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There have been many approaches proposed for the computer-aided design of control systems. The co-authors of this paper include several strong proponents of a design methodology emphasizing designer's intuition, man-machine interaction and sophisticated optimization techniques [1]. This methodology has been implemented by our group as part of the DELIGHT.MaryLin system [2, 3], an offshoot of Berkeley's DELIGHT system [4, 5]. A logical way to test this approach to computer-aided design is to apply DELIGHT.MaryLin to a number of real control system design problems and see how well it performs. This paper describes just such applications to two control problems supplied by industry. In both cases, the problems had been previously solved by other techniques. Thus, we are able to compare the solution obtained with DELIGHT.MaryLin to solutions that are acceptable in actual practice.

It should be emphasized that DELIGHT alone would not have allowed us to solve these control problems. It is necessary to combine DELIGHT with a simulation of the system to be controlled. Since the systems we were designing are linear we simply adjoined to DELIGHT various linear system analysis routines, including a routine due to A. Laub [6] and routines from the ORACLS package [7]. Ultimately, other and much more sophisticated routines can be combined with DELIGHT. These would facilitate application to much more complex problems.

Our first case study was the design of the pitch axis control of a small jet aircraft. In keeping with our philosophy of computer-aided control system design, experienced designers of aircraft control systems specified a preliminary design structure in which eight gains of the controller were left as design parameters. These parameters were to be selected, by a team of computer and control system designers, so as to satisfy the specifications for the pitch axis control of such an aircraft.

The aircraft model and the Military Specifications [8] for aircraft pitch axis control were inserted into DELIGHT.MaryLin. This involved time-domain and frequency-domain specifications, as well as bounds on the output noise level due to wind gust and sensor error. Designer and computer then interactively achieved, starting from very rough initial guesses for the unknown parameters, a design better satisfying the specs than designs previously obtained by other means. The tradeoff-oriented character of the new design methodology, allied to the powerful interaction capabilities of DELIGHT, subsequently lead to other designs of practical interest.

The second case study was the design of a servomechanism for controlling the line of sight of an airborne electro-optical device about a particular axis of rotation. Again, a preliminary design structure was specified. In this case, there were eleven design parameters. The system specifications were given in the usual form for problems of this type, i.e., in the frequency domain. It should be emphasized that this is a very different control problem from the aircraft pitch axis control problem.

Again, the model and specs were inserted into DELIGHT.MaryLin. Designer and computer achieved, starting from fairly arbitrary initial guesses for the unknown parameters, a better design than that actually built for this system. Since the original design was believed to be excellent, this result is to be construed as verification of DELIGHT.MaryLin's ability to achieve excellent controller designs.

In conclusion, this design approach worked extremely well in these two case studies. It should be emphasized that DELIGHT.MaryLin was used as a tool to enhance the productivity of a human control system designer, not as his replacement; the most creative parts of the design were done by the man.

Acknowledgments

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