Computer Aided Simulation Modelling in Design and Analysis of Farm Machinery

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S.No	Expert System	Uses
9.	Expert System for Rice	The Expert System for Rice Crop enhances the efficiency of farmers for Rice crop management and to increase the crop yield. It determines the best strategy for irrigation, applying fertilizer and insecticides.

Conclusion

In the field of agriculture expert system are used to make correct decision for farmers. Knowledge from various fields such as pathology, Nematology, weed, entomology and nutrition disorder is used in crop and integrated pest management. In modern world, rapid growth of information has increased, so the expert systems in agriculture are used by farmers during their farming activities.

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75. Simulation Modelling Techniques for Design and Analysis of Agricultural Machinery Systems

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Introduction

The modern agricultural machinery is characterized by a growing degree of automation. Recent advances in computational and system engineering have created a favorable scope for the farm machinery researchers to apply the soft skills in the field of design of farm machineries in general and precision equipment in particular. In order to achieve the goal of developing farmer friendly equipment intended for reduction of cost and time, it is imperative to grow along the technological advents and minimize the cost and time incurred in the design and testing of farm machineries. Agricultural machines operate in varied conditions due to soil diversity, soil deformation as well as changing loads exerted by the working implement. Most of the times, the following standard design procedures may not yield the desired output during the design process. Hence, simulation studies help to predict the physical and behavioral variability in real world system and thereby assist in developing a suitable prototype which can perform in varied conditions for sustainable agricultural production.

Simulation modelling is the process of creating and analysing a model of a prototype to predict its performance in the real world. Simulation modelling is used to help designers and engineers understand whether, under what conditions and in which ways a part could fail and what loads it can withstand. Simulation modelling can also help to predict fluid flow and heat transfer patterns. It analyses the approximate working conditions by applying the simulation software.

Classification of Simulation Modelling Techniques

Simulation modelling techniques can be broadly classified as event based simulation modelling and system based simulation modelling. Since the design of agricultural machines vastly depend upon the system studies, system based classification are explained in this article. Simulation modelling techniques are classified as shown below.

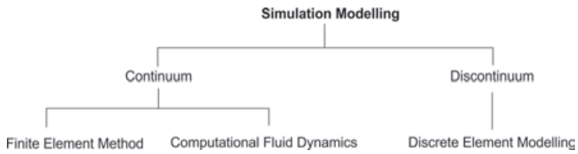

Fig. 1 Classification of simulation modelling techniques

Continuum techniques of simulation modelling are used when the system or model under the study is homogeneous in nature whereas discontinuum technique is used for heterogeneous or variable natured models.

Discrete Element Modelling (DEM)

DEM is essentially a numerical technique to model the motion of an assembly of particles interacting with each other. It is used when the system under study is heterogeneous. DEM can simulate macro-scale and micro-scale deformations of discontinuous media, such as soil particles, and is being widely used in research on tillage processes. After calculating all the forces acting upon a particle, its position and orientation is calculated by integrating Newton's second law of motion. The majority of agricultural grains are of a convex shape but some seeds or fruits have almost spherical shapes. None of them are purely elastic bodies. Therefore, the application of contact models for agricultural materials is very important step in DEM. Few of the important contact models that are widely used in agricultural DEM study are elastic contact model, elastic-plastic contact model, visco-elastic contact model, adhesion contact model and tangent stiffness model (Hertz-Mindlin model).

Some of the popular softwares which are being used for DEM studies of agricultural systems are EDEM (DEM Solutions Ltd.), UDEC & 3DEC, PFC2D & PFC3D, GROMOS 96, ELFEN, PASSAGE/DEM, Bulk Flow Analyst and Rocky DEM.

Finite Element Method (FEM)

The finite element method (FEM), or finite element analysis (FEA), is a computational technique used to obtain approximate solutions of boundary value problems in engineering. In the FEM, the structural system is modelled by a set of appropriate finite elements interconnected at discrete points called nodes. To solve the problem, it subdivides a large problem into smaller, simpler parts that are called finite elements. Typical problem areas of interest include structural analysis, heat transfer, fluid flow, mass transport, and electromagnetic potential.

Numbers of FEA softwares have been in use for the structural analysis of machine components. Some of the widely used packages are Abaqus, Analysis3D, CalculiX, Autodesk Simulation, ANSYS, CosmosMotion and HyperMesh.

Computational Fluid Dynamics (CFD)

Computational Fluid Dynamics (CFD) is a branch of fluid mechanics that uses numerical analysis and data structures to solve and analyse problems that involve fluid flows. CFD is used to perform the calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary condition. CFD provides a qualitative and quantitative prediction of fluid flows by means of mathematical, numerical methods and software tool. CFD gives an insight into flow patterns that are difficult, expensive or impossible to study using experimental techniques. The reliability of CFD simulations is greater for laminar/slow flows than for turbulent/fast ones, for single-phase flows than for multi-phase flows and for chemically inert systems than for reactive flows.

ANSYS CFX, FLUENT, STAR-CD, FEMLAB and FEATFLOW are the few CFD software packages widely used for flow simulations in engineering designs.

Advantages of Simulation Modelling

- Easy to understand: With the facilitated interactive display unit and step by step guidance and help tabs, it is easy to understand the simulation throughout the progress of activity
- Easy to test: Once the analyser is ready with required inputs the analysis process doesn't pose much of the difficulty in testing the model in relation to the prototype
- Easy to upgrade: Any conventional simulation model can be upgraded without any hassles
- Easy to identify constraints: The software system offers the predicted constraints with respect to the problem at hand which is helpful for the designed to identify the limitations and apply required boundary conditions
- Easy to diagnose problems: Any hindrances in during the progress of simulation process can be diagnosed by following simple steps

Disadvantages of Simulation Modelling

- Requires domain knowledge, training and experience: The designed/analyser should be well versed with the system under study to carry out the simulation process. It is also advisable to get acquainted to the working environment and get proper training and experience prior to interacting with big projects
- Difficult to predict the result: Results of simulation modelling are vulnerable and cannot be predicted unless the whole process is completed
- Time-consuming process: Few modelling techniques which require point to point accuracy between the model and the prototype take very long time to complete the simulation process
- Simulation results are difficult to translate: Few simulation results are not in readable form and cannot be translated in easy viewing and understandable forms.
- Simulation process is expensive: Simulation modelling softwares are expensive and they require costlier computers with high end configurations for better results

Conclusions

In the design and analysis of any farm machinery system, the iterative experiments are inevitable. Experiments with real world system may not be cost and time feasible in some cases. Simulation modelling answers the question of creating a visual environment in small scale to reflect the real world system. Since agricultural systems include both homogenous and heterogeneous systems, it is imperative to study the model in proper perspective. Accurate modelling of the soil implement interaction will allow optimisation of implements without performing expensive and time consuming field tests. Although empirical models provide practical information; multiple measurements for all situations are difficult and extrapolation of the results to all field conditions is most uncertain. Hence, simulation modelling has a vital scope in design process of various agricultural machinery systems and it can play a key role in reducing cost, time and man power required for physical experiments.

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76. Measurement in Social Science Research

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In social science research, the researchers have to deal with various social and psychological variables. Measurement of them is quite important and vital in research process. It is complex as well as demanding task.

Meaning of Measurement

In simple words, measurement can be explained as the assignment of numerals to objects or events according to rules. Numerals that are given quantitative meaning become numbers; these enable the use of mathematical and statistical techniques for purpose of description, explanation and prediction.

Need for Measurement

Generally, when the researcher develops an explanation for social phenomenon or problem, he constructs a theory. The theory is tested through the verification of a hypothesis derived from it. A hypothesis can be verified statistically, only when the variables in it are measured. Thus, the need for measurement arises.

Functions of Measurement

Major functions of measurement are as below;

1. Measurement facilitates empirical description of social and psychological phenomena.
2. Measurement renders data amenable to statistical manipulation and treatment. This will help in application of various statistical techniques for comparing groups, studying relationships between variables, etc.
3. Measurement facilitates testing of theories and hypothesis.
4. Measurement enables researchers to differentiate between objects or people in terms of specific properties they possess.

Postulates of Measurement

There are mainly three postulates basic to measurements which are;

1. **Order:** numbers are ordered. One number is greater than, less than, or equal to another.
   $A > B$ or $A < B$ or $A = B$
   If $A = B$ and $B = C$, then $A = C$
   If $A = P$ and $B = Q$, then $A + B = P + Q$.
2. **Distance:** Differences between numbers are ordered. The difference between any pairs of numbers is greater than, less than or equal to the difference between any other pair of numbers.
3. **Origin:** the number series has a unique origin indicated by the number zero.

Levels of Measurement

There are mainly four types of level of measurement as below;

1. Nominal measurement

Here, its name itself indicates that nominal means name. It is simplest and lowest level of measurement among all four levels. It involves the categorization of variable into several nominal sub-classes by assigning