Design of a closed-loop visuo-tactile grasping architecture with the GRIP software framework

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Goal

The purpose of vision-based grasping algorithms is to control the operation of the end-effector so that the gripper can grasp any object successfully.

However, the generated poses can result in unstable grasps, leading to objects slipping or falling from the fingers of the gripper.

For this reason, we present a closed-loop visuo-tactile grasping pipeline ensuring that grasps are robust before carrying out the rest of the task.
The pipeline is demonstrated in a scenario where precise placing of the object is crucial.

Introduction

Integrating and coordinating state-of-the-art software and hardware components proposed in the literature is a challenging task. For this reason, we propose GRIP [1], a ROS based software framework that facilitates robot programming for manipulation tasks with integrated software and hardware.

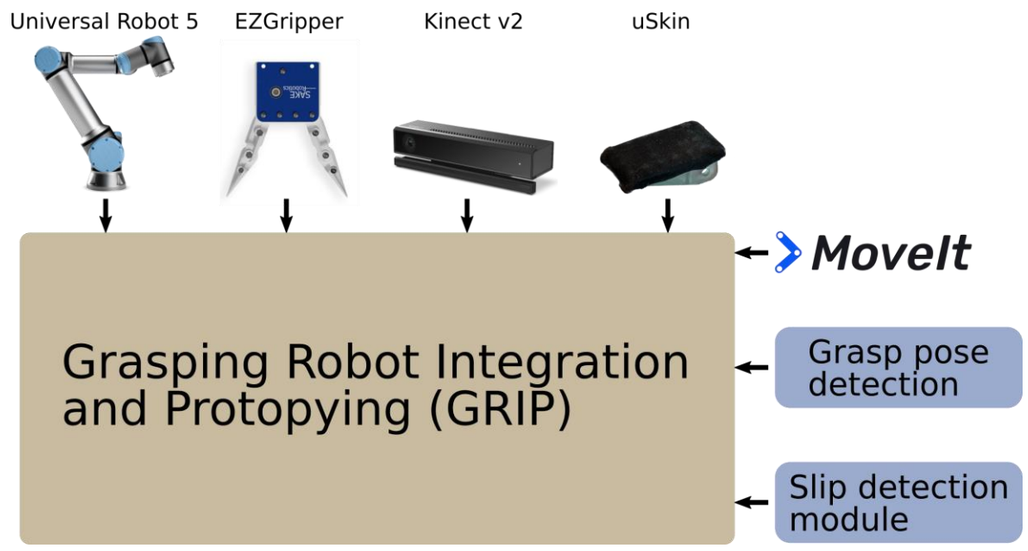
Proposed Method

We propose in this work to combine two components proposed in the literature to carry out this task; a point-cloud based grasping algorithm [2] and a slip detection model [3] based on the uSkin sensor [4].

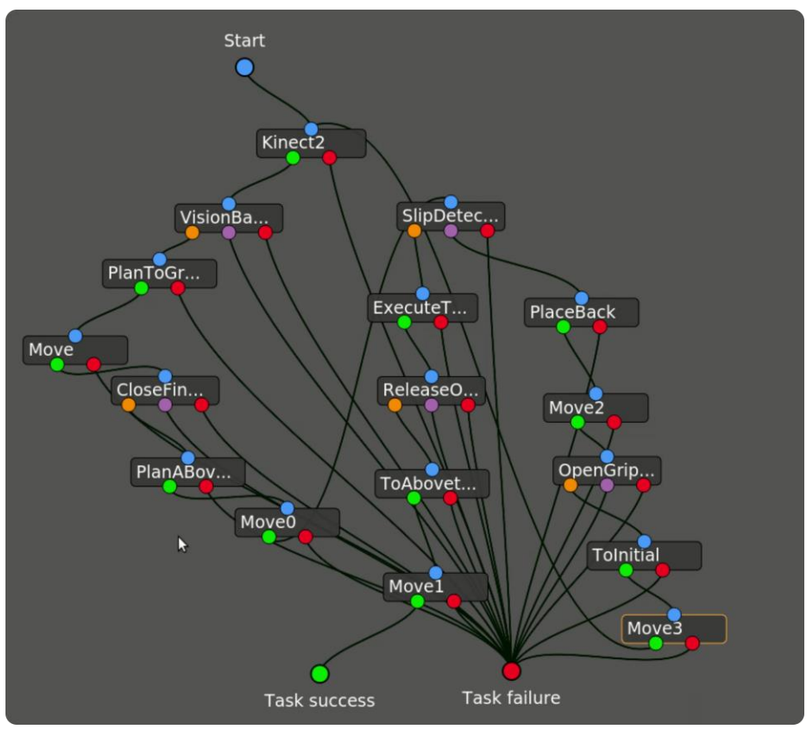
After grasping an arbitrary object, the slip detection module is run and if a slip is detected, the object is placed back on the table and the task is repeated until a stable grasp is found.

Once the object is robustly grasped, the robot places it in a pre-defined location.

Using GRIP



Integration of our robotic setup to GRIP



Design of the task using graphical programming via GRIP's GUI

Execution

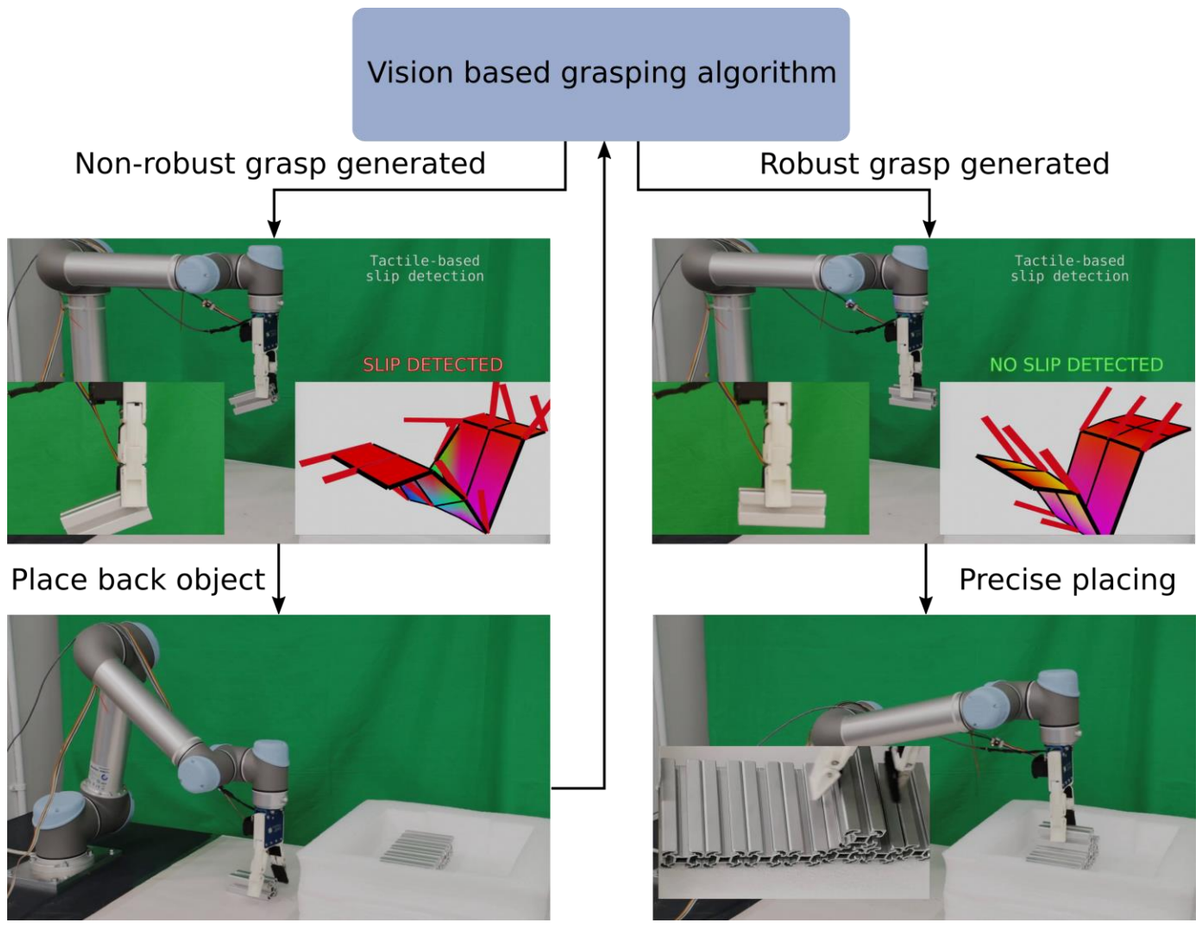
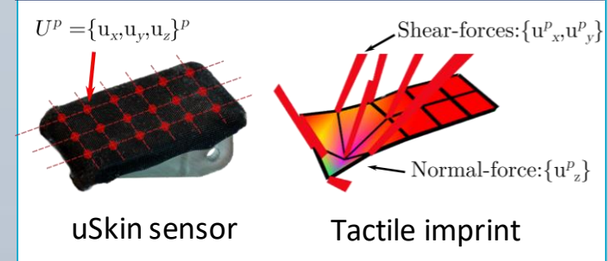


Illustration of the execution of the visuo-tactile closed-loop system

uSkin sensor



uSkin sensor | Tactile imprint

The uSkin sensor [4] has 18 sensitive pins distributed in a 3x6 layout. Each pin measures the magnetic field changes induced by the displacements of a small magnet (Hall effect principle).

A piece of fabric creates an artificial skin that reacts to stretches and friction. Contacts with the sensor induce distributed shear and normal forces, across its surface which are locally detected by each individual pins.

During grasping, the deformable surface is stretched due to the object weight. Upon slips, the elastic forces cause the pins contained within the contact area to shift against the slip direction.

Conclusion

In this work, we illustrate the benefits of GRIP to intuitively integrate and run a set of hardware and software components with minimal overhead.
The software allowed us to quickly (approx. 30min) protoype a visuo tactile closed-loop pick-and-place system for precise placing.

References

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