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Simulation: A Gateway From Unknown To Known

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Abstract
This is an era of globalization and the world is considered as a global village, due to availability of advanced communication networks. Sharing knowledge and information becomes easier and important to make some smart decisions relating to everyday life. In doing so discovery of new knowledge and improvement in the existing one is need of the day. For the said purpose research work gains so much importance and becomes vital for the growth of knowledge and self esteem. It enables us to discover more and more facts so that one may spend an easier and comfortable life and may withstand the challenges of the century. But there are certain phenomenon especially in the fields of medicines and engineering which cannot be try out to set up experiments on it, due to nature of complexity or high risk involve in it. So different types of computer simulations and physical simulators, which replicate the real state of life, may be used to scrutinize the phenomena under alternate conditions. Some of the applications of simulation technique in various fields of life and types of simulations are discussed in this paper. Simulation is the reproduction of the real state of nature through simulators or representation of that state through mathematical models and examine the complex phenomena under alternative situations. There are lots of advantages of simulation technique such as it can provide accurate results in most of the situations and can minimize the risk of experimentation. But despite of all these advantages the use of these procedures proved to be very costly over the real state experimentation.

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Introduction

There are certain phenomenons in the real world life where mathematical modeling techniques and layout of the Physical experiments are not valid due to complexity or stochastic nature of the problem, and conflicting ideas under the study of researcher. In such a situation methodology of simulation technique plays a vital role in searching for a feasible solution of the problem. It helps in the proper management of the laboratory experiments and revealing the effects of alternate conditions on the phenomena without changing the system. Simulation in straight forward terminology can be described as "an artificial or fantasy edition of some real process, stat, or event".

Simulation is the replication or reproduction of some real world phenomena despite of the fact that the system does not take place in actuality. For example in an entertainment video game and animated movies, where the players and group of actors are given complete command over some self-directed creatures or people. In realism these mortals does not exist but they are the illusions and these creatures just reproduce the real life system or event. Simulation is, therefore, fundamentally a practice that requires setting up a replica of an actual state of affairs and then performing experimentation on the duplication.

Definitions of simulation by various researchers

Simulation is the process of building a mathematical or logical model of a system or a decision problem, and experimenting with the model to obtain insight into the system's behavior or to assist in solving the decision problem (Evans et al,. 2002).

Simulation is the imitation of the operation of a real-world process or system over time. Whether done by hand or on a computer, simulation involves the generation of an artificial history of a system, and the observation of that artificial history to draw inferences concerning the operating characteristics of the real system (Banks et al,. 2001).

Simulation is a broad collection of methods and applications to mimic the behavior of real systems, usually on a computer with appropriate software (Kelton, 2002).

Simulation should be applied in situations

Simulation can be applied in the subsequent motives:

1. Simulation facilitates the study of a complex and hazardous system which cannot be set in reality.
2. The effects of alternate situations and environmental changed on a model can be observed through simulation techniques.
3. Proper investigation of the phenomena under study can provide acquaintance for improving the system.
4. Implementation of the policies can be tested and its impacts can be observed prior to its accomplishment.
5. Analytical solutions obtained as a result of mathematical model can be tested

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and verified.

6. New trainee can be trained with the minimum cost through visual animation by simulating the real phenomena and without disturbing the ongoing professionals.

Simulation would not be applied in following cases.

1. The complications can be resolved through intelligence or mathematical techniques.
2. If direct experimentation is feasible.
3. If simulation is more costly than actual experimentation or implementation.
4. If enough information about the real state phenomena is not available.
5. If the system cannot be defined

Advantages of simulation

1. Innovative policies, organizational and operating actions, and decisions can be tested before implementing it.
2. New layouts, designs and systems can be explored without acquiring resources for it.
3. Statistical hypothesis testing for certain phenomena can be carried out.

Disadvantages of simulation

1. Simulation requires expertise and specialized training in Model building.
2. Sometimes interpretation of the results of simulation is very hard to explain.
3. Simulation modeling is not possible in case of analytical solution exist for the system.

Types of simulation

Broadly there are three types of simulation

- Static simulation
- Dynamic simulation
- Gamming simulation

Static simulation

Static is a type of simulation that is driven by a deterministic model almost resembling a real state of affairs. The sampling observations generated through computer programming, are transformed to the required output by using some defined rules and formulae. The base case values are used as a domain for these deterministic models and mathematical manipulation transformed them into the desired format of output variables. The most widely technique used in static simulation is Monte Carlo simulation, which is based on repeated sampling approach and statistical modeling technique is utilized for its critical analysis (Raychaudhuri et al,. 2008)

Dynamic simulation

Dynamic process refers to the actions of a route changing over time and dynamic

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simulations monitor the activities of system over point in time. This type of simulation technique is widely used in management sciences and business administration. Modeling of inventory, queuing, production and transportation are some common examples of dynamic simulation.

Dynamic simulation can further be divided into two categories continuous simulation and discrete event simulation. The phenomena that is continuously changing over time such as distance between two cars at a national highway refers to dynamic simulation, while if the events occurred at some particular point of time for example arrival of patients at a particular hospital is called discrete event simulation .

Gaming simulation

Gaming simulation copies the real life activities in the form of dummy replicates for the purpose of training and prediction by visualizing it. These games are played and developed for the purpose of effective planning and learning the strategy making in alternate conditions. Some of the examples are the war games used to train the military, flight simulators to train the pilots, and management games to teach managers about effective administration(Zeynep et al,. 2009).

Applications of simulation in various fields of life

Simulation plays a very effective role in our daily life; this can be used in various fields for the purpose of training, construction, learning, medicines, surgery etc to reduce the cost of actual experimentation and risk as well. Some of the most common uses of simulation are given by

- **Applications in Training**

It is documented that the armed forces of any country should be equipped with the expertise training that keep them proficient enough to carry out their duties effectually justifiable to their nation. Yet trainings come up to utilize a momentous amount of the defense budget in a monetary year, and prove to be very costly. Secondly the use of heavy weapons and burnings of the oil and dynamites directly impact the environment of training area.But Advancement in the field of modeling and simulation enables the military training operations to be carried out in a safer and cheaper way (Jason,. 2012).This provides an environment, near to reality, to the soldiers and they interact with different simulator models or abstract atmosphere to react. Working with a non figurative environment and dummy objects minimize the risk of using heavy artillery and its adverse effect (Stephen., 2005). Most of the Armies have implemented a training concept where technology is evolved in the operational schemes. For example the pilots are trained with the dummy simulator, where the trainee feels himself as a part of the environment created by computer simulation (Wulfeck., 2008). Similarly various models can be tested for earth quack resistance to survive the natural disaster. Likewise automobile simulators are used to train the drivers, which duplicate the characteristics of vehicles in near practical environment. This enables the drivers to experience the external factors with which they can interact in reality and can strengthen their driving abilities (Douglas., 2007).

- **Applications in education**

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Simulation can be very effectively utilized in primary and secondary level of education for the purpose of better understanding, providing more opportunities for the students to learn in a more effective and relax environment. As simulation enables us to design and model the real world phenomena in such a way that portrays a pragmatic picture of reality on the basis of abstract argument i.e. reality can be reproduced in form of animation to the students so that they can experience it by visualization. Stančić et al (2007) shown that computer technology can be introduced in educational institutes for the better learning. Because only with the help of advanced computer programming such real life events and phenomenon can be reproduced, which may be proved very dangerous or risky by executing it without sufficient knowledge. This technique of modeling the realism through technology can be applied to almost every level of students starting right from the schooling age to the university level for enduring quality education. Stancic in his article suggest that the use of simulation techniques should be included in the information sciences courses through out their educational career so that students may be well aware of the uses of simulation, while the model building techniques by using simulation should be included only at higher level. Such curriculum will not only help the students in their future but also necessary for the advancement of the field of information sciences. Similarly video games can be proved very vital in developing the cognitive ability in the children at school going age.

Initially a number of entertainment games were developed with the growth of compute technology. Some of the most famous Games written for the purpose of entertainment were “Pong” and “Halo 3”, but latter on the educational games like “Reader Rabbit” and “Oregon Trail” gains more publicity in the scholastic community. These games were designed to entertain the children in an informative way and raise their interest in education. But latter on keeping its success in view these games were developed at a large scale to train the people for much harder tasks (Kincaid et al,. 2009). A critical review of the research studies have suggest that these computer based games can be proved very helpful in growing the cognitive ability amongst the students which is a necessary tool for developing the strategies and problem solving aptitude in the future (Gonzales,. 1995).These computer based games for learning is the best example of simulation and learning by experience where the player consider himself a member of an abstract situation and tries to overcome these alternate conditions searching the feasible optimal solutions. The players involve themselves in the process and learn about the real life environments (Brown,. 1999). Similarly those students can discover many new things and can learn many new concepts by means of these simulation games. As simulation games are based on experience and prepare individual to interact with the similar conditions in the real life.

- **Applications in Business and Management**

The practice of Monte Carlo simulation inspired the business researchers and managers to estimate the budget and time required for completion of the complex and risky projects. According to Steiner (1969) project is a group of professionals working in a collective environment to achieve a mutual goal in a specified period of time, and with a quantified level of resources. Usually project management comprises of highly risk involve in it.

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Managers are mostly interested in determining the probability of completing an activity in the project on time and get optimal results. For the said purpose two methods are widely used, one is the operational research where the project is scheduled by using networking and the other method is the imitation of real process that is simulation techniques (Williams,. 2003).

Operation research broadly deals with construction of mathematical models, so that to examine the general pattern of the project and the manager tries to accomplish their goals in terms of performance i.e. to complete the plan on time with existing recourses(Turner,. 1995). But many times the analytical procedures of mathematical modeling fail to converge as it involves tough equations and constraints on the resources such that the maximization and minimization of the objective function becomes impossible. In such circumstances optimal solution does not exist until and unless the Heuristic methods such as simulated annealing are applied (Bouleimen et al,. 1998). As Williams (1999) showed in his paper that the restriction and assumptions about the resources made Operation Research very unrealistic to use in daily life applications. Therefore in the real world life Monte Carlo simulations are used to completely investigate the model, and more prominently look the affect of alternate environments and restriction on resources(Ragsdale,. 1989).

Simulation is very effective in business for predicting the future like launching of a new product, raised the efficiency of automated machinery, capturing most of the shares in the market and increase satisfaction level of customers. Joines (2000) uses the fusion of simulation and static modeling to re-design the maneuver of British Telecommunication and show the success of these advanced techniques in business.

- **Applications in medical sciences**

Complicated and sophisticated exercise and practical familiarity with various diseases, medicines and surgeries are very necessary for medical students. Currently medical simulators are used at a great level to teach the students about diagnostics of disease and procedures, which enables them to take autonomous decisions in case of any emergency. The use of these simulators begins from the essential health check-up facilities to complicated surgeries. These synthetic simulators are linked to the computers which generate complex life saving imitation mechanism by injecting drugs to them.

In medical sciences clinical researchers work on live human beings to conduct some significant research and train the new students to polish their skills and ability. But it is their responsibility to provide full safety to the patients and minimize unnecessary risk involve in experimentation. Sometimes these experimentations and clinical trials create lots of stress amongst clinical researchers to reduce the risk hazard and guarantee the patients health safety. This anxiety can be reduced by using these artificial simulators instead of live human being to increase the safety and test life saving drugs properly (Ziv,. 2003). These simulators are the abstract replica of real human body attached to a computer system which generates the simulation results when drugs are injected to them during practicing surgery.

Simulators are mainly used by the department of Pediatrics during the teaching practices to medical students. They use these simulators to train the students in a safe environment

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and enable them to take decision in real emergency situation. But these simulates have some limitations by using them in medical sciences like they are very expensive and dummy (Ngiam,. 2011).

- **Applications in construction process**

Construction of high rise apartments is very essential at the present time especially in populated and commercial cities. Most of the kingdoms launch such housing schemes in which they construct the sky creeping residential apartments. But a structure of such apartments is a challenging task because the conditions of the site and resources used in manufacturing are time dependent. Many algorithms were presented by various researchers to solve the complex problems of construction but the most successful technique for approximation the activity completion time is the art of simulation. This technique is based on the looping and network is recycled until an optimal solution is obtained. The duration of building a particular floor depends upon the available resources so the site engineers first simulate the activity duration and cost, then the construction work can be carried out with prices results (Leung et al,. 2003). Another advantage of the simulation technique in construction phase is the installment of pre cast building on the site of construction. In conventional techniques residential and commercial apartment were built on the site by supplying the concrete material such as bricks, cements, etc. but nowadays the simulated buildings are built in factories and these pre cast structure are installed at the site. This technique solve many problems of builders as most of the resources used in construction are dynamics and time dependent but simulation techniques handle this problem very effectively (Vern,. 1998).

Similarly many builders used computer based software for simulating the activity duration and resources for optimization and to solve the hurdles facing in the construction of high rise building actually before starting the construction process. One of such software which the United States engineers are using quite widely is CAD modeling and simulation system, although it has some drawbacks but still it is used at a large scale (Vanegas et al,. 1993, Vanegaset. al,. 1994). Many researchers suggest that the choice of selection of material and the site location plays an important role in the construction process so these should be included in the simulation modeling, but such software does not take into account these information it just gives the geometry of the building to be constructed (Opdenbosch,. 1994).So it is necessary to expand the present simulation techniques for construction because a three dimensional environment can not be fully represented by a two dimensional model (Cleveland et al,. 1988).

- **Applications in Numerical Sciences**

The art of simulation can be used in numerical sciences like mathematics, statistics, and physics to develop a model for any real state of nature and then computer generated data can be used to test its validity. Ashok Kusagur et al (2012) presented a model for controlling the speed of induction motor and then using the simulated data through computer programming to check the validity of the model designed. The simulation results showed significant changes in respect to its effectiveness, efficiency and reliability. Generally model verification and validation refers to the internal consistency which concerned with association between the mathematical model and the reality replicated by

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it. This verification and validation of the model can be tested by comparing the simulated data with that of the reality (Arsham,. 1992: Arsham,. 1996).

Simulation frequently involve in such phenomena which is too complex and cannot be setup in reality. These observable facts can be determined in laboratories by simulation techniques to visualize and predict the occurrence of an event even before its realization. For example economic modeling technique can be applied for prediction of random walk in the market, effects of environmental changes on life can be tested in green houses, training of pilots can be reproduced and test in alternative conditions (Daniel,. 2001) .

Data collected through the sample survey contains a substantial amount of missing observation all the time. These missing observation needs to be estimated and replaced in the data set for accurate representation of the fact through the model and precise prediction of the future. Little et al(2002) suggested the technique of simulation study for the approximation purpose of the missing observation in the mechanism. For this intention various techniques of simulation can be adopted like Missing Completely at Random (MCAR), Missing at Random (MAR) and Missing Not at Random (MNAR) can be adopted to simulate the misplaced observation.

Discussion

Simulation and modeling technique is the process of gathering information about a real state of event, that how it will behave in various alternate conditions without actually performing the task. For example a clinical researcher wishes to treat the cancer tumor through chemotherapy drugs, but he doesn't know the after affects of the treatment. For testing this he might use different types of drugs on medical simulators and analyze the effects of interventions on it. From this abstract situation he can chose the best treatment, which can further be applied to the patient. This technique of replicating the juncture through simulators and models is gaining much interest of the researchers and is widely used in almost every field of life. It is just because that the simulation is safer and cheaper way for conducting risky and complex experimentation. Secondly simulation can provide much faster results, because it can test the phenomena under various alternate conditions without setting the experiment physically.

Simulation is the representation or reproduction of the action of real stat phenomena through models and replica's. The operations of simulation require the development of a model that fully symbolizes all the traits posses by the juncture. Then than physical or abstract sketch of the action plane is observed under alternate conditions to see its effects on the system and choose the best way that may optimize the results. This technique is used in almost every context of life ranging from the technology to the education covering the grounds of safety engineering, complex experimentation, testing of phenomena, training and health sciences.

Recreation of an event is widely used for educational purpose in order to endow quality education through experiencing the real environment. A massive number of educational games and models were developed and deployed in various educational institutes which increase the interest and cognitive abilities of the students. Similarly computer based simulation and gaming are used for training of military and other civilians in order to

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avoid the hazard of using real equipments. Pilots are provided training with the help of simulators to ensure safe flights in alternate weather conditions. Military use it for war tactics, while clinical researchers used it to increase patient's safety. Human body simulators are deployed in various clinics to teach the new researchers about the surgery and diagnostics procedures. Testing the effectiveness of different interventions, early diagnostics and therapies are some of the areas where simulation can play its part. Correspondingly computational simulation becomes an important factor for analysis and decision making in engineering and manufacturing process i.e. the surgical design of a bypass graft can be asses through aerodynamic efficiency of a wind turbine blades. Similarly various models can be tested for earth quack resistance to survive the natural disaster. Likewise automobile simulators are used to train the drivers, which duplicate the characteristics of vehicles in near practical environment. This enables the drivers to experience the external factors with which they can interact in reality and can strengthen their driving abilities. Nowadays gaming simulation and movies were developed for entertainment purpose where the player or the artist has complete control over imaginary creatures and environment. In short simulation plays an important role in the life of individual starting from entertainment to complex decision making and research, and upgrades the standard of living in this era of technology.

Conclusion

This is an era of globalization and the world is considered as a global village, due to availability of advanced communication networks. Sharing knowledge and information becomes easier and important to make some smart decisions relating to everyday life. In doing so discovery of the new knowledge and improvement in the existing one in the need of the day. For the said purpose research work gains so much importance and becomes vital for the growth of knowledge and self esteem. It enables us to discover more and more facts so that one may spend an easier and comfortable life and may withstand the challenges of the century. But there are certain phenomenon especially in the fields of medicines and engineering which cannot be try out to set up experiments on it, due to nature of complexity or high risk involve in it. So different types of computer simulations and simulators, which replicate the real state of life, may be used to scrutinize the phenomena under alternate conditions. This technique is used in almost every field of life ranging from the entertainment to technology, decision making, and complex experimentation, safety engineering, health care, training, testing and manufacturing. The Army used it for battle field tactics, drivers and pilots used it for safe journey, clinical researcher used it for safety of the patients while engineers used it for construction and manufacturing safe buildings and equipments. The educationists utilize this technique for effective learning and common man used it for entertainment purpose in the form of video gaming and movies. In short in this era of technology simulation and modeling technique is an essential feature in everyday life and this should be included in the course contents at the university level to give the basic idea of modeling to the students of every field.

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