Near Eye Displays: A White Paper

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***Abstract*—This paper discusses the technology and development of augmented reality and virtual reality in head-mounted displays. The conception of this project is based on creating an assistive device capable of allowing deaf or hard of hearing individuals the opportunity to communicate in otherwise difficult situations. This includes group conversations, noisy environments, etc.**

***Index Terms*—Virtual and augmented reality, smart clothing, microdisplay, optical head-mounted display, wearable technology,**

I. Introduction

A. Virtual Reality (VR)

Virtual Reality is a virtual environment modeled by computer simulations to recreate the effects of physical reality. It covers a wide variety of applications, such as immersive computer simulations and 3D environments and the development of CAD software, head-mounted displays and so on.

B. Augmented Reality (AR)

Augmented Reality is associated with live views of physical realities that have been altered or augmented in terms of sensory inputs such as sound, video, graphics, or even GPS. AR serves to enhance user perceptions of reality. This is in contrast to VR, which replaces real-world input.

C. Project Forerunner

Project Forerunner is a research and development project aimed at developing an augmented reality head-mounted display capable of translating spoken word into text projected in virtual space. This project's intended purpose is to provide the deaf or hard of hearing with an affordable solution to real-time communication difficulties.

II. Project Scope

The goal of this project is to ultimately design and create a working prototype microdisplay and lens system; however, the scope of this project lies in becoming familiar with the different types of technologies available on the market today. Namely, the goal is to reconstruct the near eye display system in Google Glasses.

The principle elements of Google glasses are listed: LCOS display and control board, polarizing beamsplitter cube with a half-silvered mirror/beam splitter housed inside, a polarization conversion system (PCS) composed of a crossed polarization grating and a polymer diffuser, a wedge fly-eye with a cover reflector adjacent to an LED array, and finally a concave reflector.

Advisor: Professor Moelter

A. How Google Glasses Work

Near eye display applications are lower power systems that use a small RGB LED side-emitting array that feeds light into a wedge-shaped fly-eye homogenizer lens. The wedge fly-eye has a reflective surface (most likely vapor deposited aluminum) that reflects all light back to the fly-eye. Incident illumination from the LED is homogenized by the fly-eye and then pushed through the PCS. The PCS is composed of a polymer reflective polarizing diffuser and a reflective crossed-wire grid based polarizing grating.

Unpolarized light from from the homogenizer/fly-eye reaches the polarizing diffuser, which rotates a small part of the S-input to P randomly. The S-input is the plane of incidence; which includes the propagation direction of the light and the surface normal of the component and is arbitrary for normal incidence. P polarization is defined as the condition where the plane of incidence includes the plane of polarization. The remaining S and P inputs are incident on the reflective polarizing grating which accepts all P inputs but reflects S-inputs back through the polarizing diffuser. The rotating process is repeated as the light passes through the polarizing diffuser and converts remaining S-inputs to P. The light continues through the fly-eye and hits the reflector to once again repeat the process until the PCS maximally converts LED light to P-polarized.

The PCS output beam has a uniform polarization that matches the LCOS array requirements.

III. Sustainability Issues

The presentation's content is summarized in the report in 4 pages. The author should fill, but not exceed, this space.

The report should be a self-contained report, so that it can be understood without studying additional literature.

Use this section to analyze sustainability issues associated directly or indirectly with polymer electronics. Sustainability describes a condition in which natural systems and social systems survive and thrive together indefinitely [2]. A sustainable condition allows people to meet the needs of the present without compromising the ability of future generations to meet their own needs [3]. Because humanity now consumes and pollutes the Earths resources faster than natural and human systems can replenish and clean them, we do not currently live in a sustainable manner [4]. It might prove helpful to consider Commoners laws of ecology, which sound unsurprisingly similar to laws of physics

IV. Procedures and Justifications

The report can be written in LaTeX or Microsoft Word, but LaTeX is definitely preferred. Its appearance should be as close to this document as possible to achieve consistency in the proceedings.

References should be cited as numbers, and should be ordered by their appearance (example: "... as shown in [1], ..."). Only references that are actually cited can be listed in the references section. The references' format should be evident from the examples in this text.

References should be of academic character and should be published and accessible. Your advisor can answer your questions regarding literature research. You must cite all used sources. Examples of good references include text books and scientific journals or conference proceedings. If possible, citing internet pages should be avoided. In particular, Wikipedia is *not* an appropriate reference in academic reports. Avoiding references in languages other than English is recommended.

Figures and tables should be labeled and numbered, such as in Table I and Fig. 1.

TABLE I
SIMULATION PARAMETERS

Information message length	$k = 16000$ bit
Radio segment size	$b = 160$ bit
Rate of component codes	$R_{cc} = 1/3$
Polynomial of component encoders	$[1, 33/37, 25/37]_8$

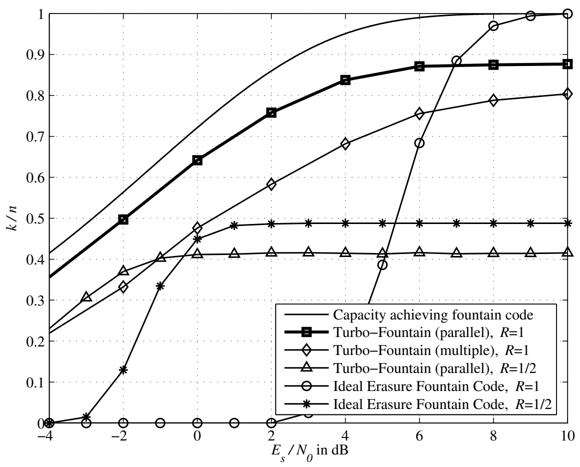

Fig. 1. Simulation results on the AWGN channel. Average throughput k/n vs E_s/N_0.

A. Data

Did the results agree with expectations? Did you encounter any problems? Quantity does not necessarily equal quality, so stay concise. Use your course lab manual as a starting point. If you follow the lab manual procedure exactly, write so, and do not copy and paste the lab manual. Do explain carefully how any procedure you use differs from the lab manual. Please record relevant data clearly, present results accurately, note numerical values, and generally document how you performed all tasks requested in the Lab Manual. Report data using appropriate units, the appropriate number of significant figures, and error bars. Annotate all plots and tables clearly. You may write annotations and some labels by hand to improve clarity or your efficiency. You may sketch figures by hand to improve clarity and save time. Please type figure captions and table captions. Label signals, data, axes, units, and don't assume that your audience can read your mind. Axis labels belong outside the plot area, usually along the left side and across the bottom. Organize data using good judgment. If it proves clearer and more concise to present data in another section of the report, leave a roadmap for your reader.

B. Troubleshooting

Document any troubleshooting completely, both in your lab notebook and in this section of your lab report. If something goes wrong, explain your methodical approach to resolving the problem. Document hypotheses developed to explain any difficulties, explain how you tested each hypothesis, and document any fixes implemented.

V. RESULTS AND DISCUSSION

Label signals, data, axes, units, and don't assume that your audience can read your mind. The previous sentence appears twice on this page, because many students encounter difficulties with this aspect of presenting data clearly. Axis labels belong outside the plot area, usually along the left side and across the bottom. Report results using appropriate units, the appropriate number of significant figures, and error bars.

A. Figures and Tables

Position figures and tables at the top or bottom of a column. Place figure captions below the figures; place table titles above the tables. If your figure has two parts, include the labels (a) and (b) as part of the artwork. Please verify that the figures and tables you mention in the text actually exist. Do not put borders around the outside of your figures. Use the abbreviation Fig. even at the beginning of a sentence. Do not abbreviate Table. Number Tables with Roman numerals. Figure axis labels often provide a source of confusion. Use words rather than symbols. As an example, write the quantity Output Voltage, or Output Voltage VOUT, not just V. Put units in parentheses. Do not label axes only with units. As in Fig. 1, for example, write Output Voltage (V) not just V. Do not label axes with a ratio of quantities and units. For example, write Temperature (K), not Temperature/K.

Multipliers can create great confusion. Write Current Density (kA/cm2) or Current Density (103 Acm-2). Do not write Current Density (A/cm2) 1000 because the reader would not know whether the axis label meant 16000 A/cm2 or 0.016 A/cm2. Make figure labels legible, approximately 8 to 12 point type. Refer to all figures and tables in the text. Each plot and table requires a caption and number. As an example, Fig. 1 shows how the Output Voltage, VOUT, of the NMOS inverter in Fig. 2 decreases with increasing Input Voltage, VIN. Fig. 1 and Fig. 2 also illustrate IEEE figure and graph formatting. Table III compares predicted circuit parameter values with measured values and illustrates IEEE table formatting

B. Sizing Graphics

Most charts graphs and tables are one column wide (3 1/2 inches or 21 picas) or two-column width (7 1/16 inches, 43 picas wide)

VI. Experimental Results / Pre-Lab Comparison

Compare results with predicted and anticipated values. Explain similarities and differences clearly, specifically, and quantitatively. Answer all how and why questions.

VII. Conclusion

Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions. The conclusion explains what you learned by doing the pre-lab, experiment, and key analyses.

Appendix

Acknowledgment

References

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[3] J. G. Proakis. *Digital Communications*. McGraw-Hill Book Co., New York, USA, 3rd edition, 1995.

[4] F. R. Kschischang. Giving a talk: Guidelines for the Preparation and Presentation of Technical Seminars. http://www.comm.toronto.edu/frank/guide/guide.pdf.

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