Phenomenologically Augmented Reality With New Wearable LED Sequential Wave Imprinting Machines

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Abstract

The Sequential Wave Imprinting Machine (SWIM), invented by Steve Mann in the 1970s, offers naked-eye augmented reality overlays with perfect alignment, through a Persistence of Exposure (PoE) of human vision, or photographic/videographic media.

This paper proposes a new SWIM design with only 2 transistor elements per picture elment, therefore making SWIM more wearable, miniature, and affordable. We present a SWIM for being worn on one finger, as a ring, to overlay a phenomenologically augmented reality for metaveillance (sensing sensors and sensing their capacity to sense) and HARCAD (Haptic Augmented Reality Computer Aided Design/Manufacture).

Author Keywords

Mediated Reality; Augmented Reality; Wearable Computing; Sequential Wave Imprinting Machine; WearTech, Lock-In amplifier; HARCAD/HARCAM; Haptic Augmented Reality CAD/CAM

ACM Classification Keywords

H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

Figure 1: World's first wearable augmented reality computer system: Sequential Wave Imprinting Machine waved back-and-forth to display radio waves, sound waves, text, graphics, etc., overlaid on reality by persistence-of-exposure, so hundreds of people could see the overlay without the need to wear special eyeglasses.

Introduction

Augmediated reality is an experience where by the means of a system of technology, people are able to seamlessly modify (mediate) their perception of reality, while it is also being augmented.

Mediated reality systems may be organized into three types:

1. dB>0: Systems of augmentation, which involve amplification / enhancement / addition of information, such as the system presented here. These systems are augmented reality.
2. dB<0: Those of diminishment which involve attenuation / subtraction of vision, like dark glass or even HDR vision glass for welding [3]. These systems are useful where diminished reality is desired.
3. Those which are dynamic and can do both, as needed.

Many augmediated reality systems are of the third type, designed as a generalized platform with the intention of supporting a variety of applications [10]. These systems consist of input and output devices, respectively, with computer processing in between [9, 6, 5, 7].

The augmediated reality system in this paper is strictly additive (type 1). It is also purpose built for the specific application of the visualization of radio waves, in the same fashion as early augmediated reality experiments carried out by Steve Mann in the 1970s [8] (See Fig. 1).

Recently, with the availability of high efficiency and small SMD LEDs, the SWIM no longer relies on incandescent light bulbs and has thus become more practical.

This paper presents two new incarnations of SWIM. The first is based on surface mount version of the LM3914 (Fig. 2) and provides high resolution (10pixels/cm) at a modest board size. The second is a novel circuit which is used to make a small wearable SWIM which is unprecedented in miniaturization, making these experiments in augmediated reality ever more practical as a wearable computer, and also making it possible, if desired, to further miniaturize the apparatus into a single die chip for use in eyeglasses or contact lens displays [Mann 1999, CA2280022], with just two transistor elements per pixel (Fig. 3).

Head mounted displays [4], have been used extensively as the output device of choice for augmediated reality systems [1]. This is natural because they are usually already designed to work as computer displays. These types of devices are well suited to personal augmediated reality experiences, but do not work as easily for activities where multiple people or groups of people are involved and wish to partake in the same experience. For everyone to participate, everyone must wear their own pair of glasses, and high level software/networking systems are required to render the experience for everyone. This creates bottleneck points and opens up opportunities for delays and other issues which can strip the system of its humanistic intelligence, making the experience anything from less convincing to illness-inducing to painful [2]. SWIM eliminates the complexity imposed by the need for a general purpose system, and instead focuses as a single-purpose-built augmediated reality system which makes visible normally invisible radio waves. In order to achieve this effect, the SWIM is simply driven with the doppler return output of any low power X band microwave radar set.

SWIM works similarly to an oscilloscope with no timebase generator, by painting out a sensed/measured wave in light so that it is made visible. Instead of the effect of the oscilloscope phosphor we have the phenomenon of persistance of

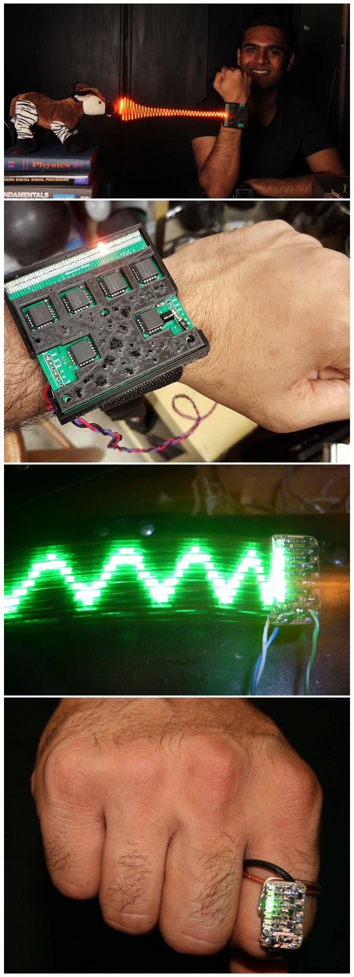

Figure 4: Wearable augmented reality without special eyeglasses. Wristworn and finger-worn. The “SWIM ring” is compact, wearable, lightweight, and easy to use. Waving the ring back and forth makes metaveillance waves visible.

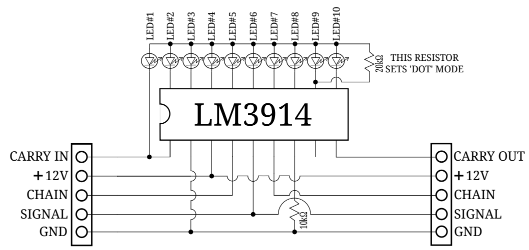

Figure 2: Schematic of modular LM3914 SWIM device.

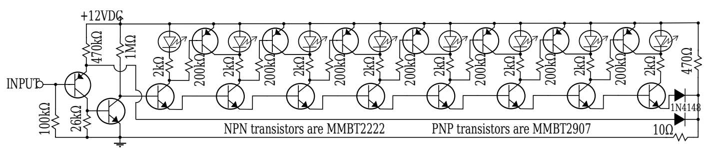

Figure 3: Schematic of novel discrete transistor LED SWIM device.

exposure [8]. An oscilloscope works in real-time but virtual-space, on its own 2D display, like most AR systems, while the SWIM uses a 1D display to produce an image like a 2D holograph, which is registered in real-time as well as in real-space, as the user sweeps the SWIM device itself through the waves in space. Last and perhaps most importantly, the augmediated reality experience SWIM creates is easily shared among a group of people, all of whom may bear witness with the naked eye, as shown in Fig. 4.

Recent Advances in SWIM

Recently SWIM (and augmented reality in general) has attracted considerable interest, and many are being built. The simplest to implement were digital, with a microcontroller driving cascaded serially programmable WS2812 RGB "neopixels", which can conveniently be purchased in a strip, but pixels are large (greater than 0.5cm) and they suffer from a limited refresh rate. SWIMs of the 1980s and ’90s were built around the LM3914 cascadable 10 segment dot/bar graph display driver IC, which produces excellent results with a high degree of accuracy, tested up to 200 cascaded ICs for HD pixel counts (2000 pixels) and large scale size. This modular design used is seen in Fig.2. The LM3914 was measured to have a bandwidth around 1.6Mhz, which translates to a very high "refresh rate" and the simple analog system controlling it approaches linear time invariancy, eliminating the possibility of any lag. Thus the system always responds instantly and the experience is seamless and convincing: humanistic integrity is maintained. LM3914 ICs were used to make a wristworn "microswim" pictured in Fig.4, which is a 60 pixel SWIM, utilizing 0603 size SMD LEDs, which fits on a 6cm square PCB (its image also shown in the same figure). A novel discrete transistor circuit has been devised, pictured in Fig.3, which makes a low pixel count SWIM smaller and cheaper than is possible with the LM3914. Pictured also in Fig. 4 is an 8 pixel discrete SWIM (fits on a 1.25cm by 1.9cm PCB small enough to be worn a ring) together with its output image.

Tactile SWIM for Haptic Augmented Reality CAD/M

Some of the early embodiments of SWIM began as electromechanical devices, which naturally lent themselves to being grasped, held, touched, etc.. One of Mann’s early experiments was to use an X-Y plotter to visualize (and feel) radio waves, sound waves, and the like (Fig. 5). This gives way to haptics for collaboratively creating physical objects: HARCAD (Fig. 7), a system to explore “Cyborg Craft”, a new kind of undigital craft: being undigital with digital computers. In this system, one or more users can grasp and touch and feel virtual objects in cyborgspace, and share the resulting haptic augmented reality experience, as a way of

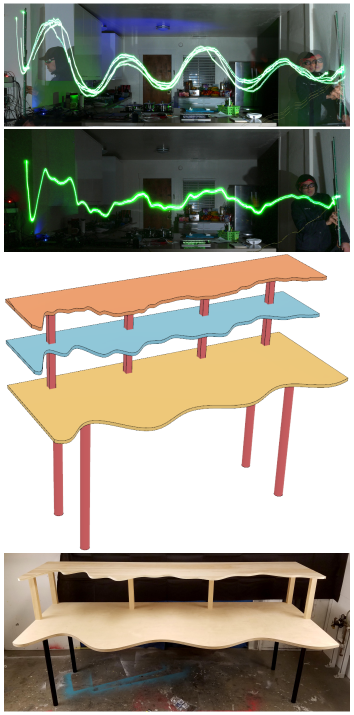

Figure 6: Furniture design with Haptic Augmented Reality CAD/CAM. A shape synthesizer generates shape information which is visualized in alignment with haptic sensation, so shapes can be seen and felt in perfect alignment. A 3D (3-dimensional) wireless position sensor comprises transducers with phase-coherent detection. Ultimately we bypass CAD altogether to directly and collaboratively interact with the manufacturing process. That's what we call "undigital cyborg craft".

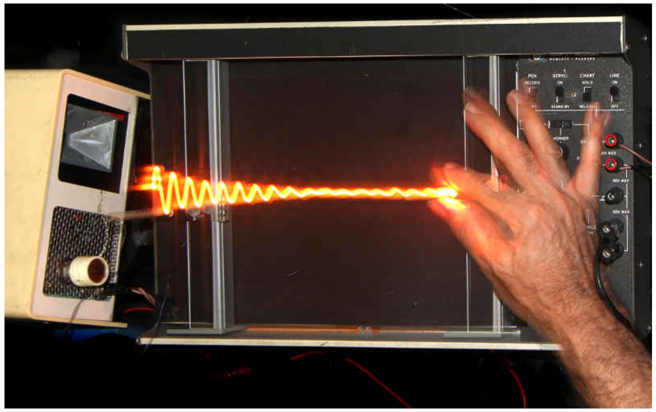

Figure 5: Mann's early haptic radio wave experiment using X-Y plotter to touch, feel, and grasp hold of radio waves in perfect alignment with reality, due to simple physical phase-coherent detection. (visuals from single light bulb + haptics).

designing and making things like cars, buildings, furniture, etc., through a collaborative design and realization process.

As a simple example, we wished to make a table with a nice curvy shape to it. A good place to begin is with waves. As a basis for synthesis, we have a shape synthesizer. In some embodiments the shape synthesizer is made in software, from simple shapes like rectangles, circles, ellipses, etc., as one might find in a computer program like Interviews idraw, Inkscape, or Autodesk Fusion 360. In other embodiments the shape synthesizer exists as a piece of hardware, as illusrated in Fig 6: Topmost is a multiple exposure, showing three exposures while moving back-and-forth, which align, approximately, with each other, while admitting a small variation. The shape is sculpted by press-pull operations. Additionally, harmonic variations are made to the shapes, to design furniture. Here a wavetable is designed in which

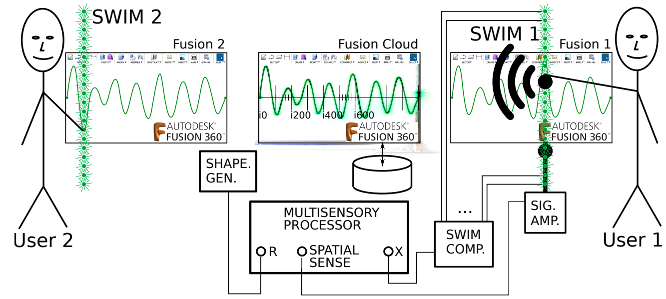

Figure 7: HARCAD system for designing furniture or other objects using two Tactile SWIMs, one held by each of two users at remote locations to press/pull on an Autodesk Fusion 360 model.

the table is the fundamental of the waveform from a musical note, and the shelf above it is the fundamental and first overtone (i.e. the first two harmonics). Here the amplitude of the waveforms decreases from left-to-right as we move further from the sound source.

Another application is PlankPoint™, a collaborative fitness system where a planking board is a pointing device for collaborative online games using HARCAD-like technology.

Conclusion

New wrist and ring worn SWIM devices make the SWIM device more wearable than ever, and LEDs allow high resultion and high luminosity with low power consumption. As a result, clear and bright AR (Augmented Reality) overlays are produced for a truly phenomenologically augmented reality. Multiple SWIMs can be used as metawands (metaveillance wands), and when equipped with haptic capability allow users to share the augmented reality with machines, for HARCAD and ultimately HARCAM.

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