A CAS routine for obtaining eigenfunctions for Bryan's effect

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Lecture Proposal for the TI-Nspire & Derive Strand

ABSTRACT

Vibratory gyroscopes are used in the navigation of submarines and space-shuttles. The operation of these gyroscopes is based on Bryan's effect, namely: "when a vibrating ring is subjected to rotation in inertial space, the vibrating pattern rotates in the ring at a rate proportional to the inertial rotation rate". Consequently, an easy mathematical treatment of the principle on which they operate is a nice real-life application of mathematics suitable for senior undergraduates. We expand on the lecture given at Dresden TIME 2006. In that lecture, unknown eigenfunctions were used to derive an expression for Bryan's factor (the constant of proportionality referred to above). At that stage we found that the derivation of these eigenfunctions was too advanced for junior postgraduates to understand. However, in the interim we have discovered an easy routine for iteratively determining these functions using the NDSolve routine of the computer algebra system (CAS) Mathematica. All mathematical expressions are simplified using the CAS from basic formulae that can be found in standard textbooks. With this approach (using the CAS at every step) it is possible for senior undergraduates to effortlessly calculate the eigenfunctions that are necessary to determine Bryan's factor.

Keywords
Bryan's factor, Iterative process, Senior undergraduates, CAS, Mathematica.