A Multimedia Handbook of Mechanical Devices

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Introduction

In the past few years, the author has been developing motion simulation courseware based on Working Model 2D (referred as WM2D) and Working Model 3D (recently renamed to visualNastran and is referred as WM3D in this paper) [1]. Visualizing mechanisms in motion is an important aspect of an engineer's design ability and is also one of more challenging aspects to many engineering students. Students today generally have less experience with machinery, mechanisms, and "tinkering" than engineering students of the past, making it more difficult for them to visualize the motion of mechanisms. On the other hand, students today are comfortable and familiar with interactive software. Additionally, most textbooks and classroom teaching are verbal, deductive, and sequential, and this environment cannot meet the needs of some students who are sensing, visual, inductive, active, and global learners [2]. So using modern software for motion visualization both fills a need for the students and generally suits their background and learning styles.

Over 250 WM2D and WM3D simulation files of mechanical devices have been developed in the past few years. These simulation files cover a wide range of mechanical devices including linkages, gears, cams, tools, machinery, automobiles, construction equipment, furniture, and others. Sources of these devices are from textbooks, reference books, catalogues, service manuals, U.S. patent documents and technical papers. A portion of these files has already been published as a part of a CD bundled to a textbook [3]. This courseware, with its homepage shown in Figure 1, can be used in lectures, as self-paced study, or as reference material for students.

As more simulation files are being developed, the endeavor to create the courseware has evolved to become building a multimedia handbook of mechanical devices. Similar compilations of motion simulations files [4,5] are also being developed in different directions. In Reference [4], over 40 WM3D files are created to highlight the sample problems in a textbook of statics and dynamics. In Reference [5], over 200 animated movie files of mechanisms and machines are generated based on ADAMS™ software.

This type of courseware or multimedia handbook matches the underpinning philosophy of National Engineering Education Delivery System (NEEDS) [6,7], a digital library for undergraduate engineering education developed by Synthesis: A National Engineering Education

Coalition to enable new pedagogical models based on internet-mediated learning environments. Since 1997, NEEDS and John Wiley & Sons has awarded the Premier Courseware [8] four times through an annual competition to recognize high-quality, non-commercial courseware designed to enhance engineering education. However, there is no courseware on simulation of mechanical devices from NEEDS, nor from other digital libraries linked with NEEDS website.

Multimedia Handbook

To organize the motion simulation files developed in an easy-to-use manner, a web browser is used to navigate hyper-linked HTML files containing text, picture, photo, video, Matlab, WM2D and WM3D files. Video files are generated from WM2D and WM3D in the format of Microsoft's Video for Windows, and these files can be played independent of WM2D/WM3D. Picture files are generated from screen copies of WM2D/WM3D files to provide a quick snapshot of the device. Additionally, photos and video clips of real devices in motion are created whenever possible.

Each device has an information page that contains the background information of the device, the sources from which the device is referred, and credits of developers. Figure 2 shows a page for a pruning saw, which contains the picture of the computer simulation model, a link to the video file of the computer simulation, a link to the WM2D file, and photos of the device in two or more different positions. In other similar pages, the information page has a link to a WM3D file when the device is a spatial mechanism, to relevant websites, to a Matlab file that generates the profile of gears or cams, or to the video clips of the device in motion.

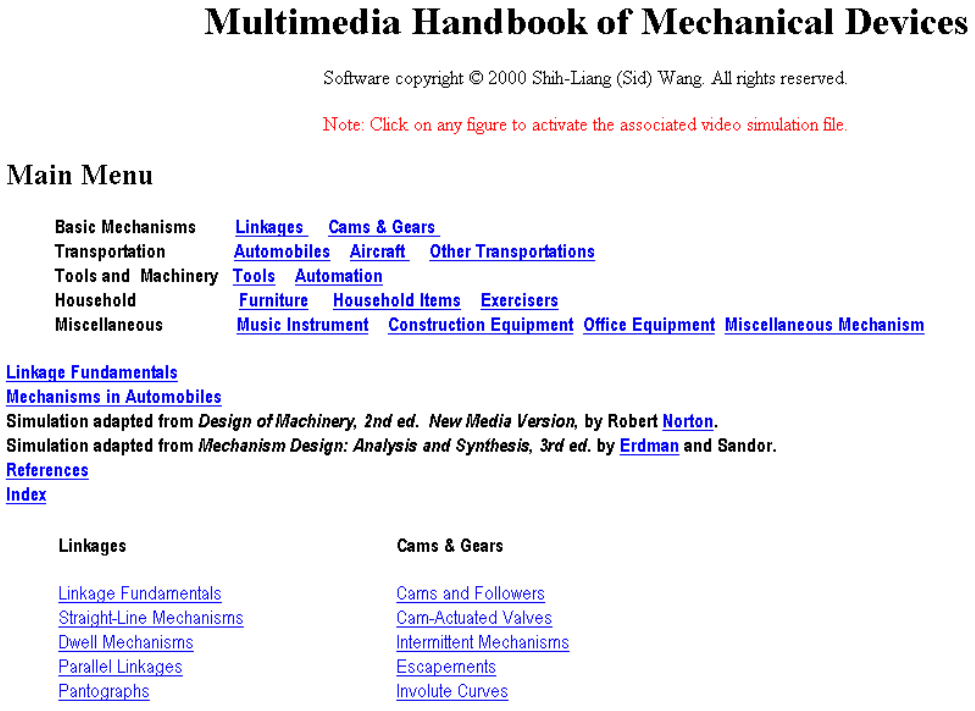

Figure 1. Homepage of the Multimedia Handbook

Photos of a device and pictures of its computer model are both presented to enhance the understanding. Pictures of computer models sometimes are superior to photos of real devices

because they can have different colors representing different parts and therefore are easier to understand. Video clips of a real device in motion will be used only when necessary, as these video files takes a large storage space and a long time to load and play the file.

Devices chosen in the multimedia handbook are based on the frequency that a device is referred in textbooks. For example, Watt's straight-line linkage, as shown in Figure 3, is frequently referred in kinematics textbooks, and oil pumps, as shown in Figure 4, is frequently referred in statics and kinematics textbooks. Mechanisms that are difficult to visualize are first developed, such as constant velocity joints, v-8 engines, and rear differentials, as shown in Figures 5-7 respectively. Additionally, devices not referred in books but are seen in everyday life, such as oscillating fans, automobile trunks, and futon frames are also developed, as shown in Figures 8-10 respectively.

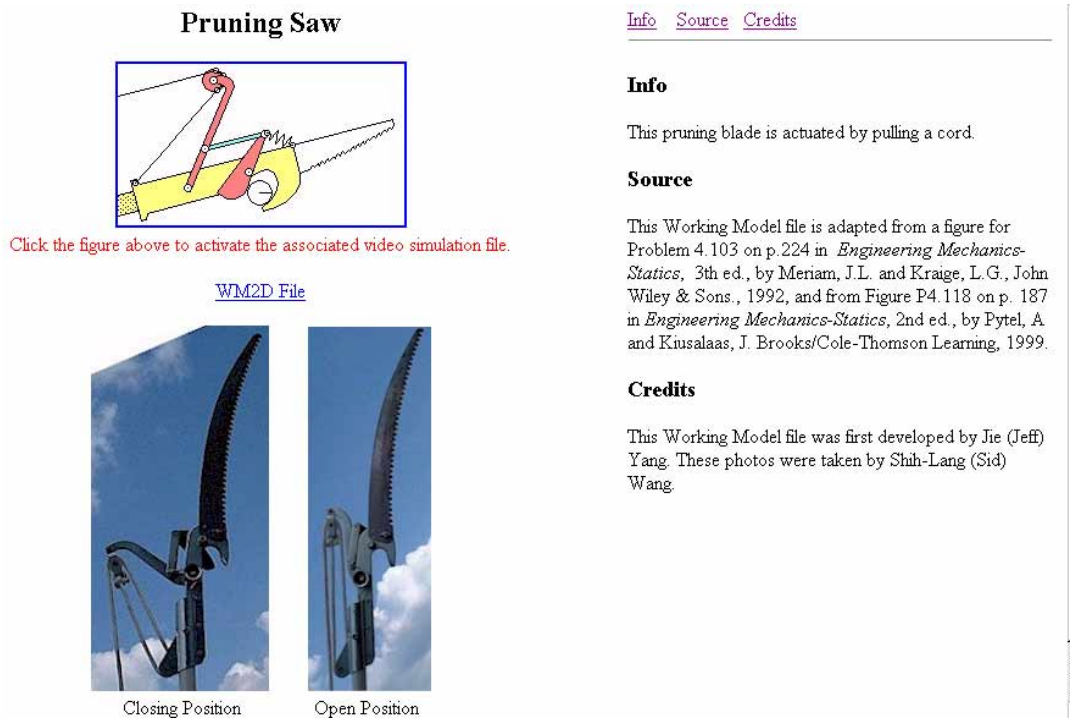

Figure 2. An Information Page of a Device – Pruning Saw

With the extensive collection of simulation files of mechanical devices, the multimedia handbook is organized with a table of content and an index. Cross-referencing these files in hyperlink becomes very simple and effective. For example, a scroll compressor can be used to highlight involute curves, Oldham coupling, and as a part of an automotive AC compressor.

Discussion

The multimedia handbook can supplement textbooks in design and mechanics areas including statics, dynamics, kinematics, machine design, and robotics to animate mechanisms referred in these books. Additionally, this courseware can be a good resource for design projects to review existing designs and stimulate new design ideas for practicing engineers and engineering

students. Moreover, it can assist the general public (including students in K-12) with a curious mind as an animated "how things work" reference.

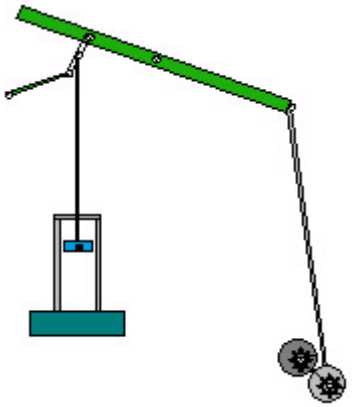

Figure 3. Watt's Engine

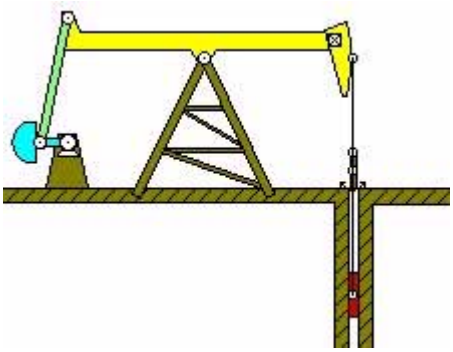

Figure 4. An Oil Pump

Figure 5. A Constant Velocity Joint

The courseware will meet the needs of just-in-time learning, instead of just-in-case teaching. It can be used as a supplementary courseware in a tight curriculum when traditional courses like kinematics are being replaced by more contemporary subjects like mechantronics. The courseware can also be used to supplement distance learning in an asynchronous environment. This mode of education can benefit students in remote or inaccessible places and is gaining importance in higher education which students are freed from the constraints of place and time. Proper courseware will enable more of these courses to be offered.

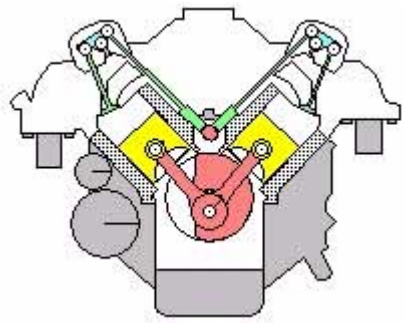

Figure 6. A V-8 Engine

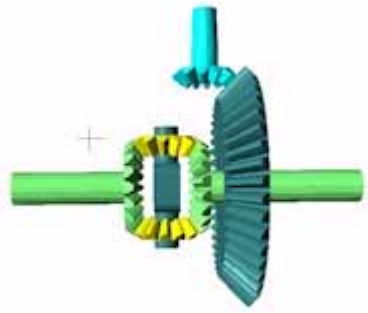

Figure 7. A Rear Differential

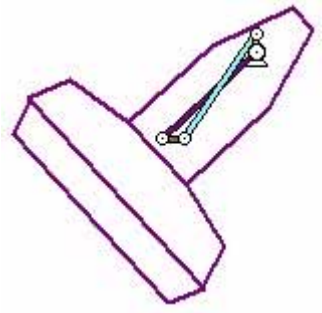

Figure 8. An Oscillating Fan

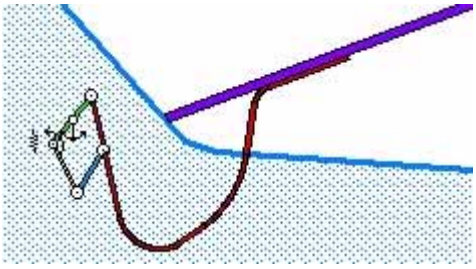

Figure 9. An Automobile Trunk

Figure 10. Futon Frame

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