Self-Assembling Robots

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INTRODUCTION

Self-assembling robots are a new and innovative category of robots that are able to fold themselves up and move around without any human assistance.

- used in medical field
  - "dried pig intestines" in a frozen pill to work inside the body
- unfolding technique
  - origami approach where the robot unfolds
  - "box pleat pattern" used to fold a 2D piece of material into any 3D shape desired

This new type of robot paves completely fresh paths for the world of science and technology and potentially an entire different category of robots altogether.

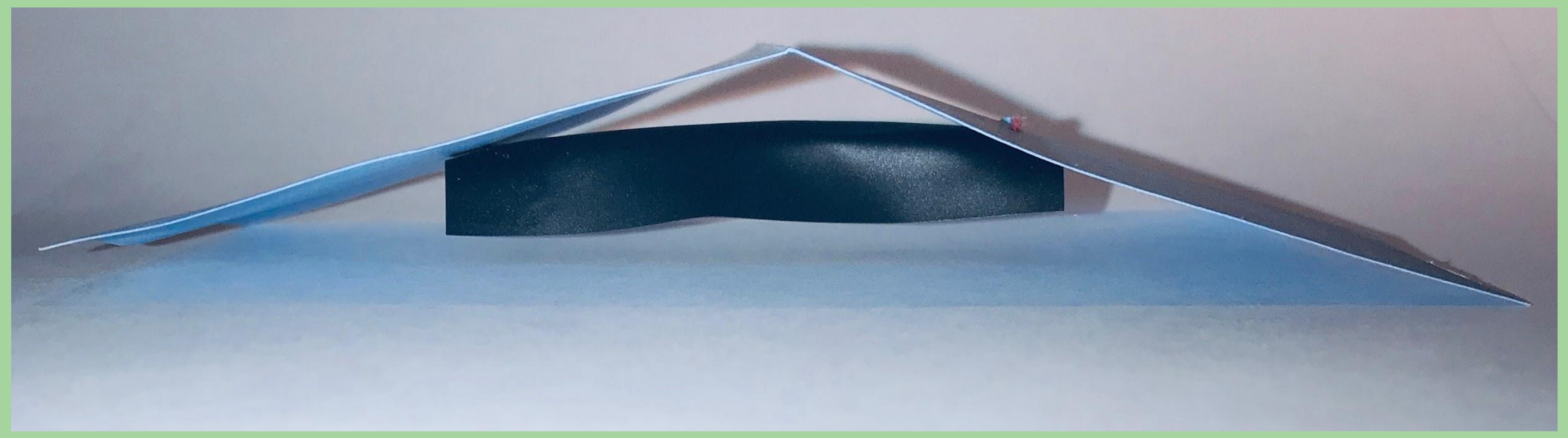
RESEARCH METHODOLOGIES

- experimental approach by making own model
- only use materials that are easily accessible to an ordinary person living in a rural area without access to expensive resources
- narrative research on own experiences doing model
- summarize and code data on own experiences
  - find trends of when no progress was made or when experimentation ran smoothly

DATA AND FINDINGS

In the very beginning, the structure was simple and easy to make. After finding heat shrink to pull the paper together and fold it, the first version of the model was made. The black strip in the middle is the heat shrink. Unfortunately, it did not shrink enough to effectively fold or bend the paper.

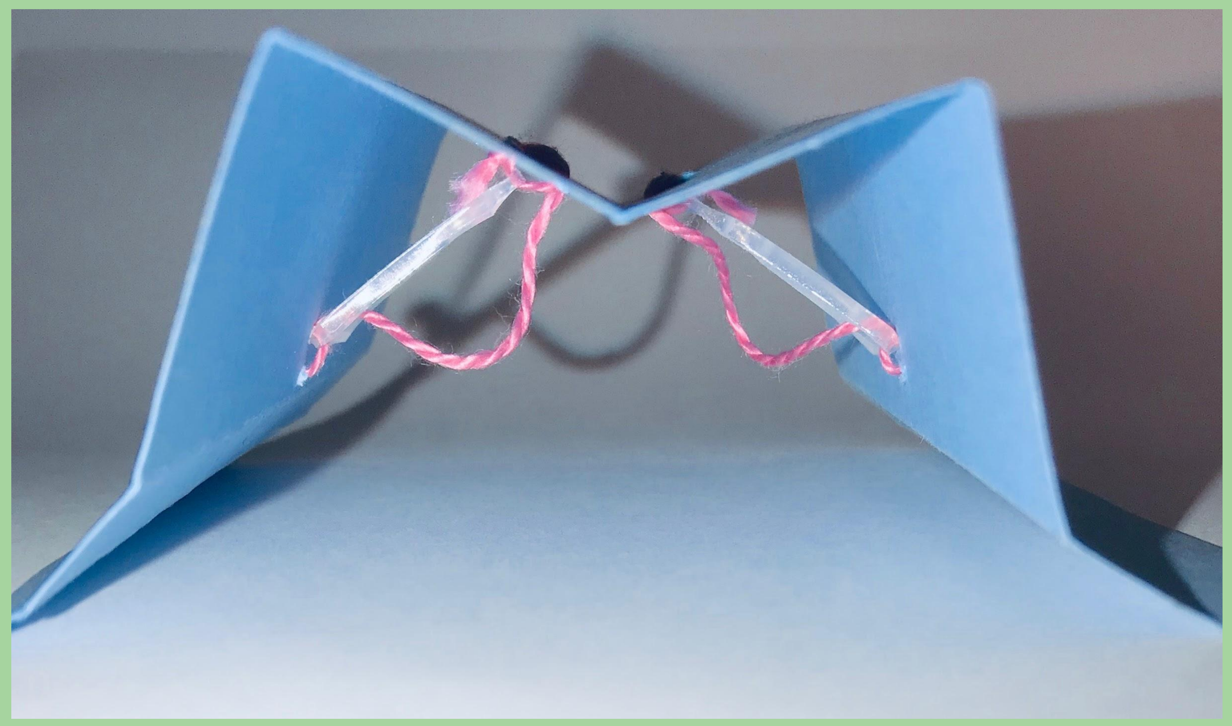
Figure 1: First Model



Idea	Materials	Build	Improve
Start with a simple idea of what you want the model to do	Find materials with the right properties for your goal	Put everything together and test it	Reflect on what worked and what didn't, then repeat the process

This is one of the later versions of the model with thicker paper and sewn-on pieces of shrinky dink as the heat reactive component. The structural integrity of the first model was too weak to stay up, and the heat shrink was difficult to shrink without human assistance of holding up a heat gun or applying something with high temperature. After finding new materials and purchasing them, the new version was built.

Figure 2: Current State of Model



CONCLUSIONS AND ANALYSIS

Building a simple model with materials available online is effective for learning about how a self-folding model works.

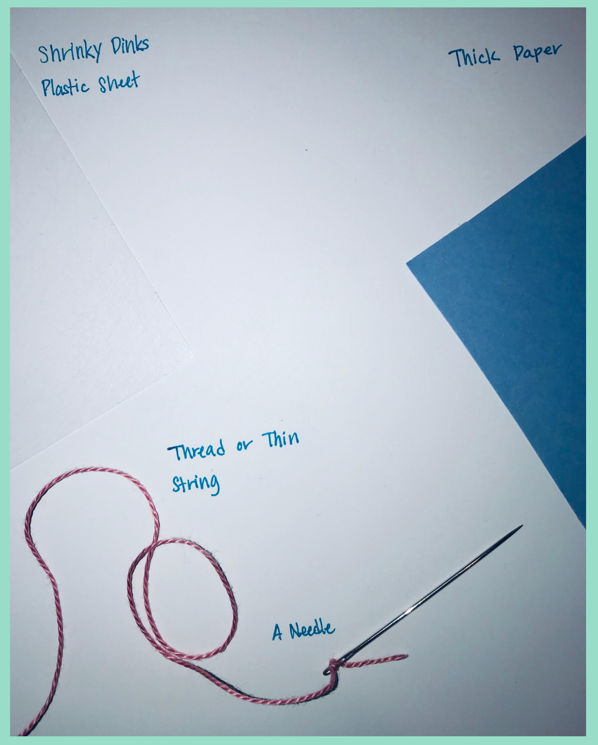
Self-folding robots use folding to start from a 2D shape and then bend where pre-creased to make a 3D shape. Heat is usually used to start the folding process without human intervention. Materials that change shape used to fold the model. There are many different sizes of this type of robot that can be used in the medical field and already used in space. In addition, there is currently a robot that folds inside the human body after being ingested.

IMPLICATIONS AND NEXT STEPS

Building a model is a great way to build interest and introduce people to self-folding robots, because it includes researching and hands on learning. It is also a great point to start because it only involves basic and introductory steps

Going forward, a few changes to this process should be made if it were used to teach how self-folding robots work mechanically and their applications:

- Having checkpoints that guide the person learning would be useful to help time manage the process
- A strict calendar with due dates for ever step or every cycle can prevent a stand-still in the process
- At some point in the process, whether it be before the start of the model and during the research phase, or during the building of the model, it would help to have someone experienced in the field or with self-folding robots to give advice regarding what to improve or different techniques/approaches



ACKNOWLEDGEMENTS / REFERENCES

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***Works Cited

1. (2011). DNA Nanotechnology Grows Up. *Science,332*(6034), 1140-1143. Retrieved from http://www.jstor.org.ez.pausd.org/stable/27977964
2. (2014, August 7). Robot folds itself up and walks away. Retrieved from https://wyss.harvard.edu/robot-folds-itself-up-and-walks-away/
3. Boroughs, D. (2013). Folding Frontier. *ASEE Prism, 22*(5), 24-29. Retrieved from http://www.jstor.org.ez.pausd.org/stable/43530838
4. Gaidos, S. (2012, December 15). Into the fold: Flat structures pop into 3-D forms, yielding miniature robots and tools. *Science News, Vol. 182 No. 12,* 22-25. Retrieved from http://www.jstor.org.ez.pausd.org/stable/23351033
5. Hardesty, L. (2010, August 5). Shape-shifting robots. Retrieved from http://news.mit.edu/2010/programmable-matter-0805
6. Merali, Z. (2011). 'Origami Engineer' Flexes to Create Stronger, More Agile Materials. *Science, 332*(6036), 1376-1377. Retrieved from http://www.jstor.org.ez.pausd.org/stable/27978046
7. Miyashi, S., Guitronm, S., Yoshida, K., Li, S., Damian, D., Rus, D. (2016). Ingestible, Controllable, and Degradable Origami Robot for Patching Stomach Wounds. *White Rose*. Retrieved from http://eprints.whiterose.ac.uk/110095/1/201605ICRA_MiyashitaEtAl_Preprint.pdf
8. Rosen, M. (2014, September 20). Heat-to-fold robots.*Science News*. Retrieved from http://search.ebscohost.com.ez.pausd.org/login.aspx?direct=true&db=aqh&AN=98259734&site=eds-live