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Issues and Challenges in Simulation and Modeling

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Abstract: Human mind can process one item at a time and has limitation about capability to relate decision to large amount of background information and can not handle multiple conditions and action situation. Modeling and simulation solve these problems efficiently. It extends understanding of how to build effective and efficient design, evaluation, and operation of new model. The active use of modeling and simulation in various areas are the cause of its popularity in design of engineering and industry. Significant progress has been observed in modeling and simulation over the last few decades, however, many challenging issues remain unresolved, and the current trends tend to use combination of nature-inspired algorithms and surrogate-based techniques for modeling.

This paper will analyses the issues and challenges in modeling and simulation in different application areas and discuss important topics for further research and the gaps between theory and applications in different application areas.

Keywords: Calibration, Complex system, Complexity, Computational model, Modeling and simulation, Verification and validation.

1. Introduction

A model is an abstraction of a system, being able to reproduce replica of it for some application in which essential data are referred as stat variables of the system. For any design of system modeling, the ultimate aim is to gain sufficient knowledge about the system of interest so as to provide more accurate predictions and better designs. Therefore, computer modeling and simulation popularity plays important role in the modern design practice in engineering and industry [1] .

Despite the significant role of modeling and simulation in the last few decades, many challenging issues still remain unsolved, related to various aspects and depend on many background factors. Such challenging issue are related to nonlinearity, size and scale of the problem, time span of delivery of product and the complexity of the system.[2].While developing the prediction model, these challenges are important in all design. This paper is focus on the major issues and challenges in Modeling and Simulation in different application areas and discusses its scope. This paper is structured as follows Second section discuses major issue of modeling and simulation in different application areas. Third section discuses major challenges of modeling and simulation in different application areas. Fourth section discuses major problem of modeling and simulation in different application areas. Fifth section discuses the Future scope of modeling and simulation in various application areas.

There is tremendous progress and activities in computational modeling and simulation and its concept apply in various application area. New trends explore its idea to shape the

research landscape in the above areas. Current trends with more active research can be summarized as the following

- Use of low fidelity model,
- Multi-modal concept adoption,
- Low cast modelling
- Genetic algorithms model
- Network model

2. ISSUES

Any Research has aim to know about internal working of system to provide better design structure of model and make accurate prediction about result. The modeling, simulation and soft computing take major share in design problem in computer application area. Two different type of issue in the modeling and simulation are

General issue or any application area oriented issue and Specific application area oriented issue [3].

General issue or any application area oriented issue

Resources utilization: As wide application of simulated model, problem required more resources but there is major issue of about maximum utilization of resources.

Way to minimize cost: Method is provided by which cost of resources is reduce as huge dynamic application area require more hardware cost, maintenance cost etc.

Less energy consumption: Energy consumption must be less as it is related with scarcity of energy.

Performance maximization: when model increases its working performances, productivity of product is also increase.

Efficiency maximization: To build model in such way that it's working efficiency is increases

These issues are found in any or all type of design of simulation and modeling.

Specific application area oriented issue: To provide better accuracy of result despite of time expenditure, design and modeling the problem help to minimize the uncertainty of prediction of result [4].

Non linearity problem: Traditional model solve only linear problem. Current model is based on multiple ways prediction and draws multiple conclusions. Traditional model cannot handle multimodal concept. Multimodal design has wide objectivity. Hence model design with multiple ways of conclusion concept is necessities of current design practice.

Size and scale of the problem: Real world problem needs lots of information to handle situation so its size and scale are larger and testing is done on such a large scale is quite difficult. With the help of complex analysis larger information is converted into meaningful information.

Time span of delivery of product: For building Model and run its simulation, time constraint is major issue. Running model with traditional model in parallel saves lots of time so to provide efficient product within time period [5].

Complexity of system: To model a complex system, it is necessary to break it down into smaller subsystems using top down or bottom up approach. Real world problem is solve with design of complex system as complex system are taken all direct or indirect parameter into consideration so as to provide efficient and accurate prediction about system. This complexity can be solved by studying inter dependability of system parameter. Algorithms must be very simple to understand and easy to implement, solve highly complex, high nonlinear optimization problems which requires little efforts for new users to learn. Therefore, researchers with versatile backgrounds can relatively easily use them in their own research [6].

Adoption of New Method: Traditional modeling based on mathematical modelings which are not solvable analytically, approximate methods and numerical methods are the alternative for such problem. But in some design problem approximate method is intractable. A complex system and perform numerically with feasible solution but this not popular approach. In fact, most research efforts in the last few decades explore way to find the most efficient methods in solving complex systems. As a result, numerical methods such as finite difference method, finite-element method and finite volume method have been developed [7].

Flexibility: In recent years, the surrogate-based models become very popular due to its flexibility to approximate complex systems. These methods are solve problems where the expensive computational evaluation and the optimization cost is a critical issue so as to provide global .The substantial research efforts in the development of surrogate modeling

methodologies that would allow to create models that are globally accurate and smooth, and computationally cheap model.

Reusability: Model components are developed for reuse so that design time complexity must be minimized followed by more rigorous testing thus, components should guarantee more robustness and reliability, necessary for longer lifetime.

Calibration, Verification and Validation:-Validation or inner validity' of the model is Checking that the model behaves as expected [8]. Validation relates to the extent that it adequately represents the system being modeled [9]. Calibration is testing of model against a small part of data applied with many assumptions as whole data are not available in agent based model. After development of model, verification is done by testing the logic of the model through its computer program.

Speed: Due to speed of computer increases, current approach move toward parallel computing, grid computing and soft computing for large scale computation [10].

Accuracy: Approximate model achieve more accuracy as high fidelity model are expensive and low fidelity model speed up and reduce computational cost. Model should build to make balance of appropriate accuracy.

Implanting model: This involves actual code used for implementation of model. Proper conversion of code should achieve without losing real product.

Software Development: Due to tremendous use of computational modeling, need of software increases [11].

3. CHALLENGES

A challenge of research problem is always related with various aspects and many dependent and non dependent factors. The mathematical and computational challenges range from technique for collecting and representing datasets, to algorithms for simulation of large scale multiplatform system, to be development and analysis of simplified description. The development of a empirical computational model requires both conceptual foundation and implementation .Challenges related to conceptual foundation can be regarded as computational complexity. A new approach in modeling in which more emphasis is on finding distinctive evolution patterns within collective systems rather than general laws as number of initial details that characterize complex systems as well as their capabilities to evolve and change continuously. Model involves some assumption and model reduces cost by simplifying assumption.

Different challenges in modeling and simulation are describe below.

i. **Time Constraint**: Model is approximation of true model as well as reality. To overcome challenges of time constraint, increase of computational efficiency.

ii. **Dynamic Nature**: These new challenges require the use of new methodologies and new tools. The computer simulation seems the most promising technique to study the complex and complex adaptive systems.

i. **Validity**: It is an exact correspondence between the conceptual model and its implementation. In fact, the limitations introduced by the computers architectures and their languages sometimes deeply affect the translation of a conceptual model into a computer program.

ii. **Graphical Representation**: Capability of representing models in a faithful way and this is possible with the use of standard languages, of code encapsulation, of effective documentation through graphical languages.

iii. **Efficient and maintain Accuracy**: The main challenge is to know how to construct the computationally efficient and yet not developing sufficiently accurate models in a practical way with the ease for implementation.

iv. **User acceptance**: It represents ease of use and credibility. For the increasing system lifetime can be applied to the user acceptance when it comes credibility

v. **Increasing System or Computational Complexity**: The development of a empirical computational model requires both concept wise foundation and elegant implementation. The conceptual foundation considered as computational complexity. Simulation Modeling determines performance measure by making direct measurement of a simplified virtual system that has been created through computational means. Hence minimization of computational complexity is big problem.

vi. **Costs/resources**.: Correct estimation of resources is needed accurate Information for reliable estimation of

modeling and simulation Verification and Validation costs and needed resources is inadequate. The management challenge is to collect and organize appropriate cost and resource information, and make it available to the modeling and simulation communities so that robust methods for model and simulation Verification and Validation cost/ resource estimation can be developed [12].

vii. **Inference**: Data availability to support assessment of simulation "predictions" is a fundamental problem, especially for the test and evaluation community on the operational side and the experimental community on the science side. Comparison of simulation results with the available data can be described statistically, and data-simulation result relationships can be specified in terms of accuracy, error, resolution.

viii. **Integration**: When dissimilar mathematical model are integrated into complex model and then integrated into overall model, this integration must be properly done.

Agent based model (ABM) can be useful tools for studying the effects on processes that operate at different scales of problem and organizational levels. For Development of agent based model, following are major challenge [13].

i. **Purpose of the model**: Earlier Model is built for urban policies rather than science phenomena but now model are built for many application areas. A model must solve problem as the purpose for which it was constructed using the right amount of detail for the model to serve its purpose and for predictive model, this needs to be clear.

ii. **The dependence of the model on theory**: Earlier Model is base on theory and role of model is to transform into form which can be tested and refined ABM is used to develop theory which is use to develop refine theory with help of what if analysis and rule method. Hence ABM is not restricted to particular field. Model must represent theory which solve prediction problem.

iii. **The representation of agents and their dynamics**: The scale of agents is number of possibility or condition or rule specified. Hence finer the scale, the less complex the definition, This means that there are greater difficulties in specifying rules for defining agents which are aggregations of lower level units Another issue involves the sheer number of agents and the sheer number of attributes represent number of parameter and its process in the model.

iv. **Validity**: Model must satisfy rule mentioned for every possible condition and must check validation and verification as software quality assurance [14].

The following list highlights major challenges for Modeling and Simulation, as identifies them:

• Increasing system complexity (e.g., networks of systems).

• Decreasing cycle times for system innovations.

• Increasing lifetimes of systems.

• Increasing variety of M&S-aspects and purposes, e.g., safety, reliability and so on.

• User acceptance: Ease of use and credibility.

• Integration of virtual and augmented reality

4. PROBLEMS

The computer simulation techniques is formal language to represent models and a laboratory for making empirical verifications. It is expressed in a formal language, even if it is much less synthetic than mathematical one. It represents a virtual environment which is used as laboratory to produce pseudo empirical result [15]. A simulation model is used to represent elements of the system and elements of environment. A model may ignore aspects of reality that are not considered crucial, while for its defined computer implementation is problem.

i. **Inappropriate level of detail**- Normally analytical modeling is carried out after some simplification adoption but in simulation and Modeling it is often use very high level of simulation detail since approach is computational .Such decision is not always recommended.

ii. **More Time requirement** - Much more time is needed to develop and run the computation.

iii. **Interdependent parameter influence**- Model introduced a large number of interdependent parameter whose

influence on system performance becomes difficult to determine and isolate.

iv. **Improper selection of the programming language**: The choice of the programming language to be used in implementing simulation model greatly affects deployment time of the model.

v. **Improperly selected initial condition**: To make a problem computable within reasonable amount of time, clearly some valuable and important assumption which is useful In some instance the assumption required to do this may invalidate the result of model.

vi. **Verification Tool:** Models are only as good as their creators. A model based on false theories bad assertion may present data which at first glance appear correct .However; Model must be examined with the same scrutiny given to any other scientific or engineering tool.

vii. **Error or Bugs**: Simulation model are very large program and also contain lots of programming error. If these Programs are not verified to be correct, they will lead to misleading result and conclusion. There is danger of bugs that leading to serious problem and expected result may be invalid due to logical error [16].

viii. **System Abstraction**: This lead to analysing a model that does not represent the real system under evaluation. It only shows part of system working.

ix. **Equilibrium with Reality**: Problem in obtaining performance measures for the model and mapping back to real system as model are mirror image of description of reality and give result not fully but that are closer to those achieved by real system analysis.

x. **Reliability and Accuracy**: Maintain reliability and accuracy of the model , testing on different environment and verify the prediction of the computer against actual or reality environment is big problem as model are adequate description of reality and give result that are closer to those achieved by real system analysis[9].

SCOPE

In depth study of issues, challenges and problem for diverse application area for computational simulation and modelling are versatile, diverse and wide-ranging. Because all models are by definition incomplete, the central intellectual issue is whether the essential aspects of the system or phenomenon are well represented. However, there are many important issues that still motivate researchers to search for better algorithms and efficient low fidelity model design, where the performance of an algorithm may closely depend on the parameter settings of its algorithm-dependent parameters.

5. CONCLUSION

After studying various aspects of simulation and modeling, the correct model is the representation of some reality that contains some essential and interesting aspects of the reality but not a whole. To train user or end user using a simulator is more convenient, safer and cheaper than real system therefore science industry, commerce and military often use model rather than real experiment. It is important to remember that current modeling and simulation has far greater capacities than in the past as it explore of idea.

The criteria for modeling and simulation in computer application area are

Controlling the performance of a algorithm and its convergence rate, to make an algorithm truly intelligent so that it can effective for multi-modal, the methodology for small-scale problems scale up and works equally well for large-scale problems and follows reusability concept, to find best way to construct a good surrogate model for a given problem and to adopt best choice of algorithms and use surrogate models for a given problem.

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