

Automating Anti-Vibration Glove Testing following ISO 10819

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Abstract— The goal of this project is to create a biodynamic mechanical hand capable of producing and maintaining at least 40 Newtons of grip force inside a variety of anti-vibrational gloves. While gripping a 2-inch rod mounted on a dynamic shaker. The development of biodynamic artificial hand is designed to Automate the ISO 10819 testing standard process allowing for continuous testing and data collection creating ideal assessments of anti-vibrational gloves. The device will also eliminate the need for human testing, which is currently the method being used in industry at the moment. The hand is to be mounted and operated by a FANUC LR MATE 200ic robot with the capability to maneuver the hand into the desired position and initiate the grip force onto the rod. The full automation of the ISO 10819 will expand the amount of data being collected while allowing for trends within the material type to be identified. (*Abstract*)

Keywords-component; formatting; style; styling; insert (keywords)

I. INTRODUCTION

ISO 10819 is the gold standard certification, used as a procedural guide to test anti-vibration gloves, to deem them acceptable for public use. It ensures that the gloves design can reduce the vibration transmitted from powered handheld tools to the user's hand. Reducing the damage being done over long periods of time in order to decrease the possibility of developing Hand-Arm Vibration Syndrome (HAVS). This syndrome causes sensory dysfunction, vasospastic problems, Secondary Raynaud's phenomenon of the hand, and Musculoskeletal problems [5]. Those most affected work within construction, maintenance, and lawn care fields.

Symptom's may not arise until 10+ years of repeated vibration exposure depending on the individual's hand structure [5,4,7]. The current testing procedure used to certify anti-vibration gloves involves an individual physically wearing a glove designed to nullify the vibration while gripping a 5.08 mm rod attached to a electrodynamic shaker which exerts low to high frequencies onto a test subject using the rod as a conduit. Humans are currently being used as test subjects to measure the efficiency of various gloves designed to dampen the vibration transmitted from the tool to the hand of the user.

Considering that the test subjects can have future complications due to prolonged exposure to high or low vibration frequencies, this method of testing the gloves can be classified as un-ethical and dangerous for those who volunteer or get a small compensation to become a test

subject. The project's main purpose is to develop an artificial hand to be used in an ISO 10819 testing procedure. This artificial hand replaces human testing currently being used. The technology currently available makes it possible to create a substitute hand. Designed to analyze the efficiency of anti-vibration gloves, while making the testing procedure more efficient. With an adequate design testing eliminates risk to the human subjects while producing a more standardized process for evaluating the functionality of various anti-vibrational gloves aimed at damping vibrations transmitted to the human hand. The design includes a minimum 40 newton grip force to ensure the gloves material and design are being fully assessed within the testing processes. Introducing a high fatigue limit ensures the structural integrity of the device under high or low vibration frequency caused by continuous testing. Hand size must be comparable to the average human hand to ensure all glove designs fit. The hand will be made in a specific way for it to be mounted into a FANUC LR MATE 200ic robot which will also maneuver and control the internal mechanism used to exert a gripping force of 40 newtons.

II. DESIGNS

The structural integrity of any device with multiple small mechanical components can be comprised by excessive vibration exposure, this vibration leads to malfunctions in hand movement and the possible deformation of the mechanical hand. Therefore, the mechanical design and material used to construct this mechanical hand are chosen carefully to ensure the structure integrity of the hand is maintained.

Within a FANUC LR MATE 200ic manual the J6 axis is referred to as the *end effector* this interface will be used to control the hands' movement and grip force as it rotates, the robotic arms programming makes it possible with its simple panel outline. The manual also introduced a motor rotation limit of 720 degrees this was taken into consideration within the design phase.

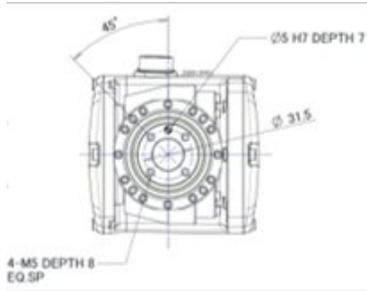


Figure (1) FANUC LR MATE J6- axis [8]

The coupler designed by the team is termed “The Puck” it is responsible for converting rotational motion to a linear motion, connecting the artificial hand to the J6 axis, and maintaining the grip force throughout the process. The second component designed by the team is the palm to puck coupler. This coupler is round on one side while it is rectangular in shape on the other, it is meant to hold the palm on the rectangular side while latching on to the puck through the other side. This component is responsible for maneuvering the pathway of the braided cable from a linear path to a radial pathway in order to distribute the force vector on the puck, locking both the puck and palm in place, and translating the linear force used to maintain the artificial hand on the dynamic shaker. The palm designed by the team is made so the braided cable can travel through it, while housing a system to allow the hand to open again. The last components are the fingers which were made to be 12.5mm in order to represent human bones while allowing for flesh-like materials to be added in the future making the testing more realistic in nature.

III. MATERIAL AND METHODS

The material for this biodynamic artificial hand was chosen specifically for prototyping, and testing, meaning the material had to be easily machinable and durable for continuous testing. Using NIU’s makerspace 3D printer for the complex components, the Machine shop & E-Machine for the metallic components. Aluminum 6061 was used for the metallic components, and film resin was used for 3D components.

IV. RESULTS AND DISCUSSION

The biodynamic artificial hand was tested and analyzed using simulators, giving validity to the basic design model created. The resulting hand model allows for the application of a tissue like material, such that further testing and analysis may proceed.

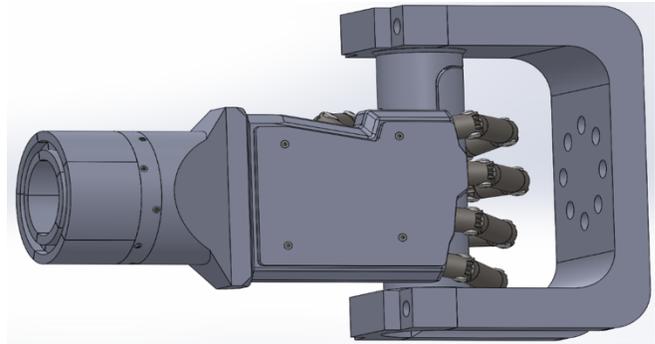


Figure (2) Bio dynamic artificial hand gripping dynamic shaker handle.

Reduction in the cross-sectional area of the analogous phalange encourages broader material selections for the outlying surface of the assembly concerning the need for vibratory damping. Computational models portray the function of the phalange joint assemblies as intended, such that sufficient static resistance may be developed to cope with the dynamic loading conditions in which they will operate. Peak loading stresses developed within the transmission cable governing the grasping motion of the assembly described the possibility of failure with respect to the initially chosen cable.

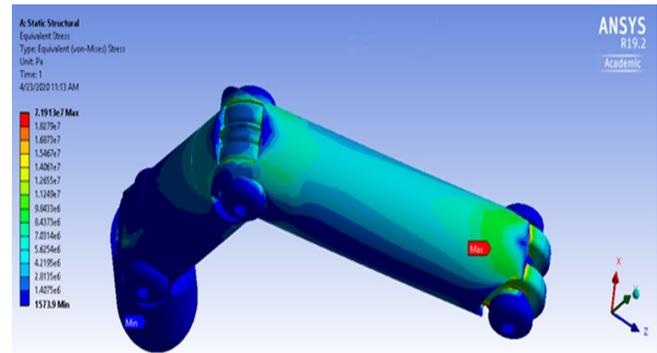


Figure (3) Ansys force simulation on index finger

Expansion of the pathways governing the transmission cable dimensions were expanded to allow the use of larger cables in the event of physical testing failures. Vibratory testing, in the theoretical sense, would be largely founded with no reasonable data derived from a computational simulation. Thus, it was applicable to use static analysis to drive the spring selections that dictate resistances that relate the developed motion of the hand assembly to the subjected vibration metrics used during testing. Each element of the hand assembly asserts realistic design concepts alongside a demand to narrow the sight of future project limitations.

V. CONCLUSION

Manufacturing a biodynamic artificial hand used in automating the testing safety procedure for anti-vibrational

gloves will reduce the number of human subjects exposed to the procedure. The device creates other benefits such as retaining a baseline variable to which each separate glove can be compared to. Meanwhile the hand can be altered in different ways to better mimic another person's hand with known vibrational properties such that to keep the tests valid for ISO 101819. Anchor points to allow other types of materials to be added thus changing the vibrational response. More real-world experimentation can be done to adjust further how accurate the hand will be to a human's hand holding the dynamic shaker. The mechanical hand needs to have a different vibrational response, material can be adjusted to different types of human hand sizes, densities, lengths. With this added material in mind the smaller frame built provided some challenges in simulations with stability during vibrational forces. Some of these challenges stem from the fact the simulations provide data on certain assumptions that will not be the same during real world testing. Analysis on the phalanges confirmed some of the original problems concerning the transmission cable that can be possibly solved on a later date. The device as it stands has the theoretical ability to grasp with 40N-100N force from the torque of a FANUC arm with no substantial concern of vibrational failure.

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