, lighter, smaller but safer[3] than industrial robot, using force sensors and appositi algorithm they are deemed safe to work side by side with a human under the [4] sets of law This ensured to provide the flexibility that the industrial robot missed allowing robot to be used in more specific and more elastic, flexible task, where the specific can change with time, which made them unfit for industrial robot, where programming tend to be more complex [4] So the robot and the human could collaborate on a task, resulting in the human doing less repetitive or dangerous tasks.

[1]:paper
[2]:paper
[3]:paper
[4]:define(ISO?)
.

What is HRC

HRC, which stands for human robot collaboration, is a field of robotics that studies collaborative tasks between robots and human.[5] .

5:difficulties in HHC paper

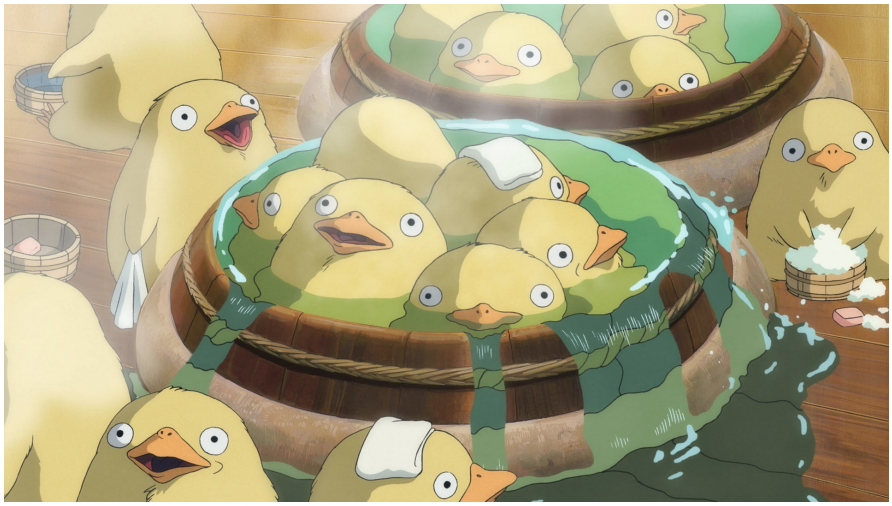

Figure 1

Literature review

Methods

Methods introduction

In this section the methods used in this thesis will be introduced and presented to the reader.

Behaviour tree

Behavior tree are a method to organize the decision making of a system, they have find usage particularly in A.I for video games and chatbot. They can be considered as an extension of finite state machine [1] . Behaviour trees progress during execution in discrete step called tick, at each tick behaviours are executed based on the structure and the status of the tree. When being ticked and thus executed a behaviour will return a status, that represent the result of the behaviour itself, this status can be **Success**, **Failure Running**. [1]:paper

The tree is composed by different type of nodes:

- Behaviour: behaviours are the leaf of the tree, they represent an action that the robot has to perform to complete the task. (Later on this document it will be further explained how the behaviours have been defined for the completation of this ???) Each behaviour is
- Composites: composites are control nodes and they define how a behaviour tree is traversed. This nodes have different children which can be both behaviours or composites. When ticked composi execute these children, and change their status based on them and different policies:
  - Sequence: they execute each children in order until one of them return running or failure, or all of them return success.
  - Fallback: they execute each children in order unitl one of them return success or all of them return failure.
  - Parallel: they execute each children in a pseudo parallel way, each children is ticked in order, the parallel composite will suceed when at least M children suceed where $M \leq N$ and N is the number of behaviour in the parallel composite

The composites nodes are what ensure scalability for behaviour trees, as you can treat composites as complex behaviours, which can be expanded or reused. This strategy of control also ensure reactivity, especially when the tree implements parallel nodes, where all the children are execute together. For all these reasons in latter years behavior tree found new employement in control of robotics arm manipulation task. The reactivity and scalability of behaviour tree make them a great candidate for human robot collaboration task as they let the robto be able to react to a complex agent as a human can be and can scale easily, adding nuances and additional behaviour easily.

Skills

Methods implementation

In this section it will be explained how the methods presented earlier have been implemented for this work

Results

Discussion

Conclusions

Bibliography

[1] Dylan Cawthorne. Robot ethics: Ethical design considerations. In *Foundations of Robotics: A Multidisciplinary Approach with Python and ROS*, pages 473–491. Springer, 2022.