

Mission 2 Justification

Control of a Robot Manipulator.

STUDENT: 190079330  
Candidate No:

Lecturer:

Date:28/03/2024

Table of Contents

[Introduction 2](#_Toc160585176)

[Traffic Light Detection 2](#_Toc160585177)

[Combination of Subsumption and Finite State Automata in Robot Behaviour: 2](#_Toc160585178)

[References 3](#_Toc160585179)

# Introduction

This document details a brief justification of design and development rationale for Mission 1’s perception and Behaviour coordination tasks.

# Traffic Light Detection

In the context of autonomous vehicle navigation, particularly under constraints such as limited sensing capabilities and low-resolution image inputs, adopting a local sensing strategy presents a pragmatic interim solution. This approach aligns with the principles outlined in the field of untethered soft robotics and swarm robotics, where localized sensing and actuation mechanisms are crucial for autonomy in unstructured environments (Rich, S. I., Wood, R. J., & Majidi, C., 2018; Brambilla, M., Ferrante, E., Birattari, M., & Dorigo, M., 2013). Given the challenges associated with high-resolution data processing and the necessity for real-time responsiveness, our methodology leverages contour detection for identifying traffic light boxes prior to state determination. This decision is substantiated by He et al. (2010), who demonstrated the efficacy of integrating depth cues with color for enhancing segmentation performance in low-resolution settings.

The implementation of local sensing, constrained by the absence of additional sensing modalities, was dictated by the immediate need for a reliable detection mechanism that could operate within the limitations of our system's low-resolution camera feed. This approach ensures that traffic lights remain within the vehicle's visual field, a crucial factor for state detection post-transition to green. The adoption of a hybrid strategy, combining local sensing with adjusted vehicle speed parameters, aims to facilitate preemptive stopping and planning, thereby maintaining continuous visibility of traffic lights.

However, this approach is not without its limitations. The reliance on contour detection in pixelated images could lead to inaccuracies in traffic light identification, particularly in diverse environmental conditions. Moreover, the system's dependency on continuous visual contact with traffic lights introduces potential vulnerabilities in dynamic urban settings. Future work will explore the integration of more sophisticated sensing technologies and machine learning algorithms to improve detection accuracy and system robustness.

# Combination of Subsumption and Finite State Automata in Robot Behaviour:

Implementing a hybrid approach that combines subsumption architecture with state machine behaviours coordination for traffic light stop behavior in autonomous vehicles offers several compelling advantages. This methodology draws inspiration from Kolar's (2020) integration of consensus-based tasks with a behavior-based algorithm, specifically subsumption architecture, for enhanced task allocation and execution in unmanned aerial vehicle swarms. Similarly, Grollman and Jenkins (2010) explored the learning of finite state machine (FSM) controllers from interactive demonstrations, underscoring the versatility of FSMs in managing complex tasks through the decomposition into subtasks. By combining these architectures, it's possible to leverage the strengths of both: the reactive, priority-based decision-making of subsumption architecture and the structured, sequence-based control of state machines.

Personal motivations for integrating these approaches into a singular framework stem from a desire for simplicity and manageability, particularly in implementing nuanced behaviors like traffic light recognition and response. Subsumption architecture allows for a flexible, hierarchical handling of behaviors, ensuring that urgent actions (e.g., stopping at a red light) override less critical ones. Concurrently, the state machine structure facilitates clear, manageable transitions between diverse driving states, such as moving, turning, and halting. This synergy not only simplifies the coding and debugging process by housing all behavioral logic within one cohesive system but also enhances the vehicle's ability to dynamically adjust to real-time traffic conditions. Furthermore, this integrated approach fosters a scalable and modular design, facilitating future expansions or modifications to the behavior logic. Overall, the decision to meld these architectures reflects a strategic choice to capitalize on their combined benefits for creating a robust, efficient, and manageable autonomous driving system.

# References

1. Kolar, P. (2020). Coupling consensus-based tasks with subsumption architecture for UAS swarm-based intelligence surveillance and reconnaissance operations. AIAA/IEEE Digital Avionics Systems Conference - Proceedings, 2020-October. <https://doi.org/10.1109/DASC50938.2020.9256816>
2. Grollman, D. H., & Jenkins, O. C. (2010). Can we learn finite state machine robot controllers from interactive demonstration? Studies in Computational Intelligence, 264, 407–430. <https://doi.org/10.1007/978-3-642-05181-4_17/COVER>
3. Brambilla, M., Ferrante, E., Birattari, M., & Dorigo, M. (2013). Swarm robotics: A review from the swarm engineering perspective. Swarm Intelligence, 7(1), 1–41. <https://doi.org/10.1007/S11721-012-0075-2/FIGURES/13>
4. Rich, S. I., Wood, R. J., & Majidi, C. (2018). Untethered soft robotics. Nature Electronics 2018 1:2, 1(2), 102–112. <https://doi.org/10.1038/s41928-018-0024-1>
5. He, H., McKinnon, D., Warren, M., & Upcroft, B. (2010). Graphcut-based interactive segmentation using colour and depth cues. Proceedings of the 2010 Australasian Conference on Robotics and Automation. <http://www.araa.asn.au/acra/acra2010/authors.html>