ABSTRACT
We introduce a physical media art installation in which the
user interacts with virtual characters by turning pages of a
physical book. The physical book is placed under a display
that shows the characters, a virtual book, and the user's
hands. The novelty of the system is in the tight synchroni-
zation between the physical book and virtual book and
the feedback to the user showing the captured hands on the
display.

1. INTRODUCTION
Imaginary objects have fascinated people for centuries. For
everything, flying carpets and live picture books with moving
characters are popular in fairy tales. The goal of our research
is to make it possible for the users to interact with imaginary
objects. This paper introduces an installation that allows
users to touch and play with a magical book with moving
virtual characters.

We set three goals to produce a convincing user experience.
First, users should be able to directly touch and manipulate
objects with their bare hands. Second, users should see the
objects that they touch. Third, users should be able to in-
teract with the objects by means of common actions. We
believe that interaction becomes difficult if any of these ele-
ments are missing. For example, if users have to wear gloves,
they cannot touch objects with their bare hands. This is
problematic because virtual tactile sensations are different
from reality, giving the user an unnatural impression.

Our installation combines physical objects and virtual movies
via a see-through video. We call this prototype installation
FUSHIGI (“mysterious” in Japanese) Desk (Figure 1). The
user interacts with an imaging book on which cats and mice
are chasing each other by flipping through the pages. The
cats and mice pop up outside of the picture or shake the
pages. Similar video see-through systems with haptic de-
vice
ces have been studied by [2] and [1]. Furthermore, similar
products are being released by SenseGraphics. However,
our system differs from these in two ways. First, the oc-
cclusion problem is mitigated by transparently showing the
users' hands on top of the virtual book in the display. Next,
our installation shows a virtual double of the object on the
display, while most mixed reality systems show physical ob-
jects itself on the display. Compared to showing real objects,
virtually representing allows for a greater variety of images.

2. IMPLEMENTATION
FUSHIGI Desk contains a physical book (Figure 2) and the
user can touch and flip the pages with their bare hands.
A display on the desk shows a virtual double of the book
and the user's arms (Figure 1). The user's arms are shown
transparently to mitigate the occlusion problem.

A camera is placed in the desk and captures mirrored images
of the user's arms (Figure 2). The mirror is placed so that
the image of the hands in the camera matches the image in
the user's view if the display is transparent. The user's arms
are clipped by skin color from the captured images.

LEDs with different colors are placed on the back end edge
of each page and their positions are detected by another
camera placed behind the desk (Figure 2). The configura-
tion of the virtual book is determined based on the measured
angles.

3. USER EXPERIENCE
We demonstrated FUSHIGI Desk at IVRC 2008 and IVR
Expo 2009. Both children and adults enjoyed the device.
We received positive feedback such as “Response time is fast
and there is no sense of strangeness” and “I can interact in
a natural way.” Some users tried to interact with the cats
and mice in the page by poking them with their fingers, so
we plan to support such interaction in the future.

4. REFERENCES
[1] Walairacht et al. 4 + 4 Fingers Manipulating Virtual
Objects in Mixed-Reality Environment, Presence.