A Conversion of Loops and Workflows Between Pedestrian Dynamics-Discrete Event Simulation and Comparative Analysis by Object

Suk-Tae Kim*
*Dept. of Interior Architecture, Inje University
e-mail : demolish@inje.ac.kr

Pedestrian Dynamics-Discrete Event Simulation간 루프 및 워크플로우의 변환과 객체별 비교분석

김석태*
*인제대학교 공과대학 실내건축학과

Abstract

Network-based Discrete Event Simulation (NDES) and Pedestrian Dynamics (PD) are essentially the same system in terms of discontinuous simulation based on workflows and events. PD, originally developed for spatial analysis, portrays a more realistic space and provides effective functions such as density analysis, but requires a longer system processing time. Therefore, the same model was applied to NDES and PD to study how to convert flowcharts and agents, and the effectiveness was examined by comparing the characteristics. The system processing speed improved significantly, but the results showed differences. This seems to be due to the difference in how service loads are calculated.

1. Introduction

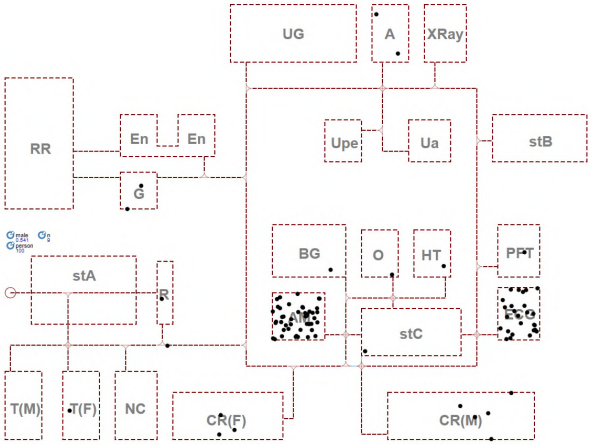
Discrete Event Simulation (DES) is widely used to study organizational processes, mainly as queuing systems. DES also is one of the most applied simulation techniques used in sustainability or green management related models[1]
Pedestrian Dynamics (PD) is a simulation technology that includes entities and spatial models in simulations to apply DES to spatial analysis, which integrates a large part of the agents (or nodes) that constitute the workflow. However, as Network-based Discrete Event Simulation (NDES) is fast and easy to operate various types of resources (static, moving, portable), its use is feasible for multiple applications. Therefore, this study reconstructed a previous study applying PD into NDES and examined through comparison the characteristics of each simulation. Before the analysis, the flowchart was reconstructed by searching workflows with different simulation configurations and the conversion between the objects (entities, agents) constituting them.

2. Experimental simulation settings

The simulation was developed by referring to the J-Hospital health examination center in Gyeonggi Province as an example model. This center was selected because it was independent of other hospital facilities such as the outpatient department, and all of the required examination rooms were installed within the center.
The simulation was based on the national basic examination, which accounts for the largest portion of the examination programs in Korea. The examination procedure was determined by referring to a study by Song (2012)[3] which applied the order specified by the Korea Association of Health Promotion.
Women received additional exams such as mammograms and pelvic ultrasounds (bone density), and there were differences compared with men in undressing and urine sampling times. The ratio of men to women was set to 54.128% : 45.872% according to the 2015 National Health Screening Statistical Yearbook. Also, 20% of the total patients received upper gastrointestinal series (UGI), and the rest received endoscopy, 25% of which comprised conscious sedation endoscopy. AnyLogic 8.3.x was used to develop the linear network simulation (i.e., NDES).
In PD, the attractors in the service nodes usually process the tasks, and the overloads are recorded in the queue variable. On the other hand, NDES uses delay nodes and

stores the queues in a separate queue node or allocates resources (ResourcePool nodes) to service nodes. This study applied the latter method, which may result in differences in how to measure the overload due to measurement by resource utilization.

Fig. 1 shows the network structure of the examination center configured by the network and Fig. 2 shows the NDES flowchart in this study. As the NDES in this study specifies a resource (pool) for each service node, the flowchart is more complicated than PD due to visually implementing the flow of the entities in the simulation separately.



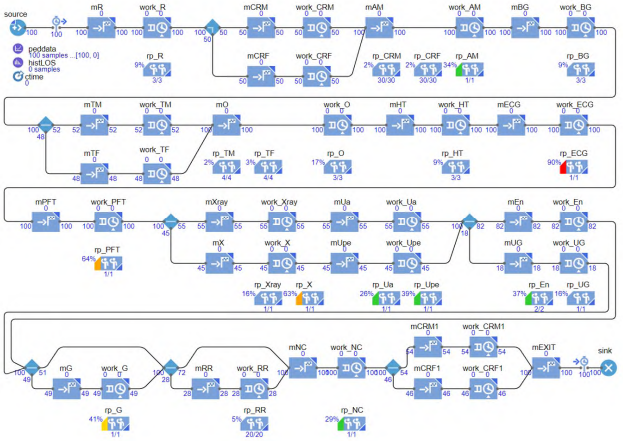
[Fig. 1] J examination center's network structure

3. Simulation results and comparative analysis

According to a previous study using PD, the fastest agent took 1 hour 14 minutes 23 seconds (4,463.81 seconds) to finish the examination while the slowest agent took 7 hours 6 minutes 12 seconds (25,572.42 seconds)[2]. On the other hand, the average processing time in the NDES simulation was 6 hours 35 minutes 34 seconds (23,734.16 seconds), with a minimum time of 1 hour 10 minutes 43 seconds (4,243.32 seconds) and a maximum of 11 hours 35 minutes 2 seconds (41,702.03 seconds).

The average utilization of resources was the highest in ECG (90%), followed by PFT(64%) > X(63%) > X(63%) > G(41%) > Upe(39%) > EN(37%) > AM(34%) > NC(29%) > Ua(26%) > O(17%) > XRay(16%) > UG(16%). The maximum loads occurred in AM and ECG (rising to 95%), which were the main cause of system processing delays.

Meanwhile, PD calculates the load by the size of the queue, not by the utilization of resources. A previous study found that queues up to 34 people in ECG and 20 people in HT caused the delay. Although ECG was also the main cause in NDES, the resource utilization of HT reached a maximum of 25% (average 9%) in NDES, which was lower than the other examination items. This partially contradicted the PD results.



[Fig. 2] Flowchart and simulation results of basic examination based on NDES

4. Conclusion

PD and LDES use different methods to process system power. As a result of applying two simulations to the same examination center model, the overall processing power analysis showed similar results. However, the delay factor analysis conveyed different results. This seems to be due to the differences in how loads (or queues) are measured. Additional studies will be conducted in the future to discover specific causes through precise simulations by gradually adjusting the number of entities. .

참고문헌

[1] M. Fakhimi, et al. "A hybrid agent-based and discrete event simulation approach for sustainable strategic planning and simulation analytics", IEEE, Proceedings of the Winter Simulation Conference pp.1573-1584, 2014.

[2] S. T. Kim, "Research on Space Systemization and Reduction of Examination Time of Medical Checkup Centers Applying the Agent based Model", International Journal of Engineering & Technology, 8(1.4), pp.356-368, 2019

[3] S. E. Song, S. T. Kim, "A Study on Traffic Line Efficiency of Health Examination Centers Based on Space Syntax : Focused on the Spatial Cognition of the Testee Taking the National Examination Program", Journal of Institute of Healthcare Architecture, 18(4), pp.53-67, 2012