Load Bearing Interface Design for a Pan-Tilt Mechanism for Severe Marine Environments

by

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Submitted to the Department of Mechanical Engineering
on May 12, 2017, in partial fulfillment of the
requirements for the degrees of
Naval Engineer
and
Master of Science in Mechanical Engineering

Abstract

The Naval Research Laboratory (NRL) requested the design of a two-axis gimbal device for the shipboard support of a sensor payload. Previous design efforts presented a low-mass two-axis (pan and tilt) machine. Vibration and shock testing induced failure in the interface between the payload and the tilt shaft, through which the control cabling connected to the sensors, taking the system out of service and creating a hazard for Sailors. This thesis proposes a tapered, hollowed shaft and flange interface connected by an interference fit that is preloaded and retained by a single hollowed bolt for ease of maintenance at sea.

This simplified design is a departure from existing rotary tapered interfaces, such as seen in machine tooling, and focuses on connecting massive payloads to their actuators when subjected to severe loading. This design is uniquely suited to withstand large bending moments and loading as demanded by military standards for shock. A custom rig was designed and constructed to subject reduced-scale designs to military standard environmental testing for shock in the laboratory. These test results were analyzed using moving average filtering to develop confidence intervals to validate the design mathematics. A full-scale prototype was manufactured and subjected to shock testing and analysis. The design exceeded all requirements and is ready for immediate integration into the gimbal. This research also revealed the potential for tapered interfaces to connect massive payloads to their actuators in industry.

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