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# musicbox: A Tangible Interface for Remote Presence and Browsable History

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**ABSTRACT**
The musicbox is a tangible interface supporting remote awareness through the mediums of music and light. The musicbox is linked over the Internet to the music and light levels surrounding a remote piano. The system communicates live music and a sense of physical movement through a luminous physical interface, while also providing browsable access to music previously played by the device.

**Keywords:** tangible interface, awareness, history, telepresence

**INTRODUCTION**
As Internet connectivity diffuses out of the workplace and into the home, it becomes compelling to consider new computational devices beyond the traditional computer terminal. The *musicbox* is one such interface that works to interconnect the spaces of net-linked residences.

The musicbox's basic function is relatively simple: it relays music from a live music source (e.g., a digital piano) to a physically remote "musicbox." Although general in function, the musicbox is targeted at families living spatially apart, and especially the elderly of limited sight.

The design grew from the first author's experiences with his grandmother. As a child, each month he would send an audiocassette of his piano music to his grandparents, who lived far away. As he grew busier and his grandmother's eyesight deteriorated, she discarded her tape player with its uniform black buttons as "too difficult to use." This stimulated the author's interest in new kinds of devices that might better link his grandmother (and others of similar circumstance) to her remaining family – devices producing a technologically-mediated sense of remote human presence.

**MUSICBOX FUNCTION**
The musicbox system consists of a pair of objects: the musicbox itself, and a relay device that links the musicbox to a remote music source (initially, a digital piano). These devices support both live and on-demand interaction.

As its most basic function, the musicbox plays live music relayed over the Internet from its remote piano. Whenever the source piano is played, the wheel of the musicbox turns clockwise, and the musicbox plays the piano's streaming music (Figures 1,2).

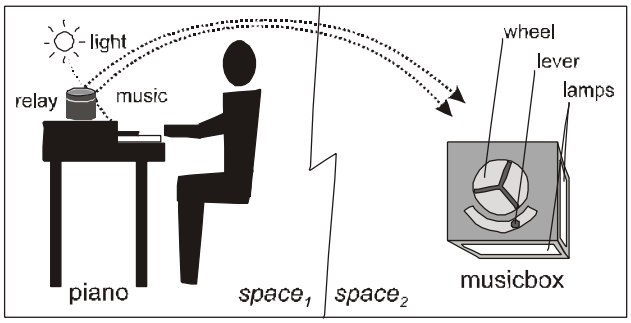


**Figure 1: Functional diagram of piano / relay / musicbox link**

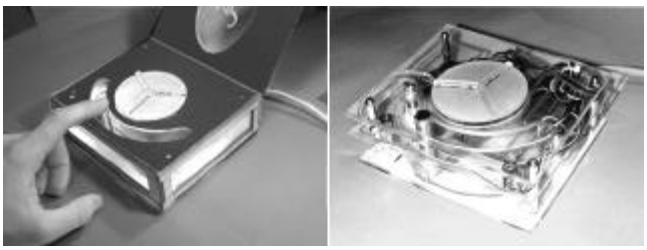

**Figure 2a,b: The musicbox, covered and internals**

The relay also measures and transmits the light level surrounding the source piano. These values, after processing to enhance changes in lighting, are used to illuminate lamps embedded within the musicbox. This dynamic lighting reflects the physical movement of the remote piano player and the remote time of day, highlighting the live, human aspects of the performance.

In addition to presenting live music, the musicbox also records all incoming music. Turning the musicbox wheel *n* revolutions clockwise, the last *n* songs are replayed. The musicbox lever, in turn, offers "absolute" access to the musicbox's complete recordings. Turning the musicbox lever fully to the left replays the sound and light of the device's earliest recordings (potentially many years or decades past). Turning the lever to intermediate positions accesses more recent recordings. The rightmost position returns the musicbox to live playback.

## RELATED WORK

The notion of "synchronous distributed physical objects" developed in [1] partially underlies the musicbox's design and function. However, the asymmetric musicbox/relay pairing strikes an interesting contrast with the symmetric inTouch and PsyBench devices [1]. The musicbox also relates to the awareness-centered styles of telepresence developed by Portholes [2], Fields and Thresholds [3], the ambientROOM [5], and ThunderWire [4], though is distinguished by its musical content and home (rather than work) usage context. Finally, the musicbox works to develop a digital/physical craft aesthetic consistent with [7].

## IMPLEMENTATION

The musicbox's function is partially based upon its use of the MIDI data format common to digital pianos. In this format, piano performance has a data rate on the order of 10KB/minute – less than the bandwidth of a 2400bps modem. At three hours of performance a week, every note played in a decade can be stored in roughly a gigabyte.

The physical structure and mechanics of the musicbox and relay device were designed in 2D and 3D CAD programs, and fabricated in cherry wood, acrylic, foamcore, and vellum with a commercial laser cutter. This implementation is discussed in more detail in a parallel submission [6].

A prototype with light and MIDI control but no mechanical movements was first constructed. MIDI music and light sequences were recorded under computer control. The prototype was transported cross-country for early feedback from the author's grandmother. This informal session indicated that the musicbox's lighting changes were readily visible, even with limited eyesight, and that the mocked-up controls seemed intelligible.

Encouraged by this feedback, we implemented a second prototype with functional electronics and mechanics. The electronics and software were adjusted to accommodate both MIDI and sampled music, seamlessly accessible through the musicbox browse lever. Audio cassette recordings of the author's piano performances as a 6..14 year old were sampled and integrated into the device, as a demonstration of the musicbox's potential long-term behavior (albeit without the associated historical lighting data).

Our current musicbox implementation is based upon an external PC and three embedded microcontroller modules – one apiece controlling music, light, and motion – and another PC and two controller modules on the side of the piano and relay. These communicate over multiple MIDI and serial links, and pass data over the Internet using text-based TCP sockets. We see the current PC usage as an undesirable conceptual dependency, and are currently implementing a standalone PC-104 based system.

## DISCUSSION

The musicbox highlights several design and infrastructure issues. First, the musicbox assumes constant Internet connectivity in the home to receive its live contents. While this assumption is not yet widely valid in practice, such infrastructure is rapidly becoming more accessible, and is anticipated to be widespread within several years. It is also worth noting that the <2400bps bandwidth of piano MIDI is far smaller than network audio or video broadcasts.

It is interesting to consider where the musicbox's storage resides. It is inexpensive to hold thousands of hours of MIDI music on disk within the musicbox. Alternatively, since the musicbox already acts as a network client for live music playback, the musicbox might also retrieve old music from online archives (perhaps hosted by the source piano).

The musicbox's use of separate music, light, motion, and (in the future) communication microcontroller-modules also has implications for new generations of digital/physical craft. When traditional craftsmen build a music box or clock, generally the underlying movement – the internal mechanical mechanism – is a pre-fabricated unit. Similarly, for designers of tangible interfaces, pre-fabricated digital/physical "movements" may play an important role in the design process.

## CONCLUSION

The musicbox speaks of shared spaces, of tangible telepresence of a new and distinctive character. Partly resembling its inTouch and PsyBench predecessors, the musicbox embodies a kind of "distributed object" that is permeable to the select phenomena of music and light, but opaque to video, voice, and other more traditional telepresence mediums. We believe these kinds of tangible interfaces for communication and remote awareness have many future applications in both home and work contexts.


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