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Research Summary

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The E-Wand

The purpose of this report is to research and discover the mechanics and the dimensioning for an LED persistence of vision display. To be brief, the requirements I will focus on are as follows: it must be visible from fifty meters, portable, storable in a trunk, easily disassembled and reassembled, and able to display images and words readable by people driving on a freeway. These are the qualities I am focusing on for this part of the research.

A person with 20/20 vision could possibly read something 73 mm across from 50 meters, but most people would probably find that difficult. This is based on the fact that at 20 feet or 6 meters, a human [eye](http://en.wikipedia.org/wiki/Real_versus_nominal_value) is able to separate lines that are 1.75 [mm](http://en.wikipedia.org/wiki/Millimetres) apart.1 People driving in a car would have difficulty probably noticing something this small so it is recommended that it be at least 363mm which is five times as large. In this case a person with 20/100 vision could read it. Also at fifty meters and traveling at 70 mph on a freeway, the object would only be visible for about 1.6 seconds. Also be aware that according to some research a driver’s reaction time can take over 1.5 seconds. Stopping at a speed like 70 mph can take over 95 meters. The E-Wand should err towards a larger size.

In relation to the weight it should probably weigh less than 20 lbs. for easy movement. Based on studies of similar products, it should not be very difficult to keep within this criterion. The material of the wand should be as light as possible for less power consumption and wobbling. Light plastics appear to be the recommended material because they are safer and sturdy enough that they will not break very easily.

If the vertical wand orientation is chosen, the wand should rotate in a direction the opposite of traffic so that driving fast in the same direction of the rotation will not affect the clarity of the image. According to Wikipedia’s article on the flicker fusion threshold, the human eye sees at around 16 frames per second, but it can vary with many factors. The brighter the flashing, the faster it can usually be seen, possibly even 60 Hz or higher frequency can still be visible.2 Based on this research, a rate of approximately 30 Hz is recommended. If needed a second wand could be attached along with another rotation arm, but research seems to state that the motors can spin plenty fast as long as the load is light enough.

In studying LED components, the RL5-RGB-C-2 Clear TriColor LED is currently the recommended LED product. It cost $0.79 each for this 5mm sized LED. Although research concerning the microcontroller is not the topic of this study, so the number of pins is not known, a recommended 90 or so LEDs seems logical for a higher quality display. However this could easily be on the expensive side and more high-end than the product needs to be. One display seen in research had 112 LEDs and appeared to be much clearer than required for this product. The needed quality could easily be attained with 45 LEDs. Ratios close to the golden ratio are easier on the eyes. Therefore the vertical orientation of the display would be the typical 16:9 aspect ratio. The height of the wand portion is therefore recommended to be 450mm with radius of rotation at 400mm.

There are many build-it-yourself kits that are for a display similar to this product. One of the easier ways to go about this project then would be to change some of these home projects into a working product that could be used in a more professional setting. Also these are mostly much smaller than this product so there are scaling issues that will have to be dealt with. These include power, materials, and storability issues. One pre-made product is called a Minipov. It comes with its own microcontroller and all the necessary components.

One of the issues mentioned in the previous section not covered previously were the storability issues. This product needs to be easily disassembled and reassembled. For this to happen, the wand and rotating arm should detach from the base. It seems reasonable based on other products and on car trunk sizes, the product should probably be able to fit in a foot by foot box aside from the detachable wand.

The device should have a stable base, but as long as the part that rotates is properly balanced there should be no problem. An interesting proposition would be to make it magnetically attachable to a car’s roof. This should probably be a permanent magnet so that it does not consume power like an electromagnet. However this could make it harder to store because a powerful magnet should be kept away from many electronics.

An alternative to the vertical wand is a horizontal radius of rotation, this could be a much easier solution mechanically, but from a coding perspective could be more difficult. It also lacks the ability to be seen from 360 degrees like the other type of display. The horizontal rotation would probably be lighter and take up less space. In general simpler it better and it would make the product simpler, but it seems to be less effective in many of the ways the original proposed product are.

Works Cited

*1.* *Visual Acuity* en.wikipedia.com, (Wikipedia cites: Encyclopedia Britannica 2006) 2/5/14

*2.* *Flicker Fusion Threshold* en.wikipedia.com, (Wikipedia cites: Intermittent Stimulation By Light : V. The Relation Between Intensity And Critical Frequency For Different Parts Of The Spectrum. Hecht S, Shlaer S. J Gen Physiol.) 2/7/14