bYOB (Build Your Own Bag):

A computationally-enhanced modular textile system

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ABSTRACT

We present bYOB (Build Your Own Bag), a flexible, computationally-enhanced modular textile system from which to construct smart fabric objects. bYOB was motivated by a desire to transform everyday surfaces into ambient displays for information and to make building with fabric as easy as playing with Lego blocks. In the realm of personal architecture, bYOB is an interactive material that encourages users to explore and experiment by creating new objects to seamlessly integrate into their lives. The physical configuration of the object mediates its computational behavior. Therefore, an object built out of the system of modular elements understands its geometry and responds appropriately without any end-user programming. Our current prototype is a bag built out of the system that understands it is a bag when the handle is attached to the mesh of modules and responds with sound and light to illuminate inner contents when it is dark, to alert users when personal items are missing, and to communicate information downloaded from the Internet (Fig 1).

Keywords

Ambient interface, tangible interface, customization, enhanced situational awareness, fabric building blocks, modular systems

Figure 1: Current prototype demonstrating light sensing capability.

INTRODUCTION

bYOB's significance is that anyone can make an object at anytime and anywhere whether they are a designer with a new vision, an office worker in need of additional light, or a student who needs useful information while in transit but does not want to carry several additional electronic devices. Therefore, the modules allow users to express themselves and create interactions with their environment. And rather than carry several electronic devices to access these applications, bYOB exploits everyday surfaces as a natural medium by which to communicate information.

With bYOB, the way we design, integrate, and use common objects like furniture, accessories, and clothing evolves from the current state where it dictates how we use it to an evolving state that is aware of the needs and capabilities of people and environments.

Applications demonstrable include:

Light sensing. The fabric of the bag illuminates when there is not enough natural or artificial light to see inside.

Object detection. Using radio frequency identification, bYOB modules detect whether or not important objects (e.g. cell phones, wallets) are nearby and alert the user, through the fabric's light and sound actuation, if the items are missing. For example, a bYOB-constructed bag will light up to inform the user if he or she tries to leave home without keys.

Wireless Capability. Using the Bluetooth protocol, bYOB modules are able to download information from the Internet (e.g. weather forecasts) to the modules. Additionally, the user will have the ability to 'log in' to one or more remote bYOB bags from a computer and search for the location of items.

Future applications being researched include:

Network Detection. Mobile lifestyles often lead to increased use of mobile phones, PDAs and laptop computers. However, the wireless networks used with these items are not immediately visible. Through the ambient display, bYOB modules can make information regarding the existence and strength of networks readily available.

Topology Mapping. We are developing the modules to understand geometries other than those of bags. A wall hanging may be configured to act as a light source or a curtain may be constructed to respond appropriately to environmental changes.

Seamless Integration Into Our Lives. We envision that when you hang your bag up for the day, it will automatically recharge its battery and synchronize itself with other objects in the bYOB network.

PHYSICAL DESIGN AND FABRICATION
Modular systems and embedding electronics in textiles have been around for quite some time. The modules of bYOB, however, allow users to construct objects in an ad hoc fashion. To realize this novel approach to building fabric objects, emphasis in the design of bYOB was placed on un-ambiguity and ease of use.

Our current prototype employs conductive hook-and-loop material that is lightweight and has impressively low resistance, allowing data to be exchanged between modules. The simplicity of snapping pieces together with hook-and-loop allows the user to, at any time, add or subtract modules from an object to fulfill a situational change or geometric design. Additional time was spent ensuring that the male/female connections on each module were part of an intuitive design where the user would not have to understand the technical complexities of lining up power, ground, and data pins.

bYOB modules are soft, light, flexible, and made almost entirely out of fabric that masks their electronic belly. By using waterproof fabric and electronics covered in epoxy we ensure that the modules are durable and washable.

The vision of a user-tailored system is furthered through the design as users are free to experiment with fabrics of their choosing. Using the innovative Dual Lock material by 3M, users have the ability to constantly change the fabric coverings of their objects.

TECHNOLOGY
The current system is comprised of three different types of modules: passives, actives, and parents. Active and parent modules contain an array of sensors, sound and light actuating elements and a microprocessor. Passive modules, while physically identical on the exterior to the active modules, have the sole purpose of contributing structural support and physical form and therefore contain no computational capabilities.

The parent module differs from the actives in that it controls the algorithm to equip the rest of the modules with appropriate applications. The shape of the parent module is dependent on the object created. For example, if the user builds a bag, the handle is designated the parent and alerts the actives that they are part of a bag and should respond correspondingly (with object and network detection applications).

To ensure that bYOB is not cost-prohibitive as an end-user technology, emphasis was placed on using inexpensive electronics and on power conservation. The PIC16F876 microcontroller was chosen because of its low current consumption and because it works well with the I2C bus, the network by which a mesh of modules communicate. I2C was chosen because of its minimal cost and its plug and play ability. RGB LEDs illuminate the fabric that covers the board. For greatest efficiency, data and power are distributed through the network of modules. The conductive hook-and-loop material that acts as a mechanical connection between pieces also transmits power and data through the object. Power is currently drawn from a centralized rechargeable battery piece.

CONCLUSION
Through further development, we hope to better understand bYOB's challenges and limitations. The user-interface is constantly being refined so that bYOB couples seamlessly with interaction we are already accustomed to. As part of a distributed sensor network, we envision several bYOB objects synchronizing with each other and facilitating visual data exchange. A bYOB curtain would respond to changes in weather like the onset of rain and dually inform a bYOB bag that it should contain an umbrella.

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