

Title, introduction and drafting of the paper

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Task 1 - 3 title options:

1. Experimental analysis on gripping technology using granular 20 different granular jamming material parameters.
2. Experimental research on suitability of granular jamming for crane-scale lifting
3. Finding material parameters that give heavy lifting capabilities for granular jamming grippers

Task 2 - Introduction

Introduction

Cranes have made their way to every industry where heavy objects need to be lifted. The technology around lifting heavy objects has always relied on strong hooks and some manual labour to attach the target object in various ways to the hook. Conventionally, in overhead crane lifting the object to be lifted are attached to the hook via chains or ropes. This system, having two mass nodes attached via ropes is prone to double pendulum dynamics (Kim, D. and Singhose, W., 2010). Also, this system requires workers to constantly work around the dangerous environment around the hook. In order to achieve more efficient and safer crane lifting, a universal gripper could be implemented.

Gripping technology in robotics has taken lots of big steps recently. Gripping technologies can be divided naturally in to 3 different categories; actuation, controlled stiffness and adhesion [soft gripping paper]. Actuation basically covers all of the traditional gripping technologies such as different rigid jaw grippers. It also covers the compliant materials that deform during the gripping process and thus dividing the pressure evenly. (Check soft gripping paper chapter 3 to add more stuff about gripping by actuation. It is in articles folder in Drive)

The idea behind controlled stiffness is that the gripper can be deformed in it's soft configuration to surround the target object. After the gripper has surrounded the target object, the gripper is then stiffened and thus it forms a grip around the target object. One example of this is granular jamming where there is a tight and air-sealed pouch filled with granular material. When the pouch is at its soft configuration, it can deform easily and it's contents can be considered as fluidic in macro-scale. After the air between the granular mass has been sucked out, the granular contents get jammed and the pouch stiffens to its deformed shape around the target object. Stiffness can be controlled also in alloys that change their phase in depending on the temperature. There are also some fluids that

respond to electric and magnetic fields by changing their viscosity. (Short review on shape memory materials chapter 4.4. and the adhesion review to be added. These are also in soft gripping paper that is in Drive)

Universal gripper could save a lot of time for crane operators. Currently crane operators have to use a lot of time for attaching their target object somehow to another object that can be lifted with a hook. Thus a lot of time could be saved with a universal gripper. Universal grippers are such that can lift objects with variable shapes [5]. Development in the robotics industry has led to promising results in lifting with granular jamming. For example, Empire Robotics has successfully lifted objects with a mass of around 10 kg with a 16.5-cm-diameter-gripper. Thus, this paper documents experimentation on different granular jamming -based techniques aiming to lift heavy objects.

Add theory around granular jamming and talk about possibility of increased strength in grip if air between granular mass is replaced with fluid.

Task 3 - Skeleton of the rest of the paper

Our paper structure should be IMRAD which stands for introduction, methods, results and discussion and with this guideline the table of contents might be following:

-----Methods section start-----

Topic

-Assembly scheme

- Single membrane gripper
- Multiple fingers
- Vacuuming machine / filters for air as a medium substance
- Hydraulic pump for fluidic medium
- Other components and CAD-model
- Everything else a peer needs to know about the setup for repeating our

experiments.

-Material parameters

- Grain size (30mm-65mm / 65mm-90mm) if they were mm in the source
- saw dust as granular substance/some rocks as a substance/ something better
- Air as a medium substance / fluid as a medium substance
- Gripping membrane size
- A fine table of material parameters

-----Results section start-----

Topic

- Plots on effect of material parameters compared to max lifted kilograms.
- Noticing if some methods failed
- A table of material parameters with a classification(True/False) of suitability to lift over 100kg

-----Discussion-----

Conclusions/discussion

- The goal of this experimental research was to analyse if granular jamming technology would be suitable for heavy lifting.(Repeating the research question in the beginning)

- Then talking about the acquired results which indicate that yes there definitely is potential to in granular jamming to build a universal gripper that would lift up to xxx kg weighing objects. Or Talking about the acquired results that definitely indicate that there is zero potential at all in granular jamming to form the basis of universal gripping technology in heavy lifting.

References and read articles related to our topic:

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