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MUGS: A Platform for Disaster Management Simulation

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***Abstract*— This paper gives a short overview of the system dynamics (SD) based simulation system named Multi-User Gaming Simulator (MUGS). MUGS allows to modify SD model and to analyze new problem setting by updating the situation. It is not a mere software rather it represents a platform for analyzing complex systems representing through SD model. We currently focus on simulating agent's behavior in decision making after a disaster and analyzed outcomes of new strategies.**

Keywords—system dynamics, gaming simulator, platform

I. Introduction

Simulation is an exercise for information management and role-playing. It focuses on individual and collective decision making. The simulation allows an organization to use operational tools, procedures, and forms to evaluate their systems and performance. It also provides for training and for practicing tasks that require decision making and coordination. The process of evaluating the results of a simulation helps to identify critical areas of management and aspects that need to be strengthened. The followings are the expected benefit of using simulation for disaster preparedness and response (Pan American Health Organization, 2011)

- They evaluate preparedness or emergency plans;
- They allow for training and updating knowledge;
- They evaluate the decision-making process and coordination mechanisms;
- They help to strengthen coordination within an organization and with other sectors and institutions;
- They validate the instruments and processes used to collect and organize information;
- They evaluate how participants react in specific situations.

System dynamics (SD) based analysis gains popularity for analyzing complex simulations with potentially great numbers of parallel and interacting sub-systems. This method is applied by integrating a number of sub-systems through logical simulation process. It is a theoretical exercise, also called a desk- or tabletop exercise since it can take place in a single, closed space, or among several interconnected sites.

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International Research Institute of Disaster Science (IRIDeS), Tohoku University has developed a SD based simulation platform named Multi-User Gaming Simulator (MUGS). It recreates a hypothetical disaster scenario where a group of participants must make decision based on information that they receive during the experiment. Each participant is assigned a role in the experiment depending on his or her actual occupation. Basic information about the role being played is necessary for correct interpretation of the role. The preliminary assumption in the experiment is that participants will provide realistic response based on the experiment scenario. MUGS allows interaction between different players and enables them to explore, experiment and learn at their own pace. The aims of the experiment is to evaluate effect of a new policy or a strategy. In addition, MUGS can be utilized to evaluate the capability of decision making in an emergency situation. The expected benefit of MUGS are to provide guidelines to prepare persons who have decision making authority to manage crisis in emergency situations.

II. Simulator Features

MUGS allows to analyze system dynamics problem systematically. Fig. 1 represents the basic components of MUGS. It consists of the basic components: simulation control, agents, analysis, and evaluation. All components are connected through coordinator

Simulation control handles the model of scenario generation and system dynamics (SD). MUGS allows to modify SD model structure and to do experiment on different problem setting. Scenario generation provides information of initial condition. Scenario provides parameters for SD model while these values are informed to the participant. SD model structure shown in Fig. 2 is currently installed on MUGS.

The SD model is developed based on the knowledge of the 2011 great east Japan earthquake and other recent disasters in Japan. In this model, there are two-level control system: upper control level and lower control level. Upper control level intentions to reduce relief wastage in relief distribution. On the other hand, lower control level has expectation of gaining more relief from upper control level. Note that, SD models calculate relief wastage in each cycle and other logistical costs.

Agents represent decision maker in SD model. In the current SD model, there are two level decision makers: upper

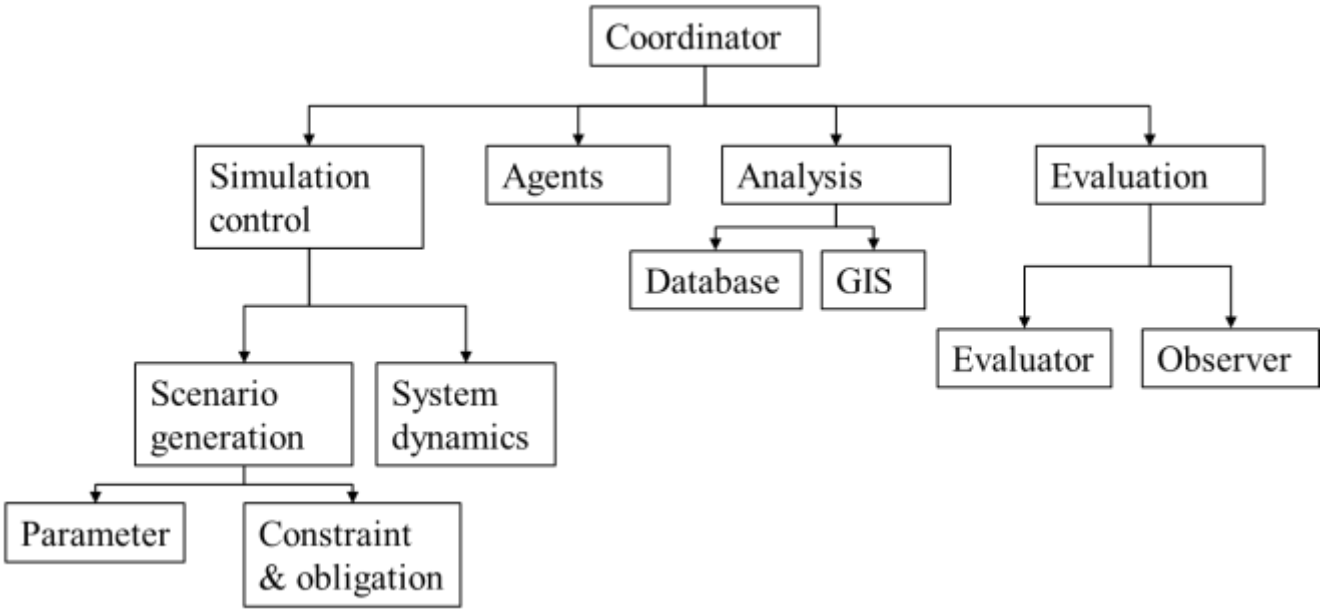

Figure 1. Structure of MUGS

and lower level control. They represent legal entities (e.g., organizations) who have experience in handing decision making in emergency situation.

A global agent named coordinator can observe the effectiveness of a decision. The coordinator does not have decision making power. Communication between sub-controller (upper and lower control level in the current SD model) and the coordinator is based on local Java method. Voice communication between coordinator and sub-controllers are possible through speaker and headphone. Information can be provided through messages distributed at different times in exercise; they can be transmitted orally, in print, or digitally, among other.

Evaluation provides the quality of decision in the whole systems. There are several indicators to evaluate the performance. Some examples of performance indicators are % of relief wastage, % of relief shortage, logistical cost and others (depending on problem setting). In addition of evaluation by the MUGS, IRIDeS has installed overhead camera for video recording of facial expression to identify the difficulties in decision making.

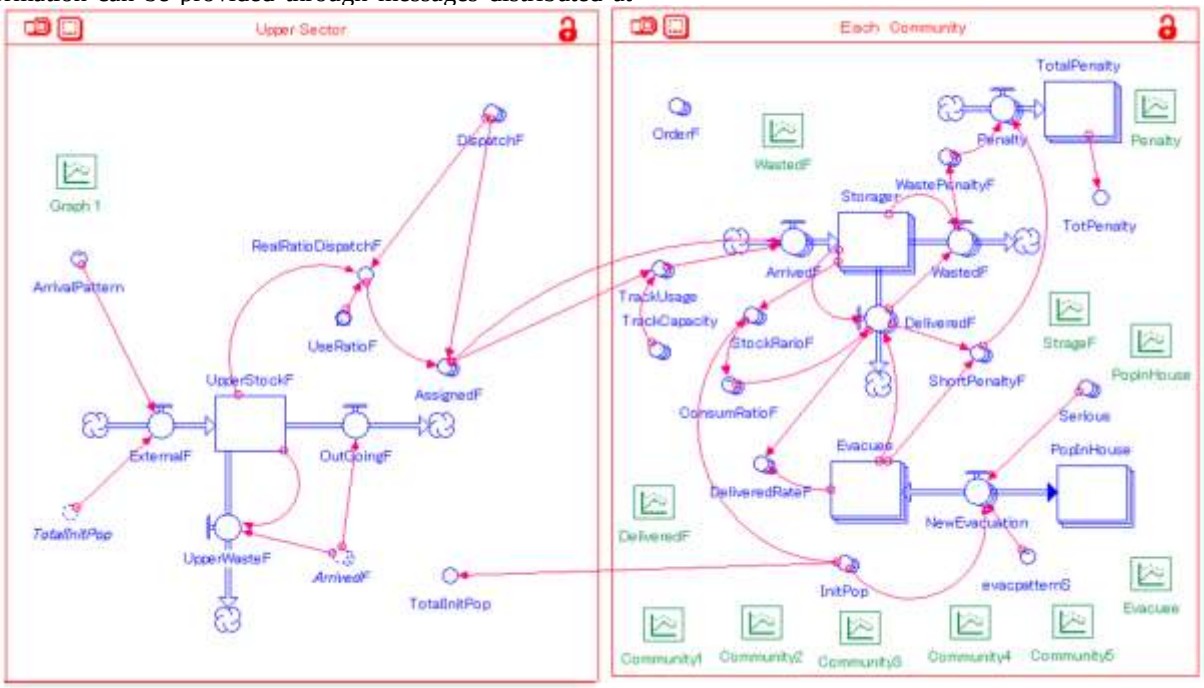

Figure 2. System dynamics model

Figure 3. Interface of MUGS

Figure 4. IRIDeS has installed video recorder

Fig. 3 shows the interface of MUGS and Fig. 4 represents the installed video recorder in IRIDeS. The analysis component consists of a relational database storing of STATE and trajectory progress of situation. This allows an interface to log and query these matrices and additional log message. Actors (depending on permission) can access STATE of previous cycle and have to make decision to tackle current problems. After making decision, the STATE will be changed according to SD model.

The metrics can be observed online within the MUGS client. When agents provide position metrics and the scenario configuration contains additional visualization information the simulation environment can also be tracked within the viewer (Fig. 5). GIS is added to represent the parameters and geographical status. In order to conduct a simulation experiment the coordinator starts the MUGS server and the MUGS client subsequently. The coordinator can select predefined scenarios available at the server. Afterwards the scenario may be started, paused, and stopped as well as visualized while running.

III. Implementation MUGS

A. *Human Involvement:*

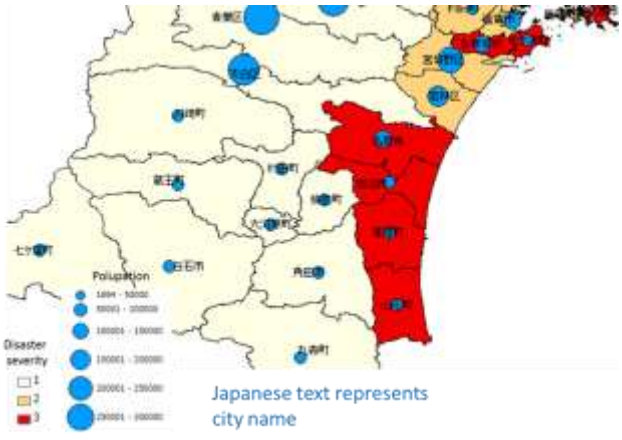

Figure 5. Data presented on GIS map in MUGS

Selection of participants: The characteristics of people who will take part in the simulation depend on the objectives of the exercise. In MUGS, players have to select one of the available roles (in the current SD model, roles include logistics manager, private donors, organizations' donor at unaffected area, organizations at affected areas and victims). As the player is the decision maker for the organization, the player must react strategically to in-game events, from negotiation to quick delivery and interact with other donors to avoid duplication of relief item.

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Selection of evaluators: Evaluators are responsible for assessing the actions and decisions of participants and for that reason are selected according to their knowledge, experience, and ability to critique the subject and characteristics of the exercise. It is planned to involve academics and professionals for acting as evaluators.

Observers: Observers are usually authorities, experts, or others invited to witness the execution of the exercise without playing an active role. They are not part of the evaluation team but may give their opinions and observations during the evaluation period if they so wish.

B. *Scenario Generation:*

Following properties are included in scenario generation in current SD model

- General description of the region
- Geographical characteristics: geographical location, political boundaries
- Victims properties: number, gender, age groups, and others
- Number of fatalities

- Disaster severity level

C. Access

MUGS can be accessed from anyplace within Tohoku University. However, if user wants to utilize video recorder and voice communication service, it is recommended to conduct the experiment within IRIDeS building. Before utilizing the MUGS software, it is required to contact with IRIDeS to receive username and password.

IV. Application and Core Target audience

Japan faces disasters every year and several organizations get involve in response and recovery of the disaster. The strategy of each organization depends on own aim, goal and target. There are high possibility to perform redundant activities. Such independent activities lead to wastage of valuable resources and some victims' life become endanger. Therefore there are urging need to promote cooperation among all players. However, there are not enough guidelines in planning cooperation. MUGS can be utilized for checking the scope of horizontal cooperation (and also vertical cooperation).

In inter-organization meeting, MUGS can be used as an engaging and fresh way to involve the participants in discussing the coordination and cooperation. The simulation will educate the policymakers by allowing them to experiment and explore the roles they will someday inhabit.

V. Conclusions

Considering the importance of disaster management, we have developed a SD model for logistical analysis. This SD model is currently installed within MUGS. Nevertheless the general system is easily adaptable for other domains. Currently MUGS is applied for comparison and evaluation of algorithms for autonomous logistics planning and special sub-process therein, e.g., coordination mechanisms of logistics objects, and information distribution. MUGS is expected to be used for horizontal cooperation in different decision makers including medical, traffic authority, police, fire and others.

References

[1] Pan American Health Organization, Guideline for developing emergency simulations and drills, Washington D.C.: PAHO, 2011.

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