Sensorless Force Estimation on Fingertip with Gravitational Compensation for Heavy-duty Pneumatic Tri-grasper Robot

Addie Irawan* *, Mohd Iskandar Putra Azahar and Muhammad Afiq Hashimi*

Robotics, Intelligent Systems & Control Engineering (RISC) Research Group, Faculty of Electrical & Electronics Engineering Technology, Universiti Malaysia Pahang, Pahang, Malaysia

*addieirawan@ump.edu.my

ABSTRACT

The paper presents the proposed sensorless force estimator design for pneumatic robot fingertip by using gravitational compensation and pressure changed in pneumatic cylinder piston. The approach is done to replace the commercial force sensor that may be expensive for heavy-duty configuration. The formulation was done by considering the torque of robot's finger joint, finger dimension as well as its actuator and the different pressures in cylinder piston. The gravitational force is calculated from the geometry of the robot's finger as dynamic gain for the force of pneumatic cylinder. The proposed method is validated on a heay-duty pneumatic Tri-grasper Robot with the simple basic movement and blocked randomly by human barehand. The results show that the force output by the estimator is almost identical to the loadcell sensor that attached on the fingertip at about 2% error in average. The sensitivity is a bit low for small and fragile material but enough for heavy-duty application that generally with hard and rough surfaces.

KEYWORDS

force estimation, force cylinder, gravity compensation, pneumatic robot.

ACKNOWLEDGEMENTS

The authors would like to thank the Ministry of Higher Education for providing financial support under Fundamental Research Grant Scheme (FRGS) No. FRGS/1/2019/TK04/UMP/02/1 (University reference RDU1901106) and Universiti Malaysia Pahang for laboratory facilities.