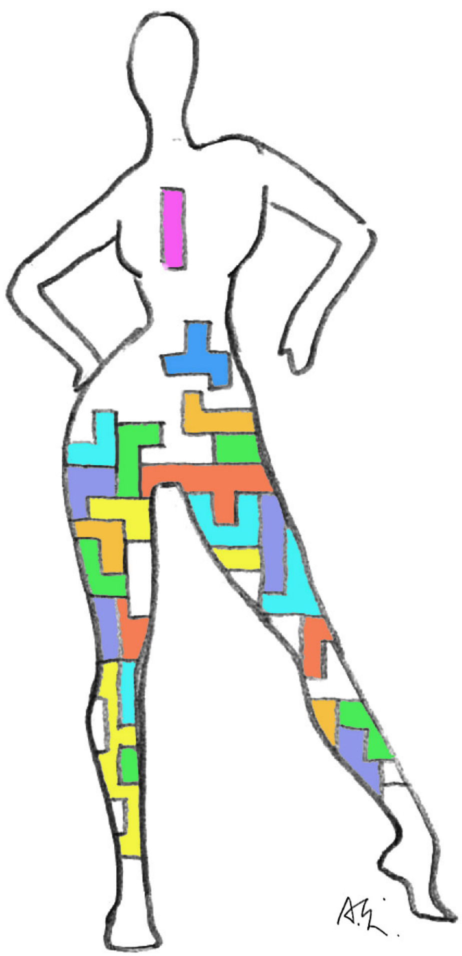
Skin Games



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Abstract
Recent developments in computer vision hardware have popularized the use of (free hand) gestures as well as full body posture as a form of input control in commercial gaming applications. However, the computer screen remains the place where the eyes must be placed at all times. Freeing graphic output from that rectangular cage is a hot topic in Spatial Augmented Reality (SAR). Using static or dynamic projection mapping and 'smart projectors' [11], it is possible to recruit any surface in the surrounding for displaying the game's graphics [17, 18]. The present work introduces an original interaction paradigm building on kinetic interfaces and SAR: in 'Skin Games' the body acts simultaneously as the controller and as the (wildly deformable) very projection surface on which to display the game's output.

Author Keywords
proprioception; spatial augmented reality; dynamic projection mapping; laser sensing display; gestural control; entertainment; computer games

ACM Classification Keywords
H.5.2 [Information interfaces and presentation]: User Interfaces - Input devices and strategies; B.4.2 [Input/output and Data Communications]: Input/Output Devices - Image display;

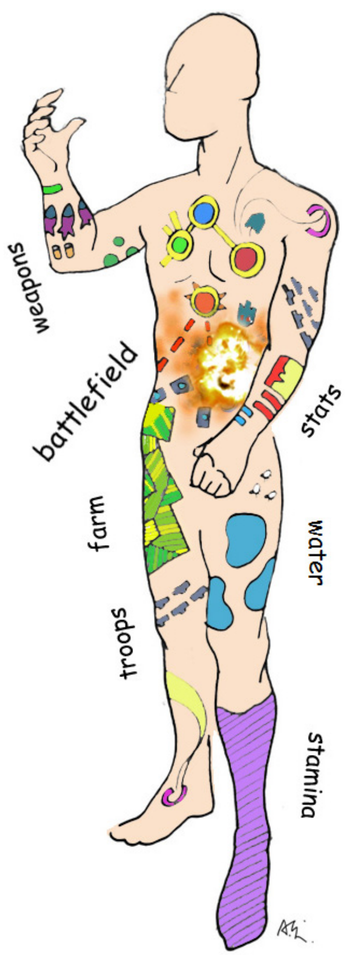

Figure 1: Wearing the game map and fighting a simulated 'infection' on the body.

The skin is the battlefield

We are interested here in the ludic possibilities opened up by harnessing the body not only as a kinetic user interface controller (using Kinect for instance), but also as the *displaying surface*. This creates a tighter connection between gesture, body posture and game control. Posture not only triggers particular game actions, but also distorts and modifies the game map *as a whole*. Construction and management simulations games (CMS) such as SimCity may be an attractive scenario for this interaction paradigm. Indeed, proprioception and 'body mnemonics' [1] can be exploited to better manage and organize game resources (see Figure 1). Simple arcade games may also be revisited in this light: instead of controlling a spaceship or hitting a ball, the player actually *moves the whole scene around* (Figure 2).

Technical challenges

There are different possible ways to materialize Skin Games. One approach is to actually wear the screen. This is technically feasible as demonstrated in numerous art/entertainment projects (see for instance Waldemeyer 'video jacket' [15]). A wearable, full body display can easily integrate kinetic sensors (accelerometers, gyros), biosensors or simple switches thus providing appropriate input, as demonstrated in [16]. A different approach is to use external tracking and projection. In the case of a traditional projector/camera setup, this requires relatively sophisticated hardware and significantly computer power because the system must realize real-time dynamic projection mapping while maintaining minimum delay and spatial mismatch. Although several techniques have been proposed in the framework of HCI [8], telepresence [14] or to augment stage performances by projecting on the actor's costumes [12], it is safe to say that to date no system providing perfect registration on deformable surfaces with unnoticeable time delay exists beyond very experimental setups such as [10].

Figure 2: Changing the topology of the soccer field

Since 2005 we have been developing a technology that is capable of displaying simple graphics with perfect registration and insignificant time delay: the Laser Sensing Display (LSD) is basically a laser projector, in which the displaying beam is simultaneously used as a *rangefinder* [3]. The information gathered by this beam can be used to adjust the geometry and color of the projected image (pre-warp when projecting on slanted or curved surfaces and color compensation when the background is uneven). The sensing beam can also be used as an input interface capable of recognizing gestures [4] or following lines [6]. The LSD fits in many ways the definition of a 'smart projector' or 'sensor-enhanced display' [2, 11] but presents a number of advantages with respect to a classical projector/camera implementation. Indeed, the sensing and the projection beam share the

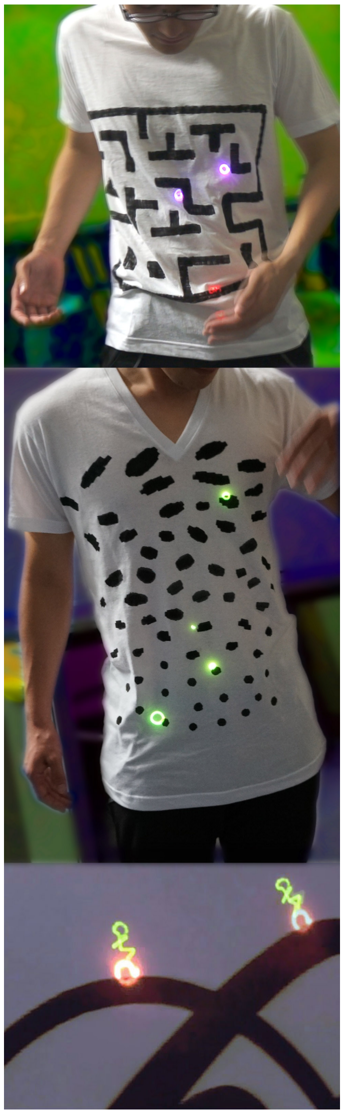

Figure 3: Vector graphics games on clothing.

same optical path, and both sensing and displaying operations are realized simultaneously. The most important advantage is therefore that *camera-projector calibration is not needed at all, and misalignment is impossible by construction*. Moreover, since there is no image processing or video buffering, very fast feedback is possible (our latest prototype takes no less than 10k measurements per second).

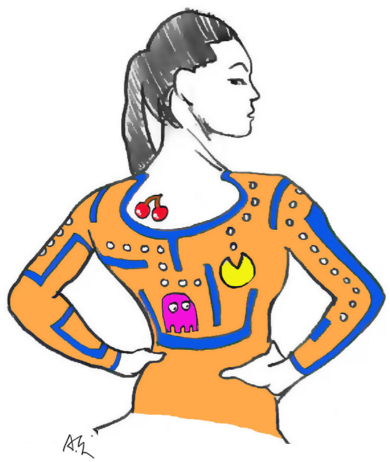

Figure 4: Towards 'playable' clothing?

Skin Games on LSD

In this (proof-of-principle) demo we will demonstrate some simple arcade games based on the LSD technology. Each game uses here a *fixed* background printed on a T-shirt - in a way reminiscent of the translucent plastic overlays used in the Magnavox Odyssey, the first home video game console [9]. One or more 'laser sprites' interact with this printed support by following contours or bouncing. The gamer interacts by the system by jumping, contorting and/or spinning, but also can use her hands to pick the sprites and replace them over her own body - or transfer them to another player. The applications demonstrated here are a 'circular' Pong game, a simplified Pac-man and a Pinball game (see Figure 3). A video demo can be seen here [13]. Although very simple, these applications already demonstrate the fundamental shift in how to engage in a game with a full body interface. Body movement can not only shift the playground in response to the interactive graphics, but also transform the topology of the "game level", by connecting patterns on the sleeve to the one in the torso for example.

Conclusion and future work

Skin Games takes the concept of 'immersion' to a whole new *physical* level: you are litterally *covered* by the game. The fact that the user needs to contort to see the graphics on her own body is perceived here as an interesting inherent feature of the Skin Games paradigm (Figure 4). It encourages a form of gymnastics more extreme that the one promoted by kinetic based interfaces such as Xbox Kinect, where the real body movement is often a subdued gesture to elicit super human behavior within the game world. The paradigm also forces to reconsider the representation and the role of the player: as in CMS, the gamer is omnipresent and does not have an 'avatar'; but more interestingly, here the gamer *impersonates the whole game* instead. In the present implementation, the dynamic graphical elements are externally projected, while the game background is printed on clothing (for extreme game lovers it could even be permanently tattooed on the skin; or existing tattoos could gain new meaning in a game context). An obvious improvement would be to project complex and dynamic backgrounds: this would require higher resolution, raster scan projectors (presumably many of them to cover the whole body surface). As explained in the technical discussion, this is not possible nowadays - at least not for games requiring relatively unconstrained and fast interaction. However, it is conceivable that in the near future fast cameras and tracking/projection hardware, coupled with GPU processing will push delay and spatial misalignment under the threshold of human perception. Another fascinating direction would be to produce multi-modal stimuli such as vibration or sound, and restrict these to different areas of the body - the player could perform with her eyes closed. This would be easier to do in the case of a 'wearable display' implementation [7], but it is also possible using directive sound projectors [19].

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