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A Force-Based Calibration of the Cervical Spine Motion Setup

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Abstract

Background: The work focuses on calibrating the cervical spine motion test setup developed to evaluate the implant's performance in stabilizing craniovertebral junction (CVJ) post neurosurgery. In this surgery bone element of the vertebrae causing compression to the spinal cord is removed, and these vertebrae are stabilized by instrumenting an implant in the CVJ. For the performance evaluation of the implant, the study is to be conducted on the cadaver. Hence the setup is developed, which can replicate human neck motion. In order to get accurate measurements, the calibration of test setup plays a vital role.

Objectives: The test setup is an integration of 1-DOF and 6-DOF parallel manipulators. The manipulator is manually actuated to measure the load needed to activate the instrumented CVJ implant. The force sensors are installed at base of the 6-DOF manipulator. Using the force data by sensor, the moment applied on craniovertebral junction is determined. Since the accuracy of measurement depends on calibration, the objective of the current work is to calibrate cervical spine motion setup.

Methodology: A test grid is used to carry out the experiment on the cervical spine motion setup. This facilitates loading at measurable locations along with the guides. The load was then applied at varying locations, keeping the legs and hence the pose of top platform locked, and force-moment combination exerted on top platform is noted. Corresponding to each load point on top platform, the load measured on each leg by force sensors was recorded. Also, a MATLAB program is written based on kinematics analysis of parallel manipulator [1] to calculate the force vector for known load.

Results and discussion: Using both experimental and theoretical results, the error is estimated. The correction factor is then evaluated and used to calculate force data when conducting the actual experiment to determine implant performance.

Conclusions and future work: The methodology for calibration of cervical spine motion test setup to evaluate the implant's performance is discussed. The evaluated correction factor is used to calculate force data while conducting the actual experiment. After calibration, the different implants are tested to know their performance when it is implanted.

References

[1] Tsai LW. Robot analysis: the mechanics of serial and parallel manipulators. John Wiley & Sons; 1999.

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