POSTER

# GRASPhere: A Prototype to Augment Indirect Touch with Grasping Gestures

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## Abstract
We present in this work GRASPhere, a prototype device that enables users to select and manipulate on-screen objects with grasping gestures. We demonstrate GRASPhere as an extension of a widely-employed force-sensing device, the Phantom OMNI. The hardware design of GRASPhere employs a minimum of components that cost less than $20, which makes our prototype easily replicable for practitioners interested in incorporating grasping gestures into their own force-feedback interactive applications. We discuss application opportunities for GRASPhere, such as exploring multimedia data with physical metaphors and providing assistance to people with visual impairments during indirect touch interaction.

## CCS Concepts
• Human-centered computing~Gestural input;

## Author Keywords
Grasping gestures; haptic feedback; Phantom OMNI; prototype; object selection; object manipulation

## Introduction
Direct touch enabled by widely-proliferating touch-screen devices, such as tablets and smartphones, allows users to select and manipulate on-screen objects with

simple taps and touch gestures. However, many application requirements (*e.g.*, interacting with content displayed on remote screens) or constraints determined by the physiological capabilities of the user group (*e.g.*, visually-impaired people) make direct touch interaction techniques unfeasible for a wide variety of interactive scenarios. Indirect touch enabled by pointing [3] and haptic feedback leveraged by force-sensing or vibrotactile devices [8,10] represent suitable alternatives for the case scenarios above. However, designing for indirect touch requires dedicated techniques; see Gilliot *et al.* [4] for recent work.

In this work, we propose a different perspective on indirect touch by augmenting it with *grasping gestures*: instead of simply touching on-screen objects, users grasp them. Next to touch, grasping gestures leverage the great dexterity of the human hand to interact with physical objects and, consequently, they have been explored for interacting with physical artifacts [5] and for recognizing object characteristics [11]. Beyond prior work, we focus in this paper on augmenting indirect touch with grasping gestures. Our contributions are as follows: (1) we present GRASPhere, a prototype device that we built to enable users to select and manipulate on-screen objects with grasping gestures. In its current implementation, GRASPhere works as an extension of the Phantom OMNI force-sensing device; (2) we discuss interaction techniques enabled by *touch* and *grasping gestures* used in conjunction; and (3) we discuss application opportunities for GRASPhere, such as exploring multimedia data with physical metaphors and providing assistance to people with visual impairments.

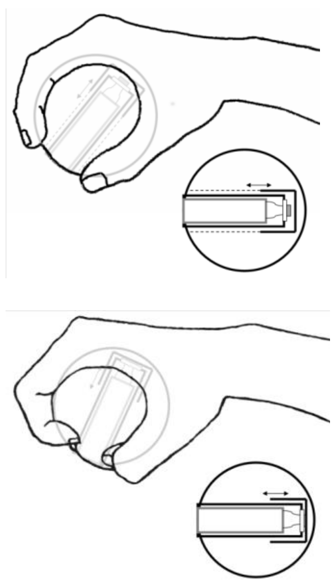

**Figure 2:** Schematic view of GRASPhere: grasping the polymer sphere closes a micro contact inserted inside.

## GRASPhere

We prototyped GRASPhere, a device that lets users grasp digital objects for selection and manipulation tasks. GRASPhere is a sphere made out of polymer material that contains a cylindrical hole of length 95% of the diameter of the sphere (Figure 1b). A plastic cap, a 6.35 mm jack connector, and a micro contact were inserted into the hole (Figure 1a) so that the micro contact closes when the sphere is squeezed (Figure 2). To demonstrate GRASPhere, we attached it to the Phantom OMNI [6], a popular force-sensing and force-feedback device, by replacing the Phantom's stylus with GRASPhere; see Figure 3 on the next page.

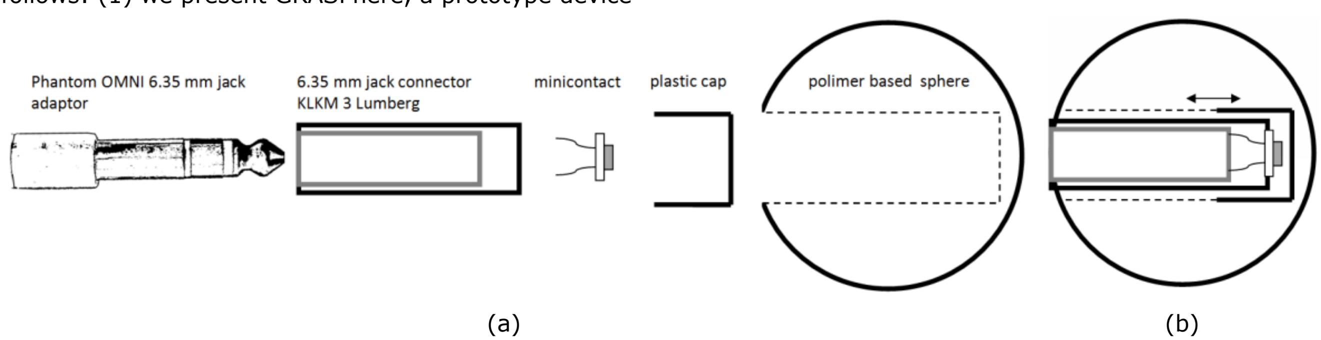


**Figure 1:** GRASPhere consists of a sphere made out of polymer material (b), in which a micro contact was inserted (a). Grasping and squeezing the sphere close the micro contact, which signals detection of a grasping gesture.

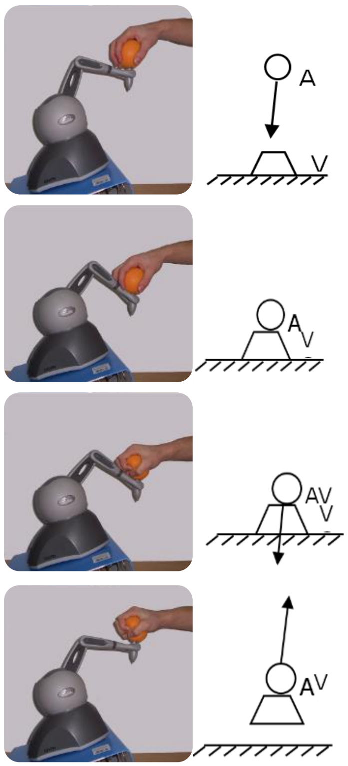


**Figure 3**: Illustration of a task performed with GRASPhere: the user approaches the object (a), touches (b) and grabs it (c), after which the object is lifted off (d). Note the different meanings and effects of *touch* and *grab* and the different consequences of the two operations. NOTES: images on the left show GRASPhere attached to the Phantom OMNI; images on the right depict representations of each atomic action.

## Interaction techniques enabled by indirect touch and grasping gestures

Grasping gestures augment indirect touch with physical manipulation in the spirit of tangible user interfaces (TUIs) [7]. GRASPhere makes possible selection and manipulation of an on-screen object by grasping it. For example, consider the task of picking up an object and moving it to a new location. The user first approaches the object (Figure 3a), touches the object (Figure 3b), grasps the object (Figure 3c) and, while keeping a firm grasp, moves the object to a new location (Figure 3d), after which the grasp is released. Note the different meaning of *touch* versus *grasp*, and the different consequences of the two operations.

GRASPhere can augment indirect touch for generic user interfaces in several ways, as follows:

a) Grasping an object *confirms selection* and provides haptic feedback to the user. Confirmation is important to prevent negative effects of unintended touches; see holdovers in Anthony *et al.* [2].
b) Touching and grasping gestures represent *different physical actions with different effects*. For example, while indirect touch selects an object, a grasping gesture takes exclusively control of that object and enables further operations on it.
c) A grasping gesture can act as a *shortcut command*. For example, grasping an object can popup a contextual menu or can directly execute a pre-defined action on that object, such as size manipulation, destroy the object, etc.
d) Grasping can be used to *switch between interacting modes*. For instance, grasping an object from a map switches the user interface from map navigation to object exploration. Releasing the grasp puts the interface back into navigation mode.

## Application opportunities of GRASPhere

The interaction techniques that we briefly exemplified for GRASPhere in the previous section are generic and apply for a wide range of applications. In this section, we discuss two application scenarios in more detail.

*Exploring multimedia data with physical metaphors*

The opportunity to grasp objects instead of just touching them can enrich user interfaces implementing physical metaphors [1]. Because haptics allow users to kinesthetically perceive the characteristics of the objects they interact with, the naturalness of using these interfaces is likely to improve. For instance, grasping an on-screen object may enable more control options rather than when the object is just touched, similar to how different affordances are exposed by physical objects when they are either touched or grasped. Grasping an object signals exclusive control, beyond the simple intention to control given by a simple touch. While hand gestures have been explored to augment direct touch for tabletops for more realistic and natural interactions [12], we believe that GRASPhere can augment indirect touch in a similar manner.

*Assisting users with visual impairments*

Grasping gestures are useful to assist people with visual impairments to explore and understand better a virtual environment through kinesthetic perception; see Pascale *et al.* [8] for prior work. For example, an automatic virtual tour of the environment can guide a user that has attached their hand to GRASPhere. Grasping the device determines whether the tour continuous or pauses. Haptic feedback provided during grasping can keep the user on track when passing nearby points of interests in the environment, while the amplitude of the feedback signals the attractiveness or the distance to those targets. Grasping gestures may also be used to effortlessly change the application state, such as switching between navigation and object manipulation. We believe that GRASPhere can provide an enriched experience for the users of a virtual environment [9] and can compensate the lack of visual cues with gestures and haptic feedback.

## Conclusion and future work

This work introduced GRASPhere, a prototype device that allows users to employ grasping gestures to work with on-screen objects. We believe that the extra degrees of freedom afforded by grasping gestures, as well as the force-feedback delivered to users when GRASPhere is attached to a corresponding device are worth exploring in the context of augmenting indirect touch. In the future, we want to evaluate GRASPhere for various applications and user groups to understand the added effect of grasping on indirect touch.

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