PROJECT MCCLANE: DEVELOPING A PIPE INSPECTION ROBOT

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BACKGROUND

Pipes - What type of pipe, and therefore size, and then problem, would be addressed by the project

Table 1: An analysis of pipes used in buildings and their common applications

Field	Application	Common Diameter
Plumbing	Toilet Drain Pipe	3 inches
Electrical	Conduit	0.5-6 inches
HVAC	Round Ducts	4-41 inches
Civil	Storm Lines	12-36 inches

Bio-inspiration – An observation of nature's locomotion and climbing solutions

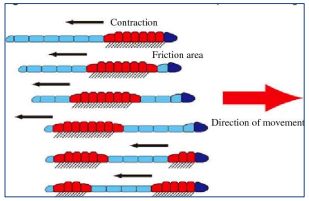

Fig. 1: Peristaltic worm-like motion (from 1)


Fig. 2: Lizard (from 2)

Locomotion – Methods being reviewed and researched for the robot design

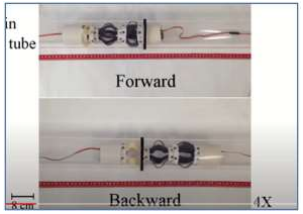

Fig. 3: Worm inspired robot (from 6)

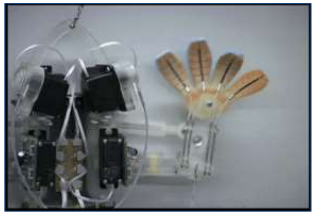
Fig. 4: Lizard inspired robot (from 4)


Fig. 5: Fiberscope robot (from 3)

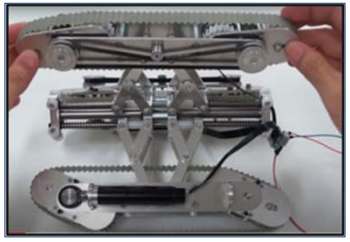
Fig. 6: Robot with treads (from 5)

ABSTRACT

Pipelines are an integral part of modern infrastructure. Whether they are installed inside, outside, or underground these systems require inspection and maintenance. The customer for this senior design project needs a robot that can maneuver through pipes, allow a user to perform visual inspections, and remove obstructions. The robots found through background research are insufficient solutions given that none of them fully fulfill the customer's requirements. Project McClane seeks to resolve these insufficiencies by improving upon existing pipe crawlers and bio-inspired robotic solutions. The team has made progress with customer contact, generating an initial requirements list, and conducting an initial literature review. Traditionally a solution is designed around a given problem and a set of requirements. Due to the undefined scope of the customer's needs the design process will diverge from tradition. A test structure made of pipes will be created first to constrain the problem and provide bounds in which the team can then design the pipe crawler. This project may provide a novel solution that can benefit a wide variety of industries for pipe inspection and maintenance applications.

MILESTONES

Table 3: Pertinent milestones and how they relate to the requirements

Progress	Name:	Requirement
Complete	Initial Literature Review	1-8
Complete	Choose Test Structure	1, 2, 3
Complete	Select Camera	7
In Progress	Locomotion Literature Review	4, 5, 6
In Progress	Obstruction Removal Method	8
Not Started	Decide Power Source	1-8
Not Started	Initial CAD	1-8

REFERENCES

[1] https://www.semanticscholar.org/paper/An-underground-explorer-robot-based-on-peristaltic-Omori-Nakamura/837ca5a56a299be36a3dfb549f1fde579ccff91e
[2] https://pixabay.com/photos/malagasy-taggecko-gecko-day-gecko-653653/
[3] https://www.youtube.com/watch?v=e-on4PAXgVk
[4] https://www.ted.com/talks/robert_full_learning_from_the_gecko_s_tail/
[5] https://www.fiberscope.net/pipe-inspection-robot/
[6] https://www.youtube.com/watch?v=EF5IDbcGhog
[7] https://www.pishop.us/product/raspberry-pi-camera-module-3/

REQUIREMENTS

Table 2: A list of the requirements of the project that are currently in progress

	The solution shall:
1	Weigh less than 23 pounds
2	Measure less than 2 inches in diameter
3	Measure less than 10 inches in length
4	Maneuver through horizontal pipe sections
5	Maneuver through vertical pipe sections
6	Maneuver through bent pipe sections
7	Visualize damage from inside the pipe
8	Remove loose debris from the bottom of horizontal sections of pipe

DESIGN PROGRESS

Damage Detection

Damage currently defined as – holes

- Raspberry Pi camera module 3 was decided upon and will be tested to understand the camera's capabilities within the testing environment.
- System will then be equipped with the small camera that will allow the user to view a video feed of the inside of the pipe and determine if any damage is present.

Fig. 7: Raspberry Pi Camera (from 7)

Obstruction Removal

Obstruction currently defined as - loose debris at the bottom along horizontal sections of pipe

The following methods of obstruction removal are under consideration:
- Small loose debris could be dislodged with pressurized air
- Large loose debris could be passed into a chamber within the robot either passively during locomotion or actively with a jaw-like mechanism

Mobility

The following methods are under consideration to achieve required mobility:
- Electric or pneumatic actuators to produce peristaltic motion
- Electric fan to propel a lightweight body through the pipe

Defining the Environment

- Factors considered in pipe selection:
  1. Opacity
  2. Sizing
  3. Material
  4. Cost
- Chosen test structure is a hamster maze
  1. Clear lets us see robot during testing
  2. 2 inches in diameter
  3. Polypropylene plastic
  4. $30 versus $400 or $4000 for PVC


Fig. 8: Testing set-up with hamster maze