

TSS 1st Singapore Engineering Design Challenge 2005 – 1st Runner Up Award and Technical Award

Scheduling efficiency is a key concern in today's transportation industry. Railroad traffic volume has increased significantly over the last two decades. Commuters are circulating in increasingly bigger, advanced and faster railway networks. Because of the immense amount of transportation tasks, it is necessary for the Mass Rapid Transit system to use available resources most effectively and to provide services to the public, under such limited resources, in an efficient timely manner. With the great advancements in communication networks, on-line information on passenger traffic and train status has become easily available. Such information flow can then generate important feedback signals and information in an intelligent system design to demand *Responsive Online Scheduling Strategies*.



Figure 1 Student Jeffrey Chua and Supervisor Professor CS Chang

EE4 student Jeffrey Chua Poh Leng (under the supervision of Assoc Prof Chang Che Sau) presented a distributed control approach in applying computational intelligence concepts such as fuzzy logic to implement a hierarchical, interactive Multi-Agent Fuzzy Expert system for Automatic On-line Scheduling of Mass Rapid Transit System. The final-year project won the 1st runner-up prize and Technical award in TechSource System 1st Singapore Engineering Design Challenge 2005, a competition sponsored by Hewlett Packard, DSO National Laboratories, Institute of Engineering Singapore and Institute of Electrical Engineering.

Agent-based systems technology has generated lots of excitement in recent years because of its promise as a new paradigm for conceptualizing, designing, and implementing software systems. This promise is particularly attractive for creating systems that operate in environments that are distributed and open. A good example of a distributed transportation system would be the Mass Rapid Transit. When a problem domain is particularly complex, large, or unpredictable, the only way it can be reasonably addressed is to develop a number of functionally specific and modular components as agents that are specialized at solving a particular problem aspect. This decomposition allows each agent to use the most appropriate paradigm for solving its particular problem, for example in this case would be the fuzzy expert system decision-making module. The fuzzy expert system also aims to raise the Agent's On-line cognition processing to supervisor-expert human performance level with heuristic rules, knowledge-base and human-like fuzzy reasoning.

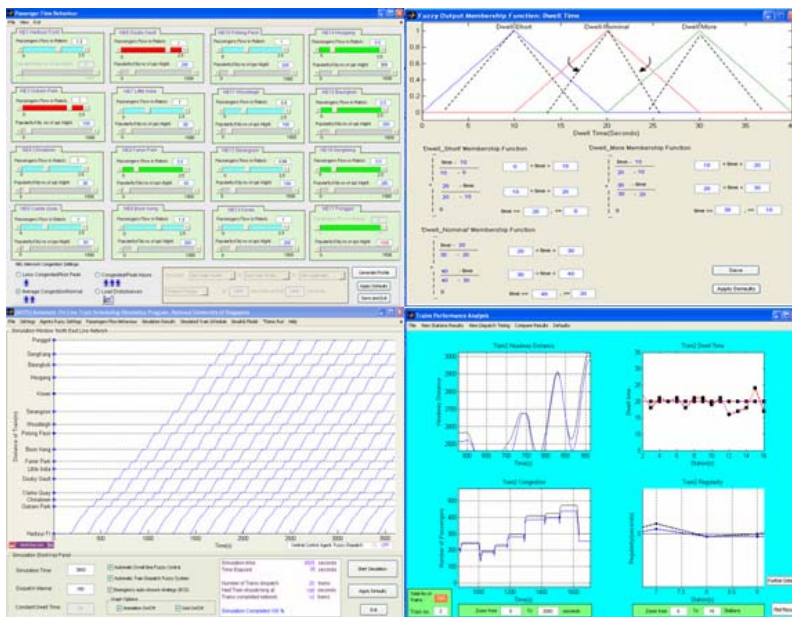


Figure 2 Some GUI interfaces of the Simulation Toolbox

Line (NEL). Simulation results verifies the robustness and efficiency of the automatic on-line scheduling to different transit environments, involving both undisturbed passengers arrival rate as well as a variety of passengers arrivals with disturbances. Simulated scenarios mimic actual scenarios like transition between a non-peak period to a peak period and passenger flows with sudden disturbances in a SMRT environment. The simulator's GUI also aids in the analysis of various simulation results, the tuning of the fuzzy membership functions for different fuzzy controls, the setting of disturbances in the passengers flow and provide a user-friendly interface between the simulation engine and the front end-users.

An Objected-oriented simulation program with Graphics User Interface GUI – Automatic On-Line Train Scheduling Simulator ToolBox [AOTS], which also won the Technical Award, is the main simulation engine for the Multi-stations and Multi-trains simulation. The simulation toolbox program is created in Matlab. The main simulation engine analyze a macro picture – a *network* of stations and trains simulation, by using information of a real world Automated SMRT network – the North East

Lastly, the online/real time scheduling work will form an important component in the on-line layer of the whole Automatic Scheduling System. Together with offline optimization of the schedule which involves pareto-optimal evolutionary algorithms, the whole Automatic Scheduling system will be a very powerful combination of using multi-agent, fuzzy logic and evolutionary algorithms methodologies for automatic scheduling and optimization of the Mass Rapid Transit system.