Pin&Mix: When Pins Become Interaction Components…

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ABSTRACT

This paper introduces a study into the realization of physical interaction components, based on a technology for providing network connectivity and power to small objects via a layered surface. Small pin-like components can be activated and networked by attaching them to the same, augmented surface, and can be used to dynamically create an interlinked set of atomic interaction components. The physical connection becomes thus also a digital link between components. To demonstrate our proposed platform, we have built atomic interface components in the form of dials and multicolour lights that are activated and integrated in a network by simply pushing their pin connectors in an augmented surface. They allow to pick and mix colours using the red, green, and blue primaries, as a physical alternative for the traditional WIMP colour mixer tools.

Keywords

physical interaction, pin-based connectors, tangible interfaces.

1. INTRODUCTION

This paper is based on a networking technology that exploits the familiarity and ease of attaching pin-like objects to a surface, called Pin&Play [5, 6]. This technology is applied to create a modular platform to network and organise a set of physical interaction components.

Prior examples include an augmented notice board with drawing pins, where 'pinning' a document to the wall also introduces the pin's digital self to the network [6], or wall-switches that can be powered, replaced and networked via augmented wallpaper [5].

Likely advantages of using this surface-and-pin metaphor to create and modify an interface with physical widget-like objects [3], are similar to the advantages of creating a graphical user interface in visual software development. It reduces the required expertise to build an interface to a minimum, and increases the time to develop or alter the interface.

After briefly discussing the core ingredients of Pin&Play, a

more detailed description of a specific case study will illustrate how such a platform could be realized. This extended focus on an actual implementation aims at deepening the understanding of both practical and conceptual issues that may be involved.

2. PIN&PLAY

The technology used in this paper is based on Pin&Play [5,6], which uses a surface where layers, instead of routes, carry data and power to devices that get attached to the surface. The devices can access these layers by insulated pins that punch into the surface to the appropriate layer. This method literally expands the network to a two-dimensional plane rather than wires or circuits, while staying in the wired networking category: Devices will connect physically and digitally anywhere on the surface. Another interesting property of Pin&Play is that orientation of the object's placement does not matter either.

Conductive Pin Surface
Isolated Pin Surface
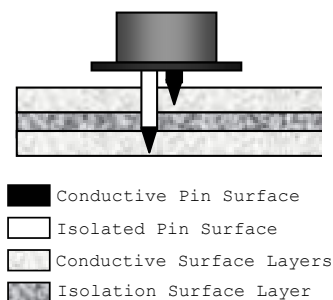Conductive Surface Layers
Isolation Surface Layer

Figure 1. Left: diagram of a Pin&Play device accessing the network layers. Right: An actual Pin&Play pin attached to the surface. It holds a coin-sized unit (iButton) for memory and application specific processes, and an LED for basic user interaction.

The protocol that is used in Pin&Play is responsible for providing both a communication network and power to any device that gets connected. The Dallas MicroLAN [1] is a protocol standard that needs two connections to network and power devices: one for ground, and one for the communication signal. This signal is furthermore pulled to a high state most of the time, so that the attached devices are able to 'steal' power from that same communications bus.

The conductive layers of the surface are connected to a network master that controls all traffic over the surface. All other devices are slaves that do not have the authority to send messages autonomously, unless the master asked them to. The complexity

of this master node depends on the specific network application, but can be implemented on embedded devices.

The actual surface material that was used in this paper consists of woven threads of nylon that have been coated with silver (AG) to give it its conductive properties [4]. To insulate two layers of this fabric, a common corkboard was used to attach the conductive layers to. Other insulators could be used as well, to make the surface flexible for instance [7].

3. PIN&PLAY AS A COLOUR PICKER

In this section, Pin&Play will be used to build a physical colour picker tool, named Pin&Mix. Pin&Mix playfully demonstrates the concept of additive colour mixing, where the three additive primary colours - Red, Green and Blue - can be overlapped in varying intensities to create a wider spectrum of colours.

The surface (referred to as 'Canvas') is used to display points of light (Mixers) that can be manipulated to display any of 256 colours by adding varying intensities of primary light using 'Primary' Pins. Up to three Primary Pins can be associated with a Mixer Pin to change its colour in real-time. The Mixer Pins reflect these changes, and remember their colour. They can be removed from the canvas, and when placed on the surface again they revert back to their last set colour which can once again be modified by using Primary Pins.

3.1 The Canvas

The canvas in this example is made of a traditional corkboard, coated on both sides with a conductive fabric. These two conductive layers are attached to a computer running the Pin&Play master software that polls for devices, reads theirs states, and executes device-specific scripts. In the case of Pin&Mix, the master reads the values form the Primary Pins (i.e., the position of their dial) and writes them directly to the Mixer Pin (i.e., to one of the three colour components of the LED).

3.2 The Mixer Pin

Figure 2. The Mixer Pin contains one multi-colour RGB LED, and three digital potentiometers that drive the red, green and blue values for the LED.

The Mixer Pin embodies a 'physical pixel' that can be set (or mixed) to any colour by specifying its red, green, and blue components. When attached to the Pin&Play surface, it acts as a receiver for commands from the surface's master. Figure 2 shows the Mixer Pin, while Figure 3 depicts its schematics.
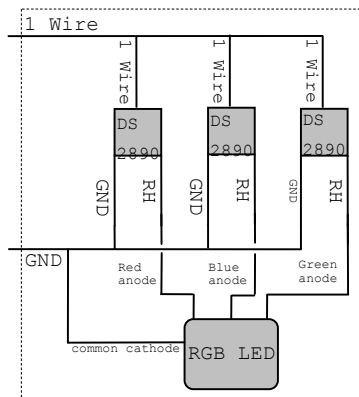

Figure 3. The schematics for the Mixer Pin, using three primary colours (Red Green and Blue).

At the heart of the Mixer Pin are three digital potentiometers, each with 256 wiper positions that can be set over the MicroLAN network to determine the colour of a Multicolour RGB LED (see the schematic in Figure 3). Three DS2890 DigiPots were used as potentiometers, which take their power from the MicroLAN network. The LED has a single common cathode, and four anodes (two for Blue, one for Green, and one for Red). The voltage supplied to each anode will determine the Red, Green or Blue intensity of the LED, and thus its perceived colour.

3.3 The Primary Pins

The form factor of the Primaries is that of a dial that can be attached anywhere on the board. Although all Primary Pins are identical in implementation, each one represents one of the three primary colours: Red, Green and Blue. Figure 6 shows a close-up of such a Primary Pin.

Figure 4. The Primary Pin contains a dial that is connected via a potentiometer to an analog-to-digital converter. It controls the intensity of one of three primary colours for the Mixer Pin.

As soon as a Primary Pin is attached to the Canvas, it becomes 'alive' (i.e. powered, and detected by the network master). Turning the dial will result in increasing and decreasing the mixing of the assigned primary colour in the assigned Mixer Pin. Currently, the assignment of the primary colour (red, green or blue) and Mixer Pin for every Primary Pin is done when the

Primary Pins are created (i.e. their target colour and Mixer Pins are fixed).

Every Primary Pin consists of a rotary potentiometer capable of varying its resistance between 0 Ohms when turned fully to the left and 100 Ohms when turned fully to the right, with an analogue range of values in between, resulting in voltages from 0 to 5.12 V.
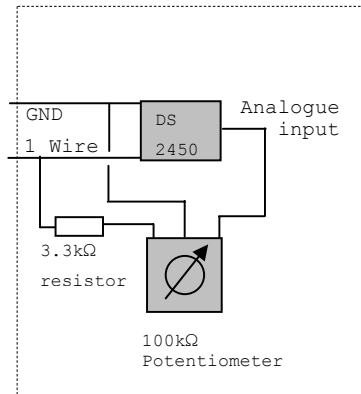

Figure 5. The Primary Pin schematics.

A DS2450, Dallas Semiconductor MicroLAN Analogue to Digital converter is used to measure these changes in voltage and translate them into a digital value that can be transmitted over the MicroLAN network. The DS2450 provides four channels, each capable of measuring voltages in the range of 0 to 5.12 volts. For our purposes, only one of these channels is used.

A 3.3kOhm resistor was placed in a series between the point of connection with the MicroLAN network that supplies the power the potentiometer to prevent shortcuts. These components are connected as shown on Figure 5. For aesthetic purposes, a metallic numbered dial is used as casing over all of these components. Turning the dial causes the potentiometer to rotate.
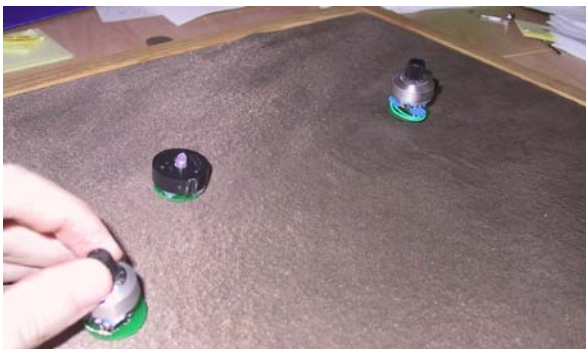

Figure 6. The surface (Canvas) with two types of interaction components: the Primary Pins (of which two are visible in the picture) are constantly being polled by the network master, and their values are mapped onto the digital potentiometers of the Mixer Pin.

The latency of the setup as depicted in Figure 8 (corkboard-sized surface with three Primary Pins and one Mixer Pin) allows three cycles per second where one cycle involves:

- Reading the dial positions of all available Primary Pins. If a Primary Pin is removed from the surface, the previous value remains in the network master's memory.

- Setting the colour of the Mixer Pin using the previously read values (if the right Mixer Pin is connected to the surface).

4. SUMMARY

We proposed a new approach to integrate a physical network of interface components, using a surface with layers of conductive textile to bring power and communication capabilities to every element of the interface. The surface has little restrictions on size, shape, or other properties, which makes it applicable in many environments. The choice of protocol and the fact that the interconnection of components is wired, means that the devices can be small and robust at an early prototyping stage.

To offer a better understanding of how Pin&Play technology could support physical interaction, a physical, modular alternative to a GUI colour picking tool was implemented, using one pin with an RGB LED as an output component and three others with dials to change the LED's colour.

5. ACKNOWLEDGMENTS

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