A RADICAL IMPROVEMENT OF SOFTWARE BUGS DETECTION WHEN AUTOMATING THE TEST GENERATION PROCESS

Awedikian R., Yannou B., Lebreton P., Bouclier L., Mekhilef M. - *Ecole Centrale Paris* (*FRA*) 571

Software bugs are a direct indicator of software quality. Whereas competition and globalisation are fierce, introducing fewer bugs and detecting bugs earlier in the development process become one of the prior objectives of software organisations and particularly of automotive suppliers of car-embedded electronic modules. In this paper, we propose to improve the software testing process of an automotive electronics suppliers. Indeed, test cases are presently designed manually and depend on the experience of the testers. As software complexity grows, it becomes difficult for testers to imagine all possible combinations to be tested. Therefore, we propose to automatically generate relevant test cases for functional software testing.

TERMINOLOGY USED FOR SHAPE IDEATION

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For successfully supporting shape ideation, the support software should match the way the designer thinks about shape and shape modification. Thoughts of designers cannot directly be observed. Therefore we performed experiments in which one subject had to explain a shape modification to another subject. The results show a frequent use of vernacular shape characteristics, shape metaphores and fuzzy values'. If a shape ideation system will be developed, it should be able to understand shape metaphors and fuzzy values. Moreover, such a system must be able to assign different parameter models to the same shape and apply the one that matches best the current operation of the designer.

IDENTIFYING FEATURES IN CAD MODELS FOR POWDER METALLURGY COMPONENT EVALUATION

Stolt R. - *University of Jonkoping* (*SWE*) 689

This paper presents a newly developed CAD-integrated system for the manufacturability evaluation of designs of powder metallurgy (PM) pressed and sintered parts. The contribution of the paper is the automated reconstruction of a specialized construction history tree from any CAD-model directly in the receiving CAD-system. The reconstruction is based on the geometrical restrictions of the shapes that can be manufactured by the PM process. This facilitates the creation of a transparent and user revisable rule-base to evaluate the parts manufacturability, which is shown. It will enable designers to get feedback on their designs, reducing the number of design loops with the PM-parts supplier needed before the parts geometry can be established.

A SIMULATED MODEL OF SOFTWARE SPECIFICATIONS FOR AUTOMATING FUNCTIONAL TESTS DESIGN

Awedikian R., Yannou B., Lebreton P., Bouclier L., Mekhilef M. - *Ecole Centrale Paris* (*FRA*) 561

Nowadays, it becomes crucial to carmakers and automotive electronics suppliers to ensure a high software quality. Although many methods have been proposed in software engineering, they are, most of the time, not adapted to embedded software. Since there is no unified format to specify a software in automotive industry, we propose through this paper a representation model for most of functional software specifications, that is able to simulate the expected input-output functions. This model is the core component of a global approach for automatically generating test cases for functional testing of the software. Indeed, a simulated specification model is the foundation of automating test generation.

TOWARDS A DEVELOPMENT PROCESS FOR COMPUTATIONAL SYNTHESIS SYSTEMS

Schotborgh W. O., Kokkeler F. G. M., Tragter H., Röring M. H. L., van Houten F. J. A. M. - *University of Twente* (*NLD*) 665

A computational synthesis system (CSS) automates the generation phase of a design process. Development of a CSS for a new design case has not received much attention in the literature, since most computational synthesis methods are developed to solve a particular design problem [Cagan 2005]. This paper outlines a CSS development process that can be used for the class of quantitative routine design. The central notion is a definition of generative knowledge for use in knowledge acquisition, representation and automation. It unites existing concepts and techniques from cognitive design research, knowledge-based engineering and computational synthesis. Three design cases are used to demonstrate its validity.

TOWARDS KNOWLEDGE INTENSIVE DESIGN SUPPORT FOR THE MICRO SURGICAL DOMAIN

Grech A. K., Borg J. C. - *University of Malta* (*MLT*) 627

This paper, which is part of ongoing research, proposes a framework for a knowledge intensive computer aided design (KICAD) tool that will be able to aid designers working in the micro surgical domain. As the name suggests, the KICAD tool is ‘knowledge intensive’ meaning that life-cycle knowledge regarding parts and design processes is incorporated within the CAD architecture. The knowledge gathered from different stakeholders involved in the different life-cycle phases is gathered and represented in computational form as ‘rules’. The KICAD tool works as follows: a) the designer selects a number of design elements from the library such as the material, micro processing technique, product design element (part to be designed) and the required feature; b) based on the designer’s decisions, the component life model starts to be evolved within the working memory of the system and c) this is monitored by LCC knowledge from the knowledge base. LCCs are evolved informing the designer about the consequences and recommendations are also given; d) while in the meantime the performance measures of time, cost and quality are evaluated for the different life-cycle phases via performance mapping knowledge. These performance measures fluctuate depending on the consequences inferred.

DESIGN CATALOGUES FOR MECHANISM SELECTION

Singh B., Matthews J., Mullineux G., Medland A. J.. - *University of Bath* (*GBR*) 673

Linkage mechanisms have many uses in design and engineering. They can be used to generate intricate motions in assembly tasks, packaging operations, and robotics. Mechanisms are preferable to their main (mechanical) alternative which is cams. The main drawback is the fact that they are difficult to design in the first place. This paper explores a means for creating computer-based catalogues of mechanisms which store the parameters for the mechanism along with its output motion. The output path is stored using Fourier techniques and the Fourier coefficients can be given physical meaning. The paper discusses the creation and use of a catalogue, how a selection can be made more optimal, and how the local design space can be explored.

INTERACTIVE EVOLUTIONARY DESIGN FOR RECOGNICING CUSTOMER NEEDS AND WISHES

Tiainen T., Ellman A. , Syrilä A. L. - *Tampere University of Technology* (*FIN*) 705

In a product development process, designers try to understand what customers need and want. Especially in the case of personalized products, it is important that customers can describe what they want. For supporting the discussion between professional designers and customers we created a prototype of a tool based on evolutionary design and utilized with a genetic algorithm. This prototype is the Table Generator. We organized a user test in a furniture fair. The results of the test are promising. Most of the users thought that the Table Generator is a supporting tool in negotiation with professionals, furthermore, about half of the test users found that the Table Generator gave them new ideas about alternatives.

DYNAMIC AND CONCEPTUAL DMU

Gerhardt F. J., Eigner M. - *University of Kaiserslautern (DEU)* 619

In times of ever increasing mechatronical product complexity, development requires early knowledge gain. We present the concept of a dy¬namically growing Digital Mock-Up (DMU), based on the Jupiter Tes¬sel-lation (JT) data format and integrated into the early phases of product development. While our so-called Dynamic DMU is to serve as a basis for a multi-disci¬plinary analysis based on a cross-do¬main description, our focus lies on an architectural point of view, and on JT as the underlying technology to manage continuously evolving geometry.

A CONCEPT FOR INTERFACES TO GENERATE 3D CAD MODEL FROM CUSTOMER REQUIREMENTS

Chahadi Y., Rollmann T., Wu Z., Birkhofer H., Anderl R. - *Technical University Darmstadt (DEU)* 593

This paper pays particular attention to the methodical inventions in the early product development stage and the information data model intended to perform the overall data management. Interactions and interfaces between the different science disciplines will be paramount to realize a continuous product development process. In particular, after the requirements have been extracted and specified from the customer wishes, an algorithmic approach is being applied to generate concrete 3D CAD models of possible solutions of bifurcated sheet metal parts. The data exchange, interfaces and the data management shall be presented here.

WEB-BASED SOLUTION REPOSITORY IN MECHANISM THEORY TO SUPPORT THE DESIGN PROCESS

Brix T., Döring U., Reeßing M. - *Technical University Ilmenau (DEU)* 583

This paper presents a solution repository that is part of the "Digital Mechanism and Gear Library" (DMG-Lib). The aim of this project is to develop a new digital, internet-based library (www.dmg-lib.org) to collect, preserve and present the knowledge of mechanism and gear science. Using the state-of-the-art in the field of interaction, metadata and search algorithms, the digital library will support engineering designers in many aspects of product development as it helps to find possible design solutions, calculation procedures for dimensioning, etc. Combined with innovative multimedia applications and a semantic information retrieval environment, DMG-Lib provides an efficient access to this knowledge space of mechanism and gear science.

INTERACTIVE VISUALISATION OF THE CONE OF VISION AS A DESIGN TOOL

Heikkinen T. - *University of Art and Design (FIN)* 635

This paper presents a study of using a software tool for augmenting two-dimensional plan drawings with interactive graphic view cone shapes, mobile isovists. Space syntax research has shown that view cone shapes relate to experiential qualities of being in space, but little discussion exists of how the shapes could be directly used in exploring design problems, which all may not be well defined. To explore this potential, a software tool was developed and tested in a student project that relied on manipulating visibility. The results of the study suggest that using interactive plan drawings opens up design problem field in sufficiently rich way to negate the need for three-dimensional modeling and navigation in natural perspectives.

SMOOTH CURVES AND MOTIONS DEFINED AND OPTIMISED USING POINT-BASED TECHNIQUES

Edmunds R., Feldman J. A., Hicks B. J., Mullineux G. - *University of Bath* (*GBR*) 603

Smooth motions are important in many areas of engineering, including robotics and machine design. Typically there are conflicting requirements and the design task can be formulated as a constrained optimisation problem. Examples of requirements include: smooth motion, minimal time of travel, minimal peak acceleration and jerk, and obstacle avoidance. Rather deal with Bézier or B-spline control points, it can be easier to deal with actual points along the motion and use variation of these to achieve performance requirements and functional constraints. The paper investigates the applicability of point-based techniques for design optimisation. Three strategies for doing this are proposed and evaluated by means of case study examples.

TOLERANCE ANALYSIS OF GEOMETRICALLY NON-IDEAL SYSTEMS IN MOTION

Stuppy J., Meerkamm H. - *Friedrich-Alexander University Erlangen-Nuremberg* (*DEU*) 697

The functionality of technical systems in motion is influenced by small geometrical variations of their components. To quantify this influence, tolerance analysis is carried out. In this paper, tolerance and motion analysis procedures are merged together for an integrated modelling strategy. All explanations are exemplified by means of the crank mechanism of a combustion engine. Different kinds of deviation are considered – a) dimensional deviation of the mechanism links crankshaft and conrod, b) position deviation of the cylinder axis and c) clearance at the conrod big end bearing. With the results gained, understanding of the correlation between defined tolerances and the functionality of the mechanism can be improved.

RECENT ADVANCES IN AVL'S MESH GENERATION SOFTWARE - ESE-TOOLS

Juretic F., Moser W., Rainer G. - *AVL-AST d.o.o* (*HRV*) 643

The paper presents the new tools aimed at automating CFD calculations at the pre-design stage. The tools are: ESE Diesel developed for in-cylinder calculations in Diesel engines, ESE Aftertreatment is an simulation environment for after-treatment systems and ESE 3DEngine is designed to enable the users in the automotive industry generate accurate engine models quickly and reliably. The tools are easy to use even for engineers with no CFD background.

A SYSTEM FOR HAPTIC TOLERANCE ANALYSIS REGARDING NON-IDEAL GEOMETRY

Wittmann S., Stockinger A., Stoll T., Paetzold K. - *Friedrich-Alexander-University Erlangen-Nuremberg* (*DEU*) 729

Incomplete or wrong definition of tolerances can cause aesthetic and functional problems. In a virtual environment the visual representation is not precise enough to reveal small deviations. Therefore a platform for haptic tolerance analysis is presented employing the human haptic sense for this task. The requirements on the system are the precise representation of geometry, realistic simulation of physics and stereographic visualization. In addition to the systems layout, experiments to acquire data about the system accuracy for gap and flush analysis are discussed. Finally, a case study for the analysis of sheet metal parts is presented. It is shown that haptic systems offer a high accuracy and extend the immersion in VR-environments.

FEM MODEL FOR THE ANALYSIS OF ROTATIONAL SPEED INFLUENCE ON TOOTH CONTACT PRESSURE DISTRIBUTION OF THIN-RIMMED GEARS WITH ...

Vuckovic K., Ulbin M., Belšak A. - *University of Zagreb* (*HRV*) 713

Conventional procedures are limited to contact pressure calculation of a solid gear. The objective of the article is to use advanced engineering tools for a numeric calculation of tooth contact pressure of thin-rimmed gears that have a special design and operating conditions. Presented finite element method approach uses a 3D parametric model of engaged gears to evaluate the influence of rotational speed on tooth contact pressure distribution. Application is shown on a thin-rimed gear with asymmetric web arrangement engaged with a solid spur gear. Contact pressure contour lines for various rotational speeds that can be used for recommendation of gear micro-geometry modifications and for defining parameters of gear life-cycle, are presented.

THE EVALUATION OF THE ABILITY OF A CONSTRAINT-BASED MANIKIN TO REPRESENT NORMAL HUMAN TASKS

Medland A. J., Gooch S. - *University of Bath* (*GBR*) 649

The health and safety of the operators of machines is an important consideration during the design of such products. A human modelling program has been created within a constraint environment that can interact with the products and models of the environment. Real restrictions are imposed by the use of constraint rules and the incorporation of anthropomorphic data. With this representation natural postures of humans can be generated and their interaction with objects such, as process machinery, can be evaluated during the early stages of design.

DIGITAL RECONSTRUCTION OF A HUMAN SKULL

Etxaniz O., Minguez R., Arias A., Barrenetxea L., Solaberrieta E. - *The University of the Basque Country* (*ESP*) 611

This paper describes the process to obtain a high quality digital model of a human skull, by reverse engineering techniques. This development was made in the Product Design Laboratory (PDL), in the Faculty of Engineering of Bilbao (The University of the Basque Country). The digitalization of the skull is the first stage of a project that PDL is developing together with a research group at the University of Cordoba. In this first step, the digitization process and the quality of the achieved digital model have been evaluated. The next stage is to scan a human jaw and to digitally reproduce the real motion of both elements (skull and jaw). A thorough analysis of this movement will allow improving the design and placement of the prostheses.

GAP AND FLUSH VISUALIZATION OF VIRTUAL NONIDEAL PROTOTYPES

Stoll T., Paetzold K. - *Friedrich-Alexander University Erlangen-Nuremberg* (*DEU*) 681

When a product is manufactured, it always has deviations from the ideal CAD-geometry. Therefore, tolerances are assigned to each part. In this paper a method is presented where a designer can generate different nonideal prototypes independently from the proposed tolerances. This is done by defining gap and flush measurements at selected points. The designer can then evaluate whether the product meets the desired aesthetic quality. This information is given to the product developer or tolerance specialist, who assures that the requirements are met. All visualizations that are generated can be viewed in virtual reality, so that the scenes are more realistic, and the interpretations made by the designer are even more reliable.

VISUAL ANALYSIS METHODS FOR NON-IDEAL ASSEMBLIES

Penzkofer F., Wittmann S., Winter M. - *Friedrich-Alexander University Erlangen-Nuremberg* (*DEU*) 657

We follow the “generate and test” approach to analyse tolerance specifications: Based on toleranced CAD data, non-ideal parts are generated. For these non-ideal parts we propose several visualization methods to reveal the geometric consequences of the defined tolerances on the resulting product. One set of methods is used to reveal the geometric properties of individual assemblies, like surface quality and progress of gaps. The other set is intended for visualizing the spatial relations between multiple assemblies, like collision probabilities, based on a statistical analysis of these assemblies. The intention of these methods is to provide an intuitive view of the complex relations between tolerances and resulting geometry.