Research Paper: Snake Robot Gripper Module for Search and Rescue in Narrow Spaces

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Read the research paper presented by your colleagues with the title

1.Category: What type of paper is this? A measurement paper? An analysis of an existing system? A description of a research prototype?

- Paper Type: An Analysis of an existing system. As it's clarifying the robot building step by another, and concerning about why they used this component in detailed analysis, then proceeding with presenting their aim from choosing this gripper module over the other.

2.Context: Which other papers is it related to? Which theoretical bases were used to analyze the problem?

- Other Related Papers:
  1. Using kinesthetic input to overcome obstacles with snake robots Click Here
  2. Design and architecture of a series elastic snake robot Click Here
  3. Snake Robot Urban Search After the 2017 Mexico City Earthquake Click Here
  4. Task-Space Control of Articulated Mobile Robots With a Soft Gripper for Operations Click Here
  5. A Dual-Mode Actuator for Soft Robotic Hand Click Here
  6. A Versatile Gripper for Cloth Manipulation Click Here
- Theoretical Bases:
  1. At first, the problem is accessing the narrow spaces which may include dangerous conditions, debris, fire, suffering human. So, CMU (Carnegie Mellon University) deployed a snake-like robot as a biomimicry.
  2. Then, How to visualize what happens inside the narrow spaces? They made only a one camera head without neither sensors nor grippers.

3. Later by Tanaka, the soft omnidirectional gripper was presented as T^2 snake-3 robot. This helped in grasping object and rotate freely in a valve.
4. Now, the gripper should be suitable and adaptable to whatever the object's shape is. That's why along the paper sections' journey, they are trying to find out an optimized actuated and free moving gripper (with some DOFs) to grip any object.
5. Some of it focuses on mimicing the human hand which can grasp several things, they are discovering different gripping modules.
6. The other sections are discussing the gripper module kinematics, electrical and mechanical perspectives, results for the experiments validations.

As a moral, they used the method of solving the problems one by another. So, they introduce the small problem, solve it, then the other , then its solution and so on.

3.Correctness: Do the assumptions appear to be valid?

- For any Project, we don't need to find a general solution for it, it's something so advanced to do that. We only need to make a unique solution.
- We also can't work in the space as it is, we have to make some restrictions or as it called in the robotics field *"Boundaries"*.

In this paper, they assumed some boundaries to achieve the goal such as:

1. The diameter of the narrow space should equal the maximum diamter of the snake robot. This is acceptable and appeared to be valid.
2. Another one which is assuming that the environment is harsh and dangerous, so the camera and sensors should be inside the robot as they are light and soft, so this is also valid.

4.Contributions: What are the paper's main contributions?

- Contributing with developing adaptable gripper module which -in this case- is "3 fingers gripper to collect and grasp any object even the irrigular ones. This is done after examining several gripping modules invain, each one has its defect."

5.Clarity: Is the paper well written?

- Yes, the paper is pretty easy to be read by beginners and the reading haters. But overall, it's different from the common research papers theme, as there are some missing sections like: (Analysis - Discussion and Results - Recomnmendations). This paper used some other sections instead which

ease the topic to be understood. So, the answer to the question of "Is it well written or not" can be **YES** or **NO** according to the reader level of proficiency.

Please suggest a modification that could be done on the proposed gripper that may enhance its capability for the desired purpose.

First of all, before Introducing modification tot he system, we have to present the defects -from my point of view- firstly.

1. The camera and one of the gripper fingers is a one part which will give it a freedom to look in multiple directions while the gripper is empty, one the fingers are busy by holding an object, the camera can look only to a unique direction.

2. The gripper mechanism while leaving the accomodation space in the robot to begin the USAR (Urban Search And Rescue) tasks. This mechanism is not practical at all in the narrow spaces.

- For the 1st problem: The solution I think is displacing the camera to a fixed position to fix it on. In this way, the camera can be put on 2 servo motors assisting its rotation to navigate 360.

- For the 2nd problem: The solution I guess is developing slider crank mechanism inside the robot and the gripper would be treated as the slider, as when the gripper is not needed, it's in his accomodation, when it's needed, it will slide to the front to go and make its mission.