AN EDUCATIVE APP FOR TOPOLOGY OPTIMIZATION

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Summary Smartphones and tablet PC's are getting more and more popular and represent interesting platforms for educative and entertaining engineering software. Built-in processors are fast: presently often dual-core and even more cores are expected for future generations. Hence, these platform can easily run advanced engineering codes based on Finite Element analysis and even perform iterative optimization updates on the fly. In this paper we present our efforts in developing an App for mobile platforms that can perform interactive topology optimization of 2d structures. The App is expected to be relevant for engineering, architectural and design education.

In Denmark 33% of the population owns a smart phone. It is expected that the percentage of engineering students owning one is much bigger than this number. Apart from the basic phone options and built-in gadgets like GPS, compass and gyroscopes, smartphones posses very powerful processing units that may be used as game drivers or as basis for more serious educational tools.

The topology optimization method [1, 2] is a finite element based structural optimization tool which optimizes material distribution in a design domain in order to maximize stiffness or other objectives subject to a volume constraint. The TopOpt-group has since 1999 been hosting a web-based topology optimization Applet (www.topopt.dtu.dk, "Applets and Software", "Compliance Design") [3]. The Applet has been extensively used by engineering, architectural and industrial design students as well as a general audience and has by now been run more 200,000 times by more than 13,000 unique users. This code is passive in the sense that the user selects design specs (design domain, boundary conditions, etc.), presses a submit bottom and then waits for the optimization to be finished (usually 5-10 seconds) before he sees an animation of the design domain on his screen.

Partially to provide a more interactive software where the user can change design specs on the fly and partially to port the Applet to the mobile platform, we are developing a fully interactive mobile App. Here, design specs can be changed on the fly by pointing and moving fingers on the screen. With an efficient code, users will have an impression that the structure becomes "alive", constantly adapting to varying loads and boundary conditions. With this set-up it is extremely simple to learn and understand the influence of load-directions and support conditions and our experience with test-versions is that users get "addicted" to the App very fast. A screen shot of the prototype App is seen in the figure below.

In order to obtain the speed necessary for providing a fully interactive tool we are developing an efficient code based on multi-grid Finite Element analysis combined with a multi-resolution topology optimization approach [4]. The App is developed using the Unity3D (CITE: webref `http://unity3d.com`) game engine since this platform allows for both graphics and interaction, while making the resulting App portable to both major mobile platforms, i.e. iOS and Android, as well as the web. The FEM and optimization code is written in C#, and due to the cross-platform portability of the App, the code does not utilize any dense matrix kernels, e.g. BLAS/LAPACK.

Apart from describing the platform and its functionality we will discuss its potential for engineering education and present ideas for future developments and applications of related engineering Apps.

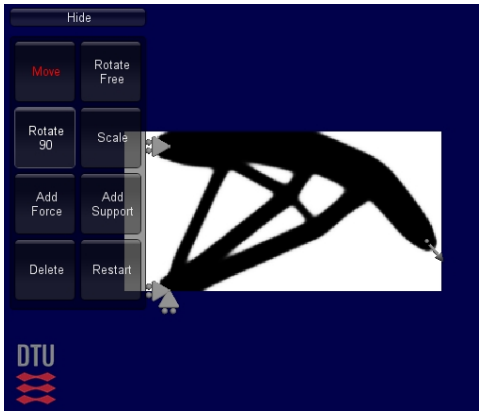

Figure 1. Screen-shot of Topology Optimization Mobile Platform App

References

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