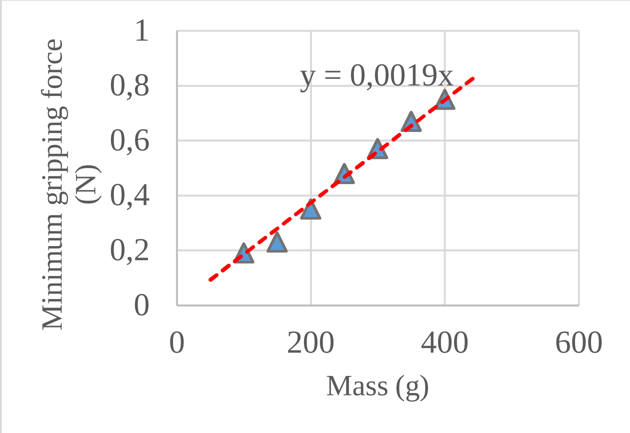

Fig. 6 Linear relationship between mass of the object and minimum gripping force

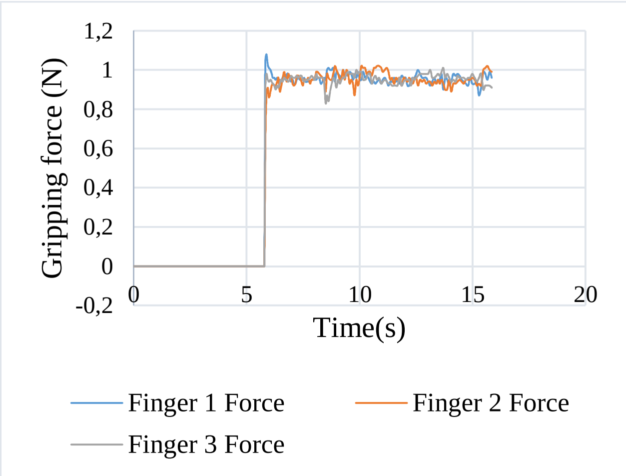

Fig. 7 Stable grasping of 500g mass with 0.95 N

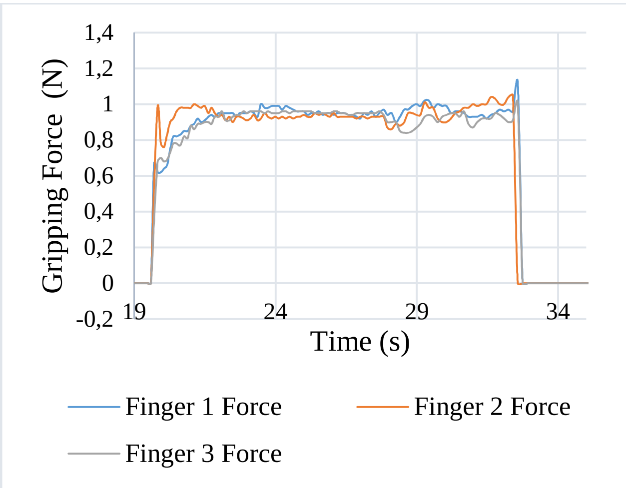

Fig. 8 Unstable grasp – slipping of 500g with 0.94 N

IV. Conclusions

This research was started with developing three finger hand model in Solidworks. After the assembly of the robot hand was done, the prototype was developed by 3D printing. The soft pad was attached to each fingertip in order to have the soft manipulations. High torque DC gear motors with encoders were used to drive the joints. A force-sensing resistor (FSR-402) was attached to the tip of each finger and surfaced with a soft and deformable material in order to measure the contact force. The system is implemented using Arduino Mega 2560 as the micro-controller. PID control systems have been embedded inside the program loop. The experiments were conducted with different masses, and the lowest gripping force for each mass was recorded. From the experimental results, a linear force relationship equation was arrived as $F_{min} = 0.0019x$, where x is the mass of the object to be grasped. Consequently, the linear relationship expression was verified for masses of 500 g and 600 g. In both instances, the prediction proved to be correct. An optimum grasp force will result in an overall efficient operation while providing other advantages such as preventing damage to the grasped object and mechanical wear and tear.

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