Object-oriented cam design through the internet

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We have developed a Web-based interactive cam design package under the programming paradigm of the C\textsuperscript{H} language environment. This package was initially developed as a teaching and learning tool for educational use in an undergraduate Computer-Aided Mechanism Design course. Because the system is Web-based and implemented through a client/server model with the user interface through the Web browser, it is easy to use and maintain. The system can also be used to solve practical engineering cam design problems with flat or roller followers and with translating or oscillating motion types. The system can be used to generate the cam profile, transmission angle, position, velocity, and acceleration of the follower. Once a cam/follower system is designed, animation of the cam/follower system can be performed. At the end of the design, the CNC code for manufacturing the designed cam can also be produced through our Web-based cam design system. The package consists of a number of modules including various Web pages, common gateway interface (CGI) programs, a C\textsuperscript{H} program called cam\textunderscore ch, and the CCam C\textsuperscript{H} class which performs the necessary computation for cam design. Two different versions of the cam design package have been designed and implemented. One runs the cam design program on the client machine as a C\textsuperscript{H} applet, and the other runs the cam design program on the Web server through CGI. In this paper, details of design and implementation of Web-based cam design package will be described. Two application examples with different motion types for the follower will be used to illustrate features of the applet-based and CGI-based implementation schemes. The ideas of the Web-based software design presented in this paper can be applied to other application areas.

Keywords: Cam, web-based design, CGI, applet, Ch

1. Introduction

Cam is one of the most commonly used mechanisms in automation and assembly systems. Because of the wide application and the underlying principles behind its design, cam design can provide students with valuable experience in the design process, and is part of the undergraduate mechanical design curriculum in most engineering schools. For engineering practice, designers may use commercial software packages such as I-DEAS (Structural Dynamics Research Corporation, 1996) and Working Model (Knowledge Revolution, 1989) for design and analysis of cams. The application of these software packages in cam design requires significant expertise and time. For educational purpose, some cam design packages for student learning have been developed (Erdman and Sandor, 1997; Norton, 1992). These packages typically can display cam profile and follower motion characteristics such as position, velocity, and acceleration. Wang (1997) developed software utilities based on Working Model for animation of cam and follower systems. Aziz (1996) also developed a Window-based cam design package with animation and generation of CNC code for manufacturing of the designed cam. However, all these software packages and utilities are not suitable for Web-based cam design and animation in a network computing environment. In addition, they are not suitable for collaborative design and distance learning.
Under the paradigm of network computing, users are not required to install all the software in local machines. Information can be easily exchanged and software can be downloaded as it is needed. The World Wide Web (WWW) takes network computing to a new level by providing a friendly and convenient user interface. Because of the ubiquitous nature of The World Wide Web, it is ideally suited for use in distance learning. Students can take advantage of remotely located design tools to complete projects, or experiment and learn on their own. We have developed a Web-based interactive cam design package that runs under the C^H language environment. The C^H language environment is a superset of C, with extensions for mechanism design and network computing (Cheng, 1993a, 1993b, 1997). This cam design software package was designed specifically for use in a network computing environment. In the current implementation, it can be used to design cams with either translating or oscillating, flat-faced or roller followers and different motion characteristics such as harmonic and cycloidal motion types. Based on the principle of modular software design in the client/server model, this package uses a number of small programs and utilities, including dynamically created Common Gateway Interface (CGI) programs (Cheng, 1996; Felton, 1997) and C^H applets, to perform the necessary computations for cam design. The user can access our software through a Web browser, therefore, the system is easy to use. After the user types in cam design parameters and CNC manufacturing parameters through a Web browser, the system can produce cam profile and follower motion characteristics such as position, velocity, acceleration, and transmission angle. Animation of the designed cam and follower system can also be performed through the Web browser. Even the CNC code for manufacturing the designed cam can be generated automatically. In this paper, details of design, implementation, and application of our Web-based interactive cam design package will be described.

2. User interface for design of cams with translating or oscillating followers

The user interface for the cam design package is implemented as a set of Web pages, some of which are created dynamically in response to user input. The Web provides an interface that is user friendly and easy to use, hiding the details of the data generation for cam design. Users can design cam profiles for either translating or oscillating, flat-face or roller followers with either harmonic or cycloidal motion characteristics. In this section, the Web interface and user-selectable parameters for cam design are described.

2.1. Follower type selection

As shown in Fig. 1, the first of the Web pages allows the user to select the cam follower to be either translating or oscillating. The two choices are presented in graphical form. The followers are selected by clicking on the respective pictures. Next, as illustrated in Fig. 2, the follower type is selected more specifically to be either a flat-faced or a roller follower and the number of cam sections (a change in follower position or a dwell) is selected. These data are submitted to a CGI program that creates the next Web page dynamically for entry of the cam parameters. Alternately, users may select the sample cam design with a flat-faced follower in which all of the cam parameters are pre-selected.

2.2. Cam design and CNC manufacturing parameters

Figures 3 and 4 show the subsequent page where the user can input the cam parameters, some of which are dependent on the follower type, and the CNC cutter parameters. Note that Figs. 3–5 are the same Web page. All cam parameters must be set for the program to work properly. However, if the user does not want the CNC code for manufacturing the designed cam as an output, no modifications to the CNC parameters are needed, as they do not affect the calculations of the cam profile.

The user-selectable parameters used in the cam design program are described in the sections below (Erdman and Sandor, 1991; Mabie and Ocviirk, 1975; Martin, 1982). Figures 6–9 illustrate the basic parameters for the four supported follower cases.

2.2.1. Parameters common to both translating and oscillating follower types

There are a few parameters that are common with both follower types. The first of these is the base radius, measured in inches. It is the initial radius of the cam.