LITERATURE REVIEW

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Contents

Introduction

Many new devices have been created to help athletes improve the quality of their training. For example, swimmers are now able to listen to music underwater and track their lap count and heart rate. Some devices even allow swimmers to see their times and stroke rates. However, not many devices are able to warn a swimmer of an obstacle in his or her way.

Capacitive Sensors

Within the broad category of capacitive sensors, there are two types of sensors: parallel-plate capacitors and fringe capacitors. Parallel-plate capacitors use two "plates" to sense the object. The sensor itself is one of the plates and the object is the other plate. However, parallel-plate capacitors can only be used to sense objects that are conductors. Fringe capacitors use live electrodes to detect an object. Unlike parallel-plate capacitors, fringe capacitors do not require the object to be a conductor. (Chen 1998)

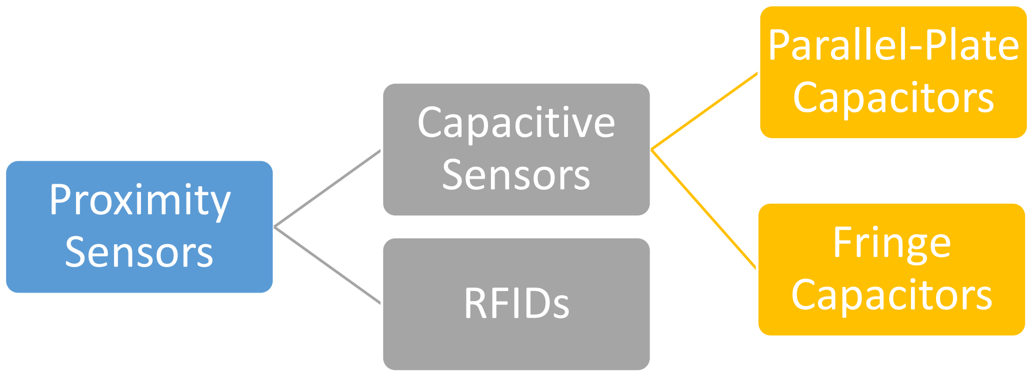

Figure 1. The hierarchy of proximity sensors.

Radiofrequency Identification

Radiofrequency identification is one way to distinguish between objects. The apparatus uses two parts: a reader and a tag. The tags are passive, meaning they do not transmit any signal. These tags do not require batteries, can be waterproof, and are very small (Nath 2006). Many systems today use radiofrequency identification to assist in simple processes. For example, "EZ-Pass" uses radiofrequency identification to allow for a quicker transition at tollbooths (Nath 2006). Although radiofrequency identification tags can be waterproof, radio frequencies do not often travel well through water (Schill 2016). Low frequencies have very short underwater ranges, and high frequencies have even shorter underwater ranges (Schill 2016).

Displays

The display of any device is critical for the device to be functional. Without the display, the user would not be able to retrieve the feedback that the device is trying to relay. In most cases, instant feedback is essential for athletes and students in learning and correcting a skill (Hagem 2015). Whether the display uses light, sound, or vibration, the user must be able to interpret these transmissions.

Heads-Up Display

One type of display often used in optical devices is the heads-up display. Heads-up displays work by projecting an image into the field of view of the user. This method creates the three-dimensional effect that makes heads-up displays similar to holographs in appearance. Heads-up displays are used by all types of virtual reality goggles to give the user a realistic experience without making the device too bulky. The visual display used in heads-up displays is effective for communicating information to the wearer without resorting to color-coding the information. (Caudell & Mizell, 1992)

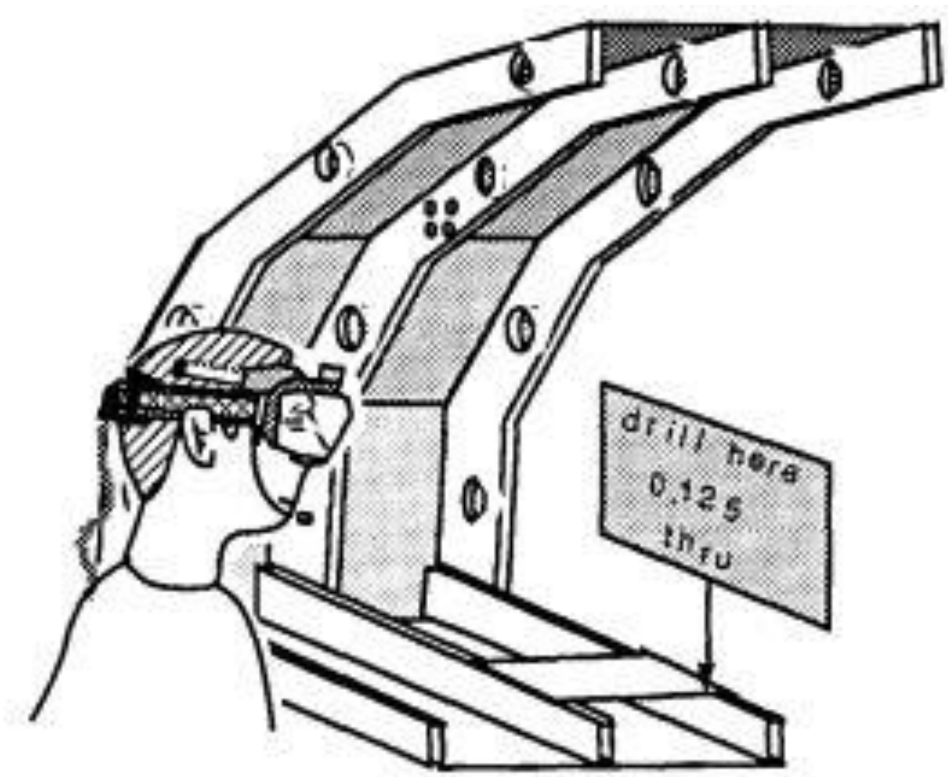

Figure 2. An example of what a heads-up display would look like in a manufacturing setting. (Caudell & Mizell, 1992)

Previous Display Methods

Many devices use a variety of display types. Light emitting diodes have been used with different colors or intensities to communicate with the user. In a stroke rate sensor, the display includes three different colors of light emitting diodes. A swimmer is able to preset a goal pace and the device is able to calculate and display whether the swimmer goes faster than, slower than, or keeps up with his or her preset pace. The swimmer is able to determine his or her speed because the display uses a red light emitting diode to indicate that the swimmer is moving too slow, a blue light emitting diode to indicate that the swimmer is right on track, and a green light emitting diode to indicate that the swimmer is moving faster than his/her preset pace. (Hagem 2013)

Similarly, a device created by a few British engineers uses optical guides as the display. The guides are paths that steer the light into the position required for the image that is to be displayed. The entire display utilizes seven, fourteen, or sixteen guides. The final result of the display is an image that can contain numbers, or a combination of letters and numbers. The display is also focused at infinity, with the depth of field starting in front of the glasses and extending to infinity. This method provides a completely transparent display that the wearer can read and see through at the same time. Heads-up displays can be used in any optical device that has a clear viewing surface. (Hazell, Millar, Williamson, & Golder, 2006)

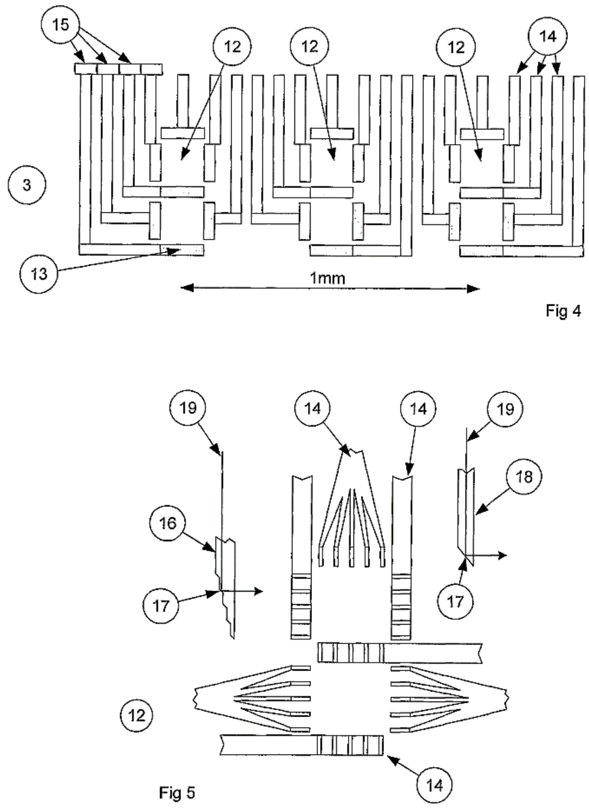

Figure 3. Light guides positioned in a segmented display (Hazell, Millar, Williamson, & Golder, 2006)

Goggle Devices

Swimming goggles are a common piece of equipment for swimmers. The goggles are comprised of two plastic cups connected by a nose bridge and a stretchy, flexible strap. The cups are designed in such a way that there is enough space between the swimmer's eyes and the plastic to prevent blurry vision. The cups also have a flat surface directly opposite the eye; this surface is angled to minimize light refraction. This slant also optimizes the swimmer's field of vision. A removable suction cushion is placed on the outside rim of each of the two plastic cups for comfort. The basic structure of swimming goggles allows the equipment to be used as a base for many other devices, such as the device described below. (Yokota 2007)

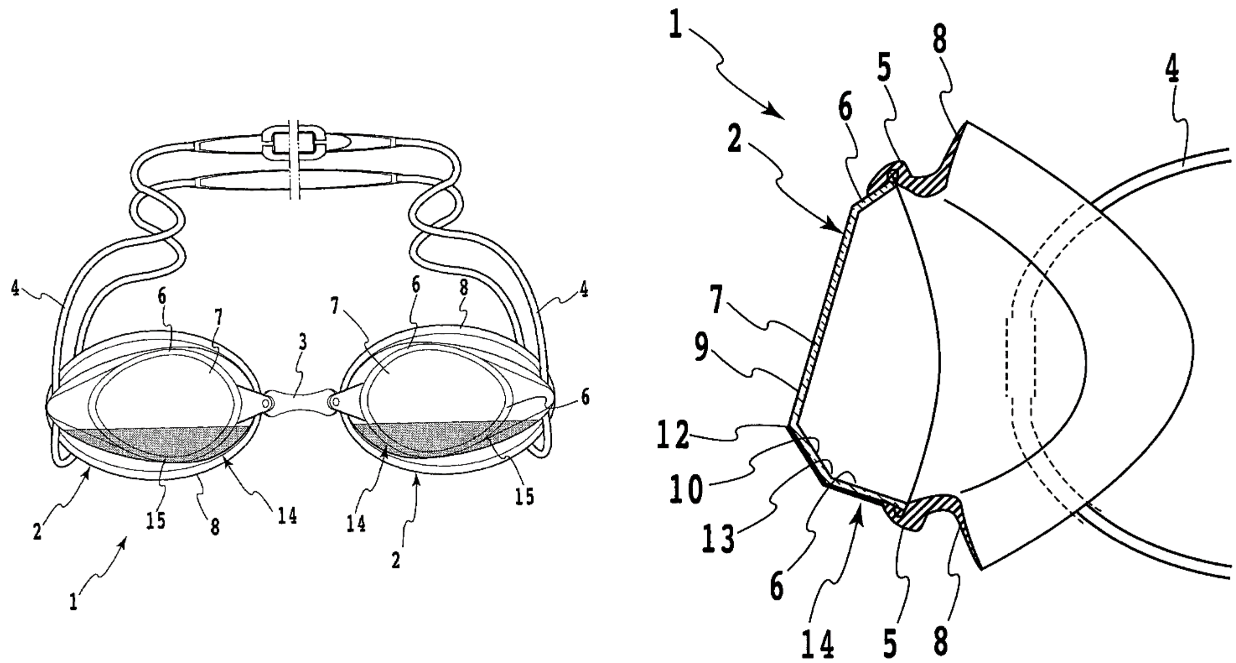

Figure 4. (Left) A front view of a pair of swimming goggles. (Right) A side view of a pair of swimming goggles. (Yokota 2007)

Another electronic timing system uses an accelerometer. The device can measure how long each swim stroke takes, recognize flip turns, and detect stops. A liquid crystal display is used in a pair of swimming goggles to show lap counts, total times, split times, and heart rates. The device shows flashing light emitting diodes when the heart rate increases or decreases. (Taba 1997)

Conclusion

Many of the devices that have already been created were designed to assist swimmers in tracking their training. Regarding displays, heads-up display is an ideal method for displaying information, but light-emitting diodes are much simpler to use. The timing systems and accelerometers used in previous devices cannot warn a swimmer of an upcoming wall, but proximity sensors could help prevent a crash. There is a need for a device that indicates when a swimmer is approaching a wall so that he or she can prepare for a turn without delay.

Engineering Plan

Problem Statement

Many swimmers do not pay attention while swimming and end up crashing into the wall. This collision can cause injuries ranging from scrapes the size of a paper cut to broken fingers.

Engineering Goal

The goal of this project is to engineer a device that utilizes a proximity sensor and a display to warn swimmers of an upcoming wall.

General Overview of Potential Methods

Radiofrequency identification technology was used for the proximity sensor. The display was built using light-emitting diodes. These technologies were attached to a pair of swimming goggles. All assembly was done at home and at school. The technology was tested outside of the water (in air) first, in order to ensure that the systems were functional. Next, the system was tested in a tub of water to check that the device was water proof. Finally, the device was tested in the water at a pool. The data that included collected during these tests was how many times the sensor was able to accurately sense the wall to within 10 centimeters and whether or not the display was functional.

The potential risks involved in this project were minimal. The main concern was putting electronic equipment in water. Safety measures such as being cautious and putting the electronics in the water while they were turned off were utilized. Proper safety techniques learned in an Engineering class were also utilized. In addition, an insulating material was used to protect the tester.

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