LightBundle: Grasping Light through Plant-Inspired Interactions

Abstract
LightBundle is an optical fiber bundle for direct manipulation between the bundle and its composing strands. The bundle changes color based on user manipulation. Inspired by our daily interactions with bundles of vegetables (e.g., asparagus), LightBundle affords grabbing, peeling and twisting of bundle and strands. The metaphoric plant properties lend themselves to interaction scenarios ranging from timing, location, social awareness to energy transfer.

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Tangible Input; Direct Manipulation, Radical Atoms

ACM Classification Keywords
H.5.2 User Interfaces

General Terms
Design, Experimentation

Introduction
Everyday human-plant interactions happen as we visit the florist and vegetable markets. Surrounded by flowers and vegetables of different shapes, sizes and colors, we are immersed in a rich visual and sensory experience. Inspired by the physical interaction of grabbing, choosing and assorting plants in the market place, we draw metaphor from the rich direct manipulations we perform.
on everyday plants. This work is particularly inspired by the action of grabbing a bundle of strands, as in grasping a bouquet of flowers or a bundle of asparagus [Fig 2]. We aim to leverage these plant-inspired direct manipulations as metaphors for new interactions with novel materials, i.e., optical fibers. As optical fibers possess the affordance to be grasped in a bundle and also released into strands, this work embeds plant-like interactions in an optical fiber bundle with color/light-changing properties. By using physical interaction to alter light, which is intangible yet ubiquitously present, this work also explores the poetic interaction of “grasping light”.

**Design and Implementation**

Inspired by plants in bundles and strands, our design rationale is coupled with the natural organic properties of plants. These plant-inspired interactions afford direct manipulation between the bundle (the whole), and the strand (the composite), seamlessly connecting these two states.

The LightBundle system [Fig 1] comprises of 61 optical fiber strands mounted upon a 3D printed plate. To enable side diffusion and for conformal stiffness, each optical fiber is placed compactly inside a small transparent acrylic tube. An array of LEDs sits beneath the fabricated plate, providing lightening sources for the optical fibers. On the acrylic tubes bounding the optical fibers, clear ITO (indium tin oxide)-coated plastic are attached for capacitive sensing. With the current Arduino code, user direct manipulation of the bundle is sensed through changes in capacitance, which triggers color changes in the LED arrays. Each strand is manipulated by clear wires, allowing the strand to actuate and change shape.

**Interaction Language**

**Figure 2. Bundling**

*Bundling*

Plants such as flowers, asparagus, scallions, etc., grow singly, but are often bundled together to form groups. We see “bundles” of these single plants at the florist (bouquet of flowers), and supermarkets (bundles of asparagus). We explore the direct manipulation of the grasping and releasing a bundle [Fig 2], creating seamless transitions between bundle and strands.
Several fruits and vegetables grow in layers, by peeling open an outer layer an inner layer is revealed, as in peeling away the husk of a corn. For the bundle, by “peeling” away a strand, we either make use of the removed strand (i.e., peeling off one scallion for cooking), or reveal the inner essence (i.e., remove worn out leaves in bouquet to show fresh flowers). We take the metaphor of “peeling and revealing” as a means to navigate multiple layers of information. We also see it as an emotionally layered communication medium [Fig 3], intensifying as it reaches the center.

**Figure 3. Peeling**

*Peeling*

Plants grow towards the sunlight to generate energy from photosynthesis, a phenomenon known as phototropism. The directionality of a plant’s growth is therefore indicative of where light is coming from. We take the growth directionality of plants as a metaphor and enable the strands in the bundle to point in different directions to indicate information [Fig 4].

**Figure 4. Pointing**

Grape vines inter-tangle and grow around each other. We use this action of twisting together strands as a metaphor for binding and connecting two different sources of information [Fig 5].

**Figure 5. Twisting**

**Use Case Scenarios**

The use case scenarios of LightBundle leverage a mix of the interaction languages elaborated above. Going beyond form changing, the lightening and color properties of each strand changes corresponding to user manipulation. Light, as an encompassing ambient property, can afford not only indication of information, but also emotional and aesthetic conveyance.
Grasping Light

Light is diffused evenly in the room throughout the evening. As it gets late, one gets into bed and grasps the LightBundle next to bed. By “grasping light”, the light in the room dims down, and light gathers in the LightBundle. Sliding his hand down the bundle turns the LightBundle off [Fig 6].

Figure 6. Grasping

Social

In the social aspect, the LightBundle enables one to keep up to date with what is happening with their friends without having to spend countless hours on social networking sites. In this scenario [Fig 7], the LightBundle can be lighted up in different colors to represent one’s acquaintances, colleagues, friends, and family. You might notice that one strand is blinking and you peel it from the bundle, revealing that it's your friend’s birthday today! You pull his strand towards you and use it like a microphone to whisper a private birthday message to him. This changes the color of the bundle to red to indicate that it is recording. When you put the strand back, yellow light diffuses outward, indicating that your message has been sent. On your friend’s end, he sees that the strand representing you is bending towards him, indicating that you have a message for him. When he pulls on the strand, your birthday message to him is sent.

Figure 7. Social

Party arrival

With the pointing metaphor, one can imagine a scenario during a dinner party where the host wants to keep track of when his guests are arriving [Fig 8]. He pulls out a few strands that represent his friends, and set them in the kitchen where he can easily see it while he prepares dinner. The strands point towards the...
respective friend showing if he is on the way, and the brightness of the strand’s glow indicates how far away that friend is from the dinner party. When a friend reaches the host’s place, the strand blinks to let the host know and he can greet them at the door.

**Bundling Appliances**

With the twisting metaphor, the LightBundle allows us to interact with our devices in more ways than before [Fig 9]. By having a strand that represents your coffee maker, a strand that represents your toaster, and another strand that represents your alarm clock; these strands can all be twisted together. With the twisting action, the LightBundle now knows that you want to start the coffee maker and toaster when your alarm goes off, ensuring that breakfast is ready for you when you get out of bed.

**Related Work**

LightBundle is technically inspired by optical fiber works in HCI. These works can be categorized into bundle versus strand interactions.


**Strands**: The work in [3] is a fiber-optic cylinder with different colored LEDs on each end. The LEDs mix color along the cylinder to create a color gradient. LightCloth [4] is a cloth woven with diffusive optical fiber cloth, giving it I/O capabilities. The Power Aware Cord [5] leverages EL wire to display energy passing though a power strip.

LightBundle focuses on the alternating interactions between bundles and strands of optical fibers, and the affordance and possibilities of user manipulations between the two states.

**Conclusion and Future Work**

In this paper, we presented how plant-inspired metaphors open interaction opportunities in bundles and strands of optical fibers. Through direct manipulation with optical fibers - an embodiment of light, we explored scenarios with both emotional and practical components.

For future work, we plan to explore more plant metaphors, such as taking strands from a bundle and "replanting" them somewhere else; or giving each
strand a unique form for meaningful mapping, as each flower is its unique form in a bouquet.

Building upon the vision of the Tangible Media Group at MIT Media Lab, we vision the LightBundle as a Radical Atom [6] that changes color, light, and sensing properties based on user manipulation. We look forward to this future where material properties become malleable and seamlessly engage our full sensory.

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References