

**MECH 4v98.001 Undergraduate Research in Mechanical engineering
Spring 2016
Topic: Design and Development of Humanoid Robots**

Instructor: Yonas Tadesse email: yonas.tadesse@utdallas.edu

Recently a 3D printed humanoid robot equivalent to a size of seven years old child was developed in the HBS lab using a combination of servo actuators and shape memory alloy materials[1]. The robot was designed based on Design for Assembly (DFA) and Design for Manufacturing (DFM) concepts. Some experimental results were presented on the performance of the robot showing its articulated movements. The hands are actuated by shape memory alloy (SMA) wires that are housed in the forearm[2]. This robot can potentially be used in many applications to assist human beings [3]and for the development of prosthetic hands. The objectives of the research are to answer the following questions by fabricating prototypes and generating data.

1. What should be the best placement of actuators? What type of actuators should be used to improve the current design?
2. How will be the performance of the humanoid hand affected if the SMA actuators are replaced by nylon muscles that were discovered in 2014 and applied in some humanoids[4]?
3. What will be the characteristics of the robot hand and how this hand can be used in prosthetics?

To answer the questions 1-3, the students will read literature (max, 3 students for this class), create or prepare artificial muscles, develop prototypes and test prototypes, and write report. There will be a weekly report for all the research activities.

Topics

- 1. Literature review and how to search papers**
- 2. Review Article 1** “BS-1: A Modular Child-Size 3D Printed Humanoid”
- 3. Review Article 2** “Humanoid robot hand with sma actuators and servo motors”
- 4. Review Article 3** “The mechanical design of a humanoid robot with flexible skin sensor for use in psychiatric therapy”
- 5. Review Article 4** “Nylon-muscle-actuated robotic finger”
- 6. Working with SMA Actuators**
- 7. Preparing Nylon Muscles**
- 8. Midterm Report/ Presentation**
- 9. Weekly/ Biweekly Report**
- 10. Presentation in Group Meeting**
- 11. Final Report – Writing Assignment**

References

- [1] L. Wu, M. Larkin, A. Potnuru, and Y. Tadesse, "HBS-1: A Modular Child-Size 3D Printed Humanoid," *Robotics*, vol. 5, no. 1, p. 1, 2016.
- [2] L. Wu and Y. Tadesse, "Humanoid robot hand with sma actuators and servo motors," in *ASME 2014 International Mechanical Engineering Congress and Exposition*, 2014, pp. V04AT04A041-V04AT04A041: American Society of Mechanical Engineers.

- [3] A. Burns and Y. Tadesse, "The mechanical design of a humanoid robot with flexible skin sensor for use in psychiatric therapy," in *SPIE Smart Structures and Materials+ Nondestructive Evaluation and Health Monitoring*, 2014, pp. 90562H-90562H-11: International Society for Optics and Photonics.
- [4] L. Wu *et al.*, "Nylon-muscle-actuated robotic finger," 2015, vol. 9431, pp. 94310I-94310I-12.

MECH 4v98 Research in Mechanical engineering
Writing assignment
This is a turnitin assignment (to be submitted in eLearning)
Due: May 5, 2016 (@ 10:00pm)

As part of the research course, you are required to submit a technical report. The report should be similar to the research articles that you read in the semester. In this report, you will compile the literature and all PowerPoint presentations (weekly reports submitted) in a technical narration style. Basically, you will summarize all the weekly reports in a cohesive way (in similar way when you write a journal or conference paper). Submit a word document only. The word document should include the following: 1) introduction, 2) Literature review, 3) Research and (4) conclusion. Figures can be embedded in the report, but do not include unnecessary figures. If you take a picture from somewhere else, you need to cite the resource of the figure in your references. If the picture is your own (it could be a sketch or a picture that you took from a camera) citation doesn't apply.

Use Time New Roman Fonts, with font size 12. All paragraphs should be justified (ctrl +J).

1. Introduction (300- 500 words count)

- Motivation and a brief introduction that a layperson can understand
- Objective of the research

2. Literature review and summary (400- 600 words count)

- Cite the articles that you read and write in your own words what the articles are discussing.
- If you did not perform literature review, this section can be reduced to the lower word count limit.
- We have endnotes in all the lab computers and you can use them for your citation. Alternatively, you can use citation manager Reworks available at UTD library service.

<http://www.utdallas.edu/library/services/refworks/index.html>

3. Research activities/results/ discussion (500- 600 words count)

3.1 Research activities

- The research you performed in the semester. It may be two or more areas. In that case, group them in two or more.
- Experimental procedures, schematic diagrams, and their explanations
- Modeling or simulations depending on your project scope
- CAD files or design and analysis / programming code or debugging methods and approaches
- Figures can be embedded in the text. Make sure to discuss about the figures by citing them in the text. For example "as shown in Figure 1 xxxxxxxxxxx high actuation was obtained".

3.2 Results

- Results obtained. It could be concepts, CAD file, test results, measurements, or data generated
- Hardware description or documentation for better understanding of the a system or subsystems
- programing code or debugging or analysis

3.3 discussions

- Discussion about the results, challenges, success, remedies

4. Conclusions (100- 200 words count)

5. References (unlimited)

- Use either [1], [2] or by authors name either APA style or Chicago style

By Numbering

[1] Hirai, Kazuo, Masato Hirose, Yuji Haikawa, and Toru Takenaka. "The development of Honda humanoid robot." In *Robotics and Automation, 1998. Proceedings. 1998 IEEE International Conference on*, vol. 2, pp. 1321-1326. IEEE, 1998.

By Authors without numbering

APA style

Hirai, K., Hirose, M., Haikawa, Y., & Takenaka, T. (1998, May). The development of Honda humanoid robot. In *Robotics and Automation, 1998. Proceedings. 1998 IEEE International Conference on* (Vol. 2, pp. 1321-1326). IEEE.

Chicago style of reference

Hirai, Kazuo, Masato Hirose, Yuji Haikawa, and Toru Takenaka. "The development of Honda humanoid robot." In *Robotics and Automation, 1998. Proceedings. 1998 IEEE International Conference on*, vol. 2, pp. 1321-1326. IEEE, 1998.

Resources

1. Duke scientific writing

<https://cgi.duke.edu/web/sciwriting/>

2. Journal-Style Scientific Writing

<http://abacus.bates.edu/~ganderso/biology/resources/writing/HTWgeneral.html>