CHAPTER II

LITERATURE REVIEW

2.1 Previous Research

At this time, VM is the common issues that experiencing development. There are many research of VM. Some of them are Park (2005) describe about A methodology for creating a virtual model for a flexible manufacturing system. This paper presents an object-oriented methodology for the modeling and simulation of a virtual FMS. For the implementation of the proposed virtual FMS model, the paper employs DEVSIM++ which is an object-oriented simulation language based on Zeigler's DEVS formalism. The OOM paradigm of Rumbaugh uses three kinds of models to describe a system: the object model, describing the objects in the system and their relationships; the dynamic model, describing the interactions among objects in the system; and the functional model, describing the data transformations of the system. The proposed virtual FMS model follows the OOM paradigm and uses four types of components: the virtual device model corresponding to the object model, the transfer handler model corresponding to the functional model, and the state manager and flow controller model corresponding to the dynamic model. A virtual device is designed considering reusability, and the device consists of two parts: shell and core the shell part allows a virtual device model to adapt to different FMS configurations, and it encloses the core part which contains the inherent properties of a device, such as kinematics, geometric shape, and the execution of device-level commands. For the fidelity of the virtual FMS model, a transfer handler model has a set of device-level commands imitating the physical mechanism of a transfer. As a result, we can check the mechanical validity of each transfer and also expect more accurate simulation results, because the total time of each transfer will be computed from its physical mechanism. The flow controller model makes decisions on fir able transfers based on decision variables, which are maintained by the state manager model. To maintain the decision variables, the state manager stores mapping relations between decision variables and the states of virtual devices in the system. The mapping relations can serves as the guidelines for the planning of a real FMS implementation.

Saadetin et al., (2010) describes about a genetic algorithm (GA) based heuristic approach for job scheduling in virtual manufacturing cells (VMCs). In this paper, their investigated the scheduling of virtual manufacturing cells (VMCs), where a virtual cell (VC) is a group of machines temporarily assigned to processing a job, and the machines are not necessarily in physical proximity. Machines that have the similar processing abilities are located different areas in the shop floor to enhance the system's agility. Separation of machines in shop floor results in increased total traveling distance. So, first develop a multi-objective mixed integer programming formulation to characterize the scheduling problem. The objectives, makes pan and total traveling distance, are converted a single objective by allocating them weights. The complex nature of the problem enforces us to develop a heuristic approach to find good solutions. For this aim, researcher develops a genetic algorithm approach. (Ga et al.'s) two-vector representation scheme is used and an effective decoding method interprets each chromosome into an active schedule. A reorder procedure is used to unify the operation sequence in the chromosome with the sequence in the decoded schedule to facility genetic operators to pass on the good traits to their offspring. In order to improve the heritability of crossover operation, operation sequence of (Gen et al.'s) representation is changed to the format of permutation representation. To measure the effectiveness of GA, we generate 45 test problems and compare the MIP solutions with GA solutions. For the 20 problems, MIP model find the optimal solution and GA find the same solutions. Sixteen problems out of the rest 25 problems, GA outperforms MIP model in terms of solution quality. GA is also promising and efficient in terms of solution time. So, GA can easily be substituted in the place of MIP model.

Slomp et al., (2005) describe about the main objective of the paper is to illustrate a new operational procedure of creating virtual manufacturing cells periodically, for instance every week, to meet the demand turbulence in markets. We define a virtual manufacturing cell as a temporary grouping of machines, jobs and workers. The grouping is meant to focus machines and the minds of workers to families of jobs. This supports the minimization of setup time losses. It also promotes the novel idea of team production. This paper shows the applicability of mathematical programming models to create virtual manufacturing cells. We assume in our approach that small cells, in terms of the number of required FTEs, simplify the realization of sequentially performing jobs of the same family on the same machine. We first present a general formulation for the design of virtual cells. In order to solve the problem for a realistic problem size, the general integer programming formulation is decomposed in two stages, which can be solved sequentially. The models in the two stages can be applied to maximize the setup savings, to minimize the number of inter-cell movements, and to keep the machine coverage and multi-functionality on a sufficient level. The goal programming models in both stages facilitate rapid reformulation in case of changes in parameter values such as families, cells, etc. Most changes can easily be incorporated in the models by simple modifications in the LINGO formulation. An illustrative example is given to indicate the usefulness of the models in the two stages.

Xue Yan and P Gu., (1996) describe about the important of product features, quality, cost and time to market for a manufacturer to remain competitive. Rapid prototyping systems offer the opportunities to make products faster and usually at lower costs than using conventional methods. Since RP&M can substantially reduce the product development cycle time, more and more businesses are taking advantage of the speed at which product design generated by computers can be converted into accurate models that can be held, viewed, studied, tested, and compared. Several new and promising rapid prototyping manufacturing techniques were discussed. They are all based on material deposition layer by layer. Each of them has particular features in terms of accuracy, material variety and the cost of the machine. Some present problems and research issues were also discussed. This is a rapid development area. Capacities and the potential of rapid prototyping technologies have attracted a wide range of industries to invest in these technologies. It is expected that greater effort is needed for research and development of those technologies so that they will be widely used in product oriented manufacturing industries.

Fok et al., (2009) describe about an intelligent virtual environment to support cognitive rehabilitation. The cognitive rehabilitation process is not only time consuming and labor intensive, but also can consume enormous training and financial resources. With the advancement of computer technology, intelligent virtual environments could become useful tools for future cognitive assessment and rehabilitation. This paper proposes a framework for an intelligent virtual cognitive rehabilitation environment and presents the development of a prototype system to guide patients to relearn meal preparation skills. Based on existing conventional rehabilitation activities, a virtual kitchen suitable for use with various with electronic exercises was developed. This virtual kitchen allows the patient to learn and practice proper meal preparation skills with guidance from an intelligent assistant. The intelligent assistant uses fuzzy logic to output appropriate visual and audio cues based on the input patient’s behaviors. The results of a preliminary clinical investigation of the intelligent virtual environment for a simple cooking task are promising. To fully realize the potential of the intelligent virtual environment for cognitive rehabilitation, the prototype system has to be further improved. With advancement in artificial intelligence and data-mining, the concept of an intelligent virtual therapist residing in the virtual environment could be the next goal. This could result in rehabilitation activities that can adapt to the patient’s conditions and performances and a system with greater sophistication and responsiveness. At this stage, much work remains to be done. Nevertheless, it is hoped that the deliberation, framework and lessons learned arising from this work would be useful for the advancement of interactive computer-based therapeutic tools for people with cognitive problems.

Amos et al., (2008) describe focuses on the use of virtual manufacturing for press line monitoring and diagnostics. A machine service support system (MSSS) has been designed and implemented. The system is an example of advanced use of 3-D graphical simulation tools in the resource domain. It extends the use of simulation models from the machine system design and development phase into the operational phase. This, however, requires special attention for the synchronization of the simulation and the various signals. MSSS can be used for continuous on-line monitoring or for analysis of previous operation with the use of media player functions. In the latter case, the user cans remotely configure the data logging to avoid logging of redundant data. Whilst MSSS may be beneficial to almost any system integrator or machine builder installing equipment at remote locations, suppliers of press lines and press cells can benefit in particular as a problem with any device in such lines or cells may hamper the operation seriously and not seldom result in a complete production stop. As a result, after successfully testing MSSS in a fully industrial pilot implementation, one of the project partners is considering to make MSSS available to their customers as an add on for their press lines and cells. MSSS in a broader context is an example of a synthetic environment that is used to create an enhanced ‘‘situation awareness’’ for human decision support in an IF context. Lack of this research is there are no more advanced functions for diagnostics and fault detection algorithms that may allow some decisions to be taken by the system automatically but also will support the human decision maker with better information in general. in short, the researchers did not use a control algorithm to reduce the fault detection algorithm.

Bruno And Luigi (2000) deals with the problem of controlling the interaction of a multilink flexible arm in contact with a compliant surface. The first stage is in charge of solving the inverse kinematics problem to compute the desired vectors of the joint and the de#ection variables that place the flexible arm tip at the desired position with the desired contact force. The solution is based on the transpose of a suitably modifed arm Jacobian so as to account for the static e!ects due to gravity and contact force. The computed variables are used as the set-points for the second stage, which is a simple PD joint regulator. The attractive feature of the scheme is that it does not require force and deflection measurements. The price to pay is that an exact knowledge of the arm kinematic model, link stifness and mass distribution as well as environment sti!ness and position is required to guarantee accurate regulation of tip position and contact force.

After seeing the presentation of the above studies it can be concluded that research on the development of control algorithms for the VM has not been done so that this study can be considered as new research is expected to contribute to both the world's manufacturing and education.

2.2 Basic Theory

2.2.1 Virtual Manufacturing

Virtual manufacturing is used loosely in number context. It refers broadly to the modeling of manufacture system and components with effective use of audiovisual and other sensory features to simulate or design alternative for an actual manufacturing environment, mainly through effective use of computers. The motivation is to enhance our ability to predict potential problems and inefficiencies in product functionality and manufacturability before real manufacturing occurs (Prashant et al., 2001). Virtual manufacturing system is organized from component of machine to collection of machines in a cell to multiple cells on a shop floor and extending to all other processes on factory floor.

In a real manufacturing system organization, the machine or processes are rarely moved from one place to another. On the other hand, the virtual manufacturing system has inherited characteristics of relocation during planning in order to explore optimal output under long term schedule. For short term schedules, while the machines remain at the designated position, the optimal part routing can be explored. This part routing maybe within factory premise or beyond (Khan et al., 2011).

Virtual manufacturing is the use of information technology and computer simulation to model real world manufacturing processes for the purpose of analyzing and understanding them. Unlike in the classical discrete event simulation, an easily understood but complex three-dimensional animation models are used to engineer the real manufacturing environment. Machines, machine cells, parts, and facilities can be designed and evaluated onscreen before actual facilities or products are constructed. In some instances the actual simulation could be carried on concurrently as the manufacturing facility is being built. The advantages of such an approach are many. It enables the manufacturer to speed up the time to market by integrating product development and production so that the system and parts are tested out in real time on a computer while at the same time allowing for ‘‘what if’’ type scenarios and conservation of valuable capital to take place. As Daly puts it, the ‘‘simulation tools are so powerful that designers can produce a perfect product on the first try without any scrap and without building a prototype’’. This level of agility in manufacturing has been made possible by advancements in information technology and its ubiquity fueled by the Internet and electronic commerce (e-commerce) (Offodile et al., 2002).

A. The benefit of virtual manufacture

Lee et al., (2001) talk about the benefit derived from virtual manufacture are as follow:

1. Enhancing the capability of risk measures and control. Virtual manufacture can be used to predict the cost of product development and production as well as provide the information related to the production process and the process capability. The information is useful for improving the accuracy of the decisions made by the designer and the management. The problems in product development and manufacturing processes can also be predicted and resolved prior to the actual production.
2. Shrinking the product development cycle. Virtual manufacturing will allow more computer based product model to be developed and prototyped upstream in the product development process. This will reduce the need for the number of downstream physical prototypes traditionally made to validate the product models and new design. Thus, the company can reduce its product development time.

3. Enhancing the competitive edge of an enterprise in the market. Virtual manufacture can reduce the cycle time and cost in product development. With the virtual environment provide by virtual manufacture, the customer can take part in the product development process. The design engineers can responds more quickly to the customer queries and hence provide the optimal solution to the customers. The competitive edge of an enterprise in the market can thus be enhanced.

B. The application of virtual manufacture.

Lee et al., (2001) talk about some typical applications of virtual manufacture are as follows:

1. Virtual manufacture can be used in the evaluation of the feasibility of a product design, validation of production plan, and optimization of the product design and processes. These reduce the cost in product life cycle.
2. Virtual manufacture can be used to test and validate the accuracy of the product and process design. For example, the outlook of product design, dynamic characteristic analysis, checking for the tool path during machining process, NC program validation, is checking for the collision problems in machining and assembly.
3. With the use of virtual manufacture on the internet, it is possible to conduct training under a distributed virtual environment for the operators, technicians and management people on the use of manufacturing facilities. The cost of training and production can thus be reduced.
4. As a knowledge acquisition vehicle, virtual manufacturing can be used to acquire continuously the manufacturing know-how, traditional manufacturing processes, production data, etc. This can help to upgrade the level of intelligence of a manufacturing system.

2.2.2 Virtual Environment

Virtual environment system differ from previously developed computer centered system in the extent to which real time interaction is facilitated and in terms of several characteristic, that the perceive visual space is three dimensional rather than two dimensional, the human machine interface is multimodal and the operator is immersed in computer generated environment.

Virtual environment, a commonly used definition of virtual environment is an interactive, virtual image display enhanced by special processing and by non-visual display modalities, such as auditory and haptic, to convince user that they are immersed in a synthetic space. The term immersion refers to the fact that the user gets the feeling that he or she is immersed in the computer environment, the screen separating the user and the computer appears nonexistence to the user (Prashant et al., 2001).

A The Nature of Immersive Environment

According to Wang et al., (2011) virtual reality is a technology that simulates object and spaces through 3D computer generated models. In a virtual reality model, the feeling of realism is derived from a sequence of high resolution, stereoscopic images. If the display allows viewers to project themselves into the scene, then a virtual environment is created. If the scene is shown in full scale and viewers are surrounded by 3D images, an immersive environment is generated. In the immersive environment of c2/c4 (both are three side) and c6 (a six-sided) at Lowa State University, which are full scale with high resolution; users have the sense of “being there”, or the sense of presence experienced in the environment resulting from cognitive processes.

The sense of presence is generated from human sense of sight, sound, taste, smell, and touch. In virtual environment, three conditions are required to generate the sense of presence through perception (Lombard and Ditton., 1997) image quality, image dimensions and view distance.

According to Wang et al., (2011) the immersive projection system fulfills these requirements, for it closely approximates actual size and distance with full scale, high resolution 3D objects generated in real time. For instance, C2 and C4 both are 12' by 12' space, in which the user is surrounded by three dimensional images, projected in real time on three walls and the floor (currently, C2 is replaced by C4). C6 is a 10'X10'X10' room in which computer generated images are projected on all four walls, the ceiling, and the floor to deliver an enclosed, interactive, and fully immersive experience. Along with the high end projectors, the system can produce up to 4096X4096 pixel images totaling over 16.7 million pixels per wall. Forty eight dual CPU workstations send images to 24 digital cinema projectors. Images generated by these projectors would have high resolution of approximately 1165 pixels per square inch. This resolution gives users a clear and detailed display of virtual environment.

B. Design in Virtual Environments

A virtual architectural Design Tool (VADeT) was created in the C2, which had a number of metaphorical icons that served as design tools for generating, modifying and editing three dimensional objects of architectural elements. There were also tools for defining dimensions, materials, and colors of the objects. By using these tools in the system, users could create a design in a synthetic virtual reality facility (Cru-Neira et al., 1993; Chan et al., 1999)

2.2.3 Basic Concepts in Robotic

Industrial robots are beginning now to revolutionize industry. These robots do not look or behave like human being, but they do the work of human. Robots are particularly useful in a wide variety of industrial application, such as material handling, painting, welding, inspection, and assmbly. Even more impressive, however, is the new perspective thats robots may bring to the factory of the future.

Industrial robots, as other modern manufacturing systems, are advanced automation systems that utilize computer as integral parts of their control.Computers are now a vital part of industrial automation. They run production lines and control stand alone manufacturing system, such as various machine tools, welders, inspection system, and laser-beam cutters. Even more sophisticated are the new robots that perform various operations in industrial plants and participate in full automation of factories (koren, 1985).

A. Basic Structure of Robots

The industrial robot is a programable mechanical manipulator. Capable of moving along several directions, equipped at its end with a work device called the end effector and capable of performing factory work ordinarily done by human beings. The term robot is used for a manipulator that has a built-in control system and is capable of stand alone operation.

One popular dictionary define a robot as “any mechanical device operated automatically to perform in a seemingly human way.” By this definition, a garage door opener, which automatically opend the door by remote control, could also be a robot. Obviously this not an industrial robot. The Robotics International of the Society of Manufacturing Engineers (RI/SME) defines the industrial robot as “a reprogramable multi fuctional manipulator design to move material, part, tools or specialized devices through variable programmed motions for the performance of variety of task. However, the RI/SME definition of an indsutrial robot should include also the following key words: motion along several directions (degree of freedom), end effector, and factory work. Modern robotic system consist of at least three major parts, which are:

a. The manipulator, which is mechanical moving structure.
b. The drives to actuate the joints of the manipulator.
c. The computer as a controller and storer of task programs.

In general, the structure of a robot manipulator is composed of a main frame and a wrist with a tool at its end. The tool can be a welding head, a spray gun, a machining tool, or a gripper containing open-shut jaws, depending upon the specific application of the robot (Koren, 1985).

B. Robot Anatomy

Robot anatomy is concerned with the physical construction of the body, arm, and wrist of the machine. Most robots used in plants today are mounted on a base which is fastened to the floor. The body is attached to the base and the arm assembly is attached to the body. At the end of the arm is the wrist. The wrist consist of a number of components that allow it to be oriented in a variety of positions. Relative movements between the various components of the body, arm and wrist are provided by a series of joints. These joints movements usually involve either rotating or sliding motions. The body, arm, wrist assembly is sometimes called manipulator.

Attached to the robot's wrist is a hand. The technical name for the hand is "end effector". The end effector is not considerd as part of robot's anatomy. The arm and body joints of the manipulator are used to position the end effector, and the wrist joints of the manipulator are used to orient the end effector (Koren, 1985).

C. End Effectors

For industrial applications, the capabilities of the basic robot must be augmented by means of additional devices. We might refer to these devices as the robot's peripherals. They include the tooling which attaches to the robot's wrist and the sensor systems which allow the robot to interact with its environment.

In robotics, the term end effector is used to describe to the hand or tool that is attached to the wrist. The end effectorrepresent the special tooling that permits the general purpose robot to perform a particular application. This special special tooling must usually be designed specifically for the application.

End effectors can be devided inti two categories: grippers and tools. Grippers would be utilize to grasp an object, usually the work part, and hold it during the robot work cycle. There are variety of holding methods that can be used in addition to the obvious mechanical means of grasping the part between two or more fingers. These additional methods include the use of suction cups, magnets, hooks, and scoops. A tool would be use as an end effector in applications where the robot is required to perform some operation on the workpart. These application include spot welding, arc welding, spray painting, and drilling. In each case, the particular tool is attached to the robot's wrist to accomplish the application (Koren, 1985).

D. Robot Arm Kinematics and Dynamics

Robot arm kinematis deals with the analytical study of the geometry of motion of a robot arm with respect to a fixed reference cordinate system without regard to the force /moments that cause the motion. Thus kinematics deals with the analytical description or the spatial displacement of the robot as the function of time, in particular the relation between the joint variable space and the position and orientation of the end-effector of a robot arm.

There are two fundamental problems in robot arm kinematics. The first problems is usually referred to as the direct(or forward) kinematics problem, while the second problem is the inverse kinematics (or arm solution) problem. Since the independent variable in robot arm are the joint variables, and a task is usually stated in terms of the reference coordinate frame, the inverse kinematics problem is used more frequently. Denavit and Hartenberg (1955) proposed a systematic and generalized approach of utilizing matrix algebra to describe and represent the spatial geometry of the link of a robot arm with respect to a fixed reference frame. This method uses a 4 x 4 homogeneous transformation matrix to describe the spatial relationship between two adjacent rigid mechanical links and reduce the direct kinematics problem to finding an equivalent 4 x 4 homogeneous transformation matrix that relates the spatial displacement of the hand coordinate frame to the refence coordinate frame. These homogeneous transformation matrices are also useful in deriving the dynamic equations of motions or a robot arm. In general, the inverse kinematics problem can be solve by several techniques. The most commonly used methods are the matrix algebraic iterative, or geometric approach (Fu et al, 1988).

E. Robot Programming Languages

One major obstacle in using manipulators as general purpose assembly machines is the lack of suitable and efficient communication between user and the robotic system so taht the user can direct the manipulator to accomplish a given task. There are several ways to coomunicate with a robot, and the three major approaches to achieve it are discreate word recognition, teach and playback, and high level programing languages.

Current state of the art speech recognition is quite primitive and generally speaker dependent. It can recognize a set of discrete words from a limited vocabulary and usually requires the user to pause between words. Although it is now possible to recognize words in real time due to faster computer components and efficient processing algorithms, the usefulness of discrete word recognitionto describe a task is limited. Moreover, it requires a large memory space to store speech data, and it usually requires a trining period to build up speech tamplate for recognition.

The method of teach and playback involvesteaching the robot by leading it through the motion to be performed. This is usually accomplished in the following steps: (1) leading the robot in slow motion using manual control through the entire assembly task, with the joint angles of the robot at appropriate locations being recorded in order to reply the motion; (2) editing and playing back the taught motion; and (3) if the taught motion is correct, then the robot is run at an appropriate speed in repetitive motion. This method is also known as guiding and is the most commonly used approach in present day industrial robots (Fu et al, 1988).

F. Robot Intelligence

A basic problem in robotics is planning motion to solve some prespecified task, and then controlling the robot as it executes the command necessary to achieve those actions. Here, planning means deciding on a course of action before acting. This action synthesis part of the robot problem can be solved by a problem solving system that will achieve some stated goal, given by initial situation. A plan is, thus, a representation of a course of action for achieving a stated goal.

Research on robot problem solving has led to many ideas about problem solving system in artificial intelligence. In typical formulation of robot problem we have robot that is equipped with sensors and a set of primitive action that it can perform in some easy to understand world. Robot actions change one state, or configuration, of the world into another. In the "block world," for example, we imagine a world of several labeled block resting on a table or each other and a robot consisting of a tv camera and a moveable arm and hand, that is able to pick up and move blocks. In some situations the robot is a mobile vehicles with a tv camera that performs task such as pushing object from place to place in an environment containing other objects (Fu et al, 1988).

2.2.4 Truvision 3D

The TV3D SDK is a complete 3D middleware solution for programmers looking to create anything from next generation games to complex simulations. By using our complete API and favorite development language, it can write less code, and get more done in a shorter amount of time. The entire TV3D SDK has been built from the ground up to give the programmer total control over every aspect of their 3D world.

Complete control is maintained through a very easy to learn system of objects, each with a very specific set of functions. This easy to learn system still gives all the power of programming with DirectX, without having to learn a complex API. Truevision3D is focused on building cutting edge development tools at an affordable price. Large studios, indie developers, universities, and government agencies across the globe use our products for games, simulations, training, broadcast, and more.

2.3.4 Research Comparative

From the table below, can be compared to studies conducted by previous studies that note the difference.

Table 2.1 Research Comparative

Title	**Researcher**	**Using 6 Degree of freedom**	**Using Control Algorithm**	**Using VM simulation**
A Novel Robust Algorithm robotic manipulator	Ronald A. Perez & James C. Brendelson	✘	✓	✘
Inverse kinematics in robotics using neural networks	Sreenivas Tejomurtula & Subhash Kak	✓	✓	✘
Development of Control System to Control Virtual Model	Abiyoga Kristanto	✓	✓	✓