Simulation technology for
digital mockup based mechatronics control software development


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(1974)


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(1962)


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(1958)

1. Overview

This simulation technology enables digital mockup-based control software debugging before the prototype hardware becomes available for connecting to the software module. In the mechatronics industry, higher quality and shorter design lead time are critical due to increasing complexity and functionality. Functions are realized by close interaction between complex mechanical hardware and software, and therefore software testing and debugging cannot start until prototype mechanical hardware is ready. This is one of the most difficult problems for realizing better quality.

Our simulator builds a virtual mechanism model (digital mockup) utilizing 3D-CAD and algebraic equations of physical behaviors (Figure 1). Fast 3D rendering and collision detection are implemented based on XVL data representation. The dynamics module which is implemented based on newly developed modeling language, DCML™ (Dynamics Constraint Modeling Language), and kinematics module are other key components which are connected with control software via the software interface module. This technology leads to lower development cost by requiring fewer prototype hardware and higher quality through intensive testing including exceptional mechanical situations. This simulator can be connected with a micro computer based controller and sequence controller, and has been actually used in precision machinery industries including printers, medical equipments, manufacturing devices, and home appliances.

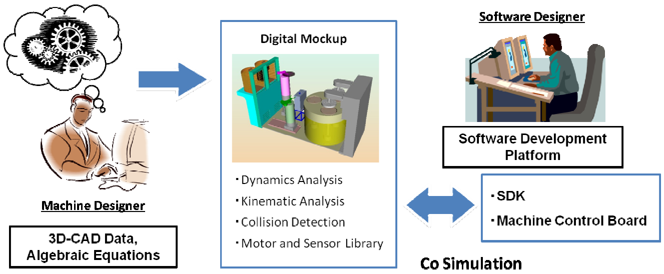

Fig.1 System architecture of digital mockup based control software development

2. Technology

Dynamics behaviors of mechanisms, motors and sensors are modeled and simulated using the newly developed language DCML™. Figure 2 shows an example of DCML™ based model and corresponding simulation result. DCML™ can model mechatronics systems which include discrete events such as communication interruptions and continuous behavior such as motor accelerations using algebraic equations and state transitions (Fig.2(b)). Such a model can be described in a compact manner (Fig.2(c)), and can be simulated very efficiently (Fig.2(d)). Previously, differential equations were required to be manually converted into a numerical integration model, but DCML™ accepts simultaneous ordinal differential equations directly. Moreover, our original control statements allow compact description of state transitions.

The kinematics engine enables mouse-based user-friendly mechanism definition, and motion simulation and collision detections in 3D space. Mechanical relations such coaxial relation and plane-plane sliding mate relations are internally represented in terms of nonlinear algebraic equations which are flexibly solved in a unified manner.

Figure 3 shows connectable software development environments which can be used to build appropriate digital mockup-based control software.

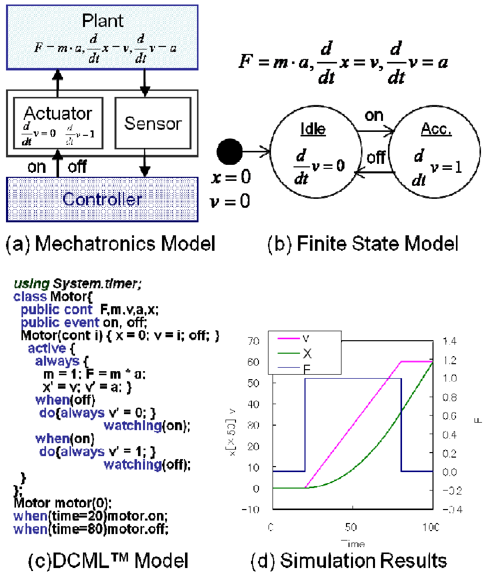

Fig.2 DCML™ model and simulation example

3. Summary

This technology has been actually utilized as a digital mockup based mechatronics control software development tool after its commercial release in 2002, and has contributed in realizing shorter development time and better quality.

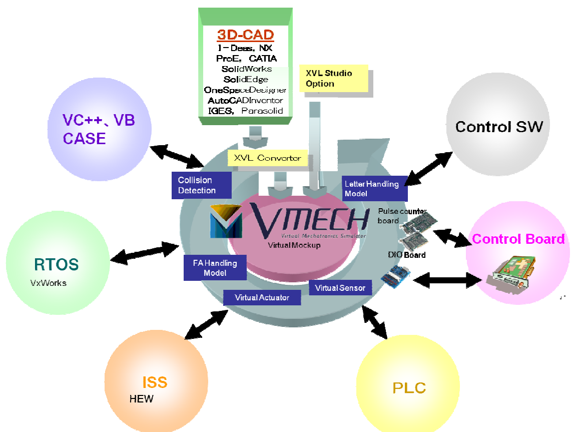

Fig.3 Vmech™ simulator and connectable software platforms

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