Chapter 23 Multi-Perspective Modeling of Healthcare Systems

Ignace Djitog

African University of Science and Technology, Nigeria

Hamzat Olanrewaju Aliyu Federal University of Technology, Nigeria

> Mamadou Kaba Traoré Université Blaise Pascal, France

ABSTRACT

This paper presents a multi-perspective approach to Modeling and Simulation (M&S) of Healthcare Systems (HS) such that different perspectives are defined and integrated together. The interactions between the isolated perspectives are done through dynamic update of models output-to-parameter integration during concurrent simulations. Most often, simulation-based studies of HS in the literature focus on specific problem like allocation of resources, disease propagation, and population dynamics that are studied with constant parameters from their respective experimental frames throughout the simulation. The proposed idea provides a closer representation of the real situation and helps to capture the interactions between seemingly independent concerns - and the effects of such interactions - in simulation results. The article provides a DEVS (Discrete Event System Specification)-based formalization of the loose integration of the different perspectives, an Object-Oriented framework for its realization and a case study as illustration and proof of concept.

INTRODUCTION

Being composed of concurrent, fragmented and diverse components interrelated with intricate processes, modeling the domain of healthcare will require the understanding of the behavior of the overall system (Barjis, 2011). Decision-making concerning questions related to the performance of HS - such as the extent to which the system achieves its mission - have no clear or simple answers while the need to produce more with less resource despite the scarcity is becoming a widely-acknowledged concern

DOI: 10.4018/978-1-5225-3926-1.ch023

among policy-makers and healthcare managers worldwide. This is proven by a considerable volume of work published in recent years being dedicated to simulation-based study of HS. Frequently, modeling approaches used to investigate different aspects of HSs related to healthcare simulation include discrete event simulation, mixed method that combines simulation with optimization techniques, goal programming and discrete event simulation with data envelopment analysis (Weng et al., 2011). Arguably, unit specific studies of simulation modeling in healthcare that deals with specific problems have been predominant in the published research articles. Such unit specifics include A&E (Accident and Emergency Departments), inpatient facilities, and outpatient clinics (Choi et al., 2013). The common issues addressed in the literature include, but not limited to scheduling and patient flow, sizing and planning of beds, rooms, and staff.

The main challenge in modeling a complex system such as HS is the large number of its components and their diversity. To the best of our knowledge there has not been a generic model of healthcare simulation that considers the different elements of HS and their interactions to describe a complete whole. This paper investigates HS through multi-perspective modeling and addresses the challenges that come with modeling such a complex system. Multi-perspective modeling allows constructing distinct and separate models from different aspects of HS for a better understanding of its complexity. Furthermore, an integrative approach based on live updates of output-to-parameters translation is developed to allow the simulation output of a model of a given perspective to update the simulation parameters of another perspective dynamically. Arguably, a closer representation of the real situations can be achieved if these parameters are systematically modified at runtime in such a way that the outputs of the simulation models corresponding to different perspectives provide live updates of their parameter(s) in concurrent simulations. Therefore, the formalization of the bases of the proposal is provided with a case study that presents the models of different perspectives in HS and shows how their integration is being achieved.

The rest of this paper is organized as follows: the next section presents the literature review followed by the multi-perspective modeling of HS. The DEVS-Based formalism for integrating HS perspectives is then presented with a case study to illustrate its application before concluding the paper with directions for future work.

LITERATURE REVIEW

Modern HSs have been explored with a variety of studies over many decades. Although not exhaustive, a number of examples of these studies include discrete event simulation, system dynamics, agent-based simulation, Monte Carlo simulation, hybrid simulation (combination of discrete-event and continuous) and simulation combined with optimization techniques. Roberts (2011) presented an extensive tutorial of such simulation modeling methods with a revision of taxonomy of the use of computer simulation in healthcare into two categories: Patient flow optimization and Analysis, and healthcare asset allocation. More specifically, Gunal and Pidd (2010) enlarged this taxonomy in a review of the literature for discrete event simulation for performance modelling in healthcare into scheduling and patient flow, sizing and planning of beds, rooms, and staff. Unit specific studies of simulation modeling in healthcare focusing on solving specific problems in individual HS units such as Outpatient clinics, A&E (Accident and Emergency Department), and Inpatient facilities are predominant in healthcare simulation literature.

Consequently, most of the published articles look into HSs with focus on a single perspective modelling. For example, patient pathway across different healthcare units has been regularly examined to 20 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/multi-perspective-modeling-of-healthcaresystems/192686

Related Content

An Evaluation of Laboratory Information Systems in Medical Laboratories in Jamaica

Donovan McGrowderand Romeo Bishop (2015). *Laboratory Management Information Systems: Current Requirements and Future Perspectives (pp. 280-296).*

www.irma-international.org/chapter/an-evaluation-of-laboratory-information-systems-in-medical-laboratories-injamaica/115617

Evaluating the Effectiveness of Boxing Headguards in Mitigating Head Impact Accelerations That Cause Concussions by Using a Dynamic Head Model

Tyson R. Rybak, Paolo Sanzo, Meilan Liuand Carlos E. Zerpa (2023). International Journal of Extreme Automation and Connectivity in Healthcare (pp. 1-15).

www.irma-international.org/article/evaluating-the-effectiveness-of-boxing-headguards-in-mitigating-head-impactaccelerations-that-cause-concussions-by-using-a-dynamic-head-model/319811

Transfer Learning for Highlighting Diagnosis in Pathological Anatomy Based on Immunohistochemistry

Mohamed Gasmi, Issam Bendiband Yasmina Benmabrouk (2021). International Journal of Healthcare Information Systems and Informatics (pp. 1-23).

www.irma-international.org/article/transfer-learning-for-highlighting-diagnosis-in-pathological-anatomy-based-onimmunohistochemistry/301232

Patient Portal Acceptance by the Elderly: Explained by the Elaboration Likelihood Model and Social Heuristics

Karoly Bozan, Kevin R. Parkerand Bill Davey (2020). *Handbook of Research on Optimizing Healthcare Management Techniques (pp. 67-90).*

www.irma-international.org/chapter/patient-portal-acceptance-by-the-elderly/244696

Transition to ISO 15189 : 2012 for Cytopathology Laboratories Part 4: Examination Processes and QC / QA System (QCAS)

Eleftherios Vavoulidis, Stavros Archondakis, Maria Nasioutziki, Ourania Oustambasidou, Angelos Daniilidis, Konstantinos Dinasand Aristotelis Loufopoulos (2016). *International Journal of Reliable and Quality E-Healthcare (pp. 62-82).*

www.irma-international.org/article/transition-to-iso-15189--2012-for-cytopathology-laboratories-part-4/159070