O-TRAIN CONTROLLER USING DISCREET EVENT METHODOLOGY FOR EMBEDDED SYSTEMS

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ABSTRACT

In this paper, we present an illustrative model and implementation of a transportation system using Discrete Event Methodology for Embedded Systems (DEMES). The model is implemented in Seeed Shield Studio Bot using E-CD Boost simulator. A light rail transportation system used in Ottawa (O-train) for local transportation where passengers can make stop requests while inside the train or outside the train (in a station) is modelled and implemented. The model is divided into two parts – the first part handles stop requests from inside passengers while the second part handles stop requests from passengers in their respective train stations.

Keywords: O-Train, Embedded Systems, Model Driven Development, DEVS, Embedded-CD boost,

1 INTRODUCTION

The O-Train trillium line is a light rail system in Ottawa, Ontario, Canada operated by OC-transpo. The key task of O-Train is to transfer the passengers from one station to another. The stops of these stations are fixed and are controlled manually by a pilot. However, the issue with the current system is that it stops the O-Train on every station even when there is no passenger boarding or disembarking from that station, which wastes a significant amount of travel time. In an attempt to tackle this problem and make the O-Train more efficient, we propose a stop control system in which the train would be stopped only when passengers need to board or get off from that stop. There have been several methods proposed for developing control systems some of which are conventional, agent-based or model based. However, Model-based methods have become very popular because they are flexible, reusable and more convenient to test. In this paper, using the line follower models as a starting point, we model the O-train control system based on DEMES owing to its unique advantages highlighted above.

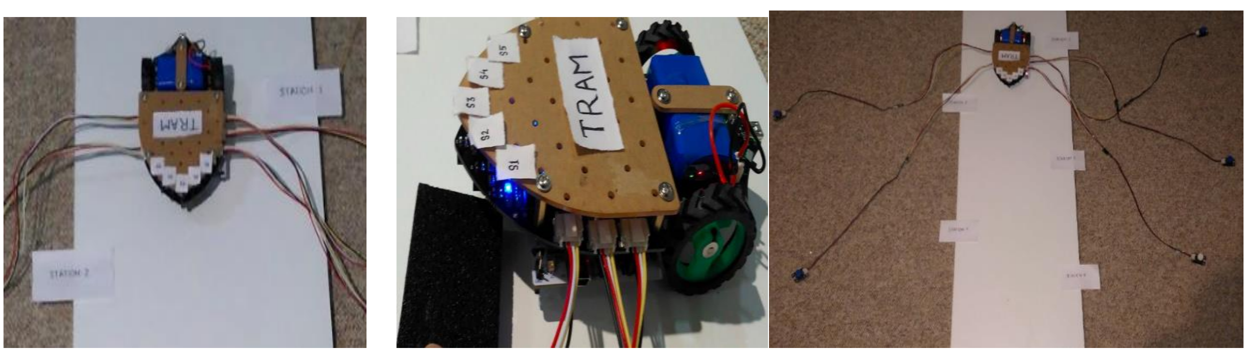
2 BACKGROUND

Some methods proposed for controlling autonomous robot cart include: The first group of methods use conventional controller for example, a control system for an autonomous robot cart designed to operate in well-structured environments. A second group of methods use modelling and simulation for example, Simulink for model-driven development. However, recent industrial trends have increased the demand for rigorous verification on safety-critical applications, which is a very challenging task for Simulink Modeling and simulation (M&S) provides an alternative method for implementing an autonomous robot cart. Despite the limited practical application of modelling and simulation in literature, the application of modelling and simulation in real-time system design has gained popularity in recent years because construction of the system model and analysis by simulation enhances both the capabilities of the system and improves the quality of the final product while reducing cost and the risk. Compared to the other methods outlined above, however, O-Train controller using M & S can be controlled using the cart sensors as well externally through the digital push buttons. It is more efficient since testing of the model is done under actual operating conditions. Also, the set of conditions under which the system is observed can be automated.

Discreet Event Modelling of Embedded Systems (DEMES) allows models to be used throughout the development cycle. DEMES enable the development of embedded systems. Initially, a System of Interest is defined using DEVS. Once the system is defined, model checking can be done for validation of the model. The model is then used to run DEVS simulations and derive test cases. The model is then incrementally moved to the target platform. E-CD Boost implements the DEVS theory with real-time functionalities. It provides a platform for models to be defined according to the DEVS formalism and implemented in real time. The tool allows atomic models to be programmed in C++ and provides a method for coupling them. For implementation directly on hardware, this tool allows for the generation of a binary file that can be interfaced with input/output devices through the ARM MBED Library.

3 RESULTS

For this project, an ECD based simulator is used to simulate the O-Train controller which consisted of Stop and Wheel Controller as its Atomic models. After successful completion of its simulation, it generates a bin file which is pushed to the real hardware i.e. Shield Robot. Depending on the different inputs the cart moves to different stops in the way. For an example, the O-train rests at station 1 until and unless an input through sensors or push buttons is given to it. When an input is provided to one of the infra-red sensors, the train starts moving forward. Each sensor represents a station; therefore, the next destination is determined by input to a sensor. Similarly, there are five push buttons and each push button represent a station. When a button is clicked the train starts moving forward or backward according to the requested destination but would only change direction when it has reached the last station or the first station depending on the direction requested. The Train can be controlled by using a sensor or a button for both forward and backward movements.



(Left) The O-train positioned at station 1 waiting for a request. (Center) Next stop is requested through IR-sensor 1. (Right) Train Movement, different stations and their respective push buttons

The complete real time model structure with the train, its path, different stations along with the push buttons of respective stops can be seen in the above figures. It is also observed that the time wasted for every unnecessary stop would be saved if the control system presented in this paper is adopted.

4 CONCLUSION

We have successfully implemented the DEVS models of the O-Train control system with the advantage of saving time for passengers. The implemented model on the hardware works as expected, receiving external inputs from the sensors as well as from the digital push buttons. Although this is a simple model it clearly shows the advantages of DEMES and would pave way for the adoption of this simple model as a starting point to implement more complex control systems.