Abstract

Control of systems are important in most industrial sectors, they find applications in electronics, machine design and navigation. These control systems often use sensors to work effectively. One such sensor is an accelerometer, which is used to measure acceleration with one or more degrees of freedom. This research report investigates the modelling, system identification and controller design for an accelerometer, a Fibre Optic Accelerometer (FOA). Such a device may be applied in many applications such as anti-skid control, structural failure in buildings and bridges, as well as strategic missile guidance. This report presents a model of a FOA demonstrator which crudely models an industrially developed accelerometer, the demonstrator is made of a jig consisting of a guitar string and electromagnets. Such a model needs to account for a distributed parameter beam combined with a permanent magnet and four electromagnets. The guitar string is modelled using three beam models, namely a spring/damper model, an Assumed Modes Model (ASM) and a Transfer Function Model (TFM). The parameters for these beam models are identified using the Nelder-Mead simplex algorithm and the least squares method. The electromagnets within the jig, are modelled using a mathematical model obtained through curve fitting of experimental data. The overall FOA sensor is optimised using a lead-lag controller. Five cost functions where investigated, these cost functions are H_∞, Integral Square Error (ISE), Integral Absolute Error (IAE), Integral Time Square Error (ITSE) and Integral Absolute Time Error (IATE). It was found that the guitar string may be modelled using a single degree of freedom beam model. This is based on a number of reasons, such as the aperture size - through which the tip Light Emitting Diode (LED) projects, the tip mass (permanent magnet) - acting as a natural damper and the fact that Position Sensing Device (PSD) only measures the tip position. It was found that a single degree of freedom model in two orthogonal axes, with a single link beam spring/damper model was the most suitable representation of the guitar string. And the IAE lead-lag controller was found to be the most effective in controlling a guitar string, this effectiveness was due to least settling time.