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Flutter of aircraft wing using parallel processing

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Flutter of an aircraft wing is a multi-physics transient problem involving fluid-structure interaction. The aerodynamics over the wing provides the lift and the wing structure bends. The bent structure alters the aerodynamics flow and the altered aerodynamics further bends the structure. The structure and flow eventually may lead to dying of vibrations and making the structure stable. On the other hand under certain conditions there may be sustained instability and large deflections of the structure that may lead to eventual failure. This is a dreaded case as it leads to catastrophic failures. The flutter being free vibration usually takes place at the first few lower modes. In 3D wing, the flutter calculation needs at least 100 steps in one fundamental vibration period. The aerodynamics in each time step takes enormous computational time. The problem and flutter solution in the conventional manner of an aircraft wing structure will be discussed with the time domain results for the case of flutter. This computational time can be reduced considerably by adopting a parallel processing algorithm. This paper discusses the parallel processing that can be employed for aerodynamic flow by considering several volumes around the pressure and suction surfaces rather than the whole volume considered in a conventional computer code. First a steady state solution of the problem with inlet boundary conditions of state quantities can be performed. From this solution, the state quantities at the inter-connecting boundaries and their connecting conditions are determined. In parallel processing, each control volume is solved separately in different processors separately and combined them to give the conventional solution. An iteration procedure may be adopted in subsequent time steps rather than solving the fluid problem in all time steps. This will reduce the computational time drastically.

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