DARPA WHITE PAPER (Version 5.0)
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Title - Full Spectrum Night Vision

Technical Subtitle - Low cost, mass producible, inexpensive, conventional eye-glasses: providing the war-fighter with a 24 hour vision experience, functionally equivalent to normal daytime eyesight.

ABSTARCT:

It should be possible, using purely optical physics principles, to construct eye-glasses that collect light and images, and/or a combination of both. For the purposes of this paper, "light" will refer to total luminosity, at the front and back surfaces of the lenses, where light enters the eye, and inside the eyeball itself. These phenomenon are almost purely optical, and require no knowledge of bio-physics. "Images" will refer to a wider range of phenomenon that take place within the eye itself, which does cross over into bio-physics. These images can occur anywhere from the front-most surface of the eyeball, to the optical plane at the back of the eye. This is where the rods and cones are, and where vision ceases to be purely a matter of optical physical phenomenon, and becomes (at least partially), a matter of neuro-science; which is beyond the scope of this paper.

From a manufacturing and materials science standpoint, the lenses can be any optically suitable plastic or glass. However, the primary focus will be on plastics. Glass is a major cost driver at every level, from the finished product, to tooling for prototypes, and tooling for mass production. All are at least an order of magnitude more expensive with glass. Glass can be developed more fully later, when the technology matures. Then we can make other products, like automotive "smart windshields," which will be able do everything these glasses can do, plus everything required of automotive glass. The author will submit a second white paper focused exclusively on automotive, and other, larger, glass applications.

HOW IT WORKS:

There are two important parts in the product, the lenses and the frames. The lenses and the frames will initially be manufactured as two different parts. This will keep costs under control and make possible the use of a much wider range of rapid prototyping techniques. The lens has to come first anyways, because it will provide us with physical proof-of-concept which lowers technical risk close to zero. With a single lens in hand, we can experimentally verify and demonstrate, with near 100% certainty, that we have not overlooked anything critically important. In other words, there are no show stoppers.

To simplify the problems we are likely to encounter in future phases of development, we will not presently be concerned with marketability. If the product is slightly over sized, requires some training to work properly, or even if it is just plain ugly and/or uncomfortable, that's O.K. for now. The ability to make these glasses without much concern for their overall appearance and aesthetics will allow us to do things like fitting electronics and power into the frames which will become increasingly important as the project progresses.

The plastic lens will have around the edge, a series of small, but not microscopic, parabolic reflectors. The parabolas will have geometry such that they will gather ambient light from the wearers environment and redirect it towards the region surrounding the center of the lens. This will increase visual acuity but will not produce a large enough image to project onto the retina. A second smaller ring of planar mirrors will be molded near the center of the lenses visual field, it has to be large enough to cover the iris and pupil, yet small enough to see around. Most importantly, it must be able to redirect an image from the parabolic surfaces without interfering with normal human vision.

It helps to think of the parabolic reflectors as “reverse telescopes.” If you look backwards through a pair of binoculars, you can begin so see for yourself some of the optical phenomenon involved. Binoculars also intensify the luminosity of images, but they do so by destroying depth perception, and severely limiting both the total included angle of vision, and depth of field. This would not be acceptable for our purposes because we want to preserve human depth perception in the near visual field. This includes what we see starting about six to twenty inches from our faces, extending out approximately 100-300 feet.

Typically, only a trained fighter pilot can learn how to perceive depth beyond 100 feet. There are hard and fast limits to stereoscopic vision which can be overcome only with great practice and the risk of severe eye injury.

Most people think they can see depth at longer ranges, it's only because they have memory and knowledge of their environment. If you take the time to look at two distant traffic lights which are not at the same intersection, they both appear roughly the same in size and intensity. You really can't judge how far away they are from each other, at least not without doing some math, while bobbing your head from side to side, and thinking very carefully, about what you can really see, and what you only think you can see.

Fortunately, the science and physics are such, that none of these typical human limitations will stop us from producing a working prototype. We might have to make 100-1000 prototypes before we get to one that does absolutely everything we have outlined above, but we can easily pick off the low hanging fruit and produce something genuinely useful in a wide range of military operations and applications. That said; with around 100 iterations of prototype, experimentation, and re-design, I am highly confident we can get a solid 85-95% of the total functionality described above.

MANUFACTURING PLAN:

Since these glasess will require both a lense and a frame we anticipate the need to produce threee injection mold cavities for the right lense, left lense, and the frame. The very firs step will be to build a 3-D solid model of the entire product. The second step will be to use 3-D printing directly from the model to find out how many of the critical optical features we can produce with commercial-off-the-shelf RP technology. Ideally we could produce the entiree working prototype this way, but that will not work.

The problem has to be broken down according to technical requirements, then cost requirements, then volme requirements, in that order. Failure to plan in the early phases of prototyping leads to massive cost over runs by the time you get into production using injection molding machines and production grade (steel not aluminum) tooling. JAMCORP, the Authors, and our network of 5000+ highly qualified subcontractors can build just about anything; from a pair of glasses to a small fighter jet.

For the purposes of this effort we don't need to concern ourselves with steel tooling. Steel tooling costs 20 times more than aluminum, and produces 50,000 times as many parts before it wears out. Since we need only 100-1000 parts to work out the optics, it makes sense to try aluminum molds first. We will only move to harder materials if we can't get both an adequate tolerance, and satisfactory surface finishes, using aluminum.

We should plan to build 3-5 complete aluminum molds before we consider building our first steel molds. This will cost no less than $5,000 per mold and no more than $10,000 each. The minimum cost for a steel mold is closer to $25,000. This figure will increase rapidly as the needs for finer RMS surface finishes, tighter local and global tolerances, and higher levels of production become important factors in the overall technical success of the project or program.

The manufactuirng aspects of the project are by far the most expensive to carry out. They require high levels of expertise in many areas, and highly skilled, highly qualified manufacturing subcontractors. In general, when managing a prtoject like this one, it is best to push off production for as long as possible. Ideally we can produce a working prototype, which is absolute proof of concept, before we need to move to a phase-2 SBIR.

A Phase-1 SBIR contract ($80K-120K) should be more than adequate to accomplish almost all of the objectives set forth in this white paper. By the time the Phase-1 effort is complete, it will be very clear if a Phase-2 effort (with many serious manufacturing issues), is actually worth the time and expense. Maintaing cost control on this type of effort is something the Authors are extremely good at.

KEY PERSONELL:
Principle Investigators:

Lead investigator, Dr. Jonathan North Priluck PhD
Assistant Investigator, Mr. Ulf Dunberger, Technology Advisor

Technical Advisors
Dr. Peter Weitzman PhD, Optics and Electronics
Dr. John Donovan, PhD, Nanotechnology and micro-fabrication
Mr. Shawn Nelson, Lead Machinist – Owner?Operator One Drop Design

There are many others who will contribute to the success of this project, but they will not add to the overall cost and will only be contacted if the need arises. As President and Founder of Jonathan Aerospace Materials Corporation, Mr. Priluck knows literally thousands of high level techinical, government, business, and industry personell. If we run into a particularly vexing or persistent problem we can always lean on this valuable resource.

WHAT IT WILL COST TO GET STARTED:

Cost is an independent performance variable. It will cost whatever DARPA wants it to cost. Price is a different issue. The price will be fixed and set in stone at the outset of the project. This is because JAMCORP is a Firm Fixed Price Contractor (FFP), we will not even consider a cost plus effort for Phase-1. Firm Fixed Price Contracting is so much more cost effective than Cost Plus Fixed Fee that it is not even worth talking about.

JAMCORP hereby offers a Firm Fixed Price of $120,000 for the complete Phase-1 effort. We require 10% within 15-30 days of a signed contract. All other payment terms are flexible, and should be driven by the needs of the project. Typically we suggest that payments be linked to a schedule of technical reports. When the reports are sent in, and accepted by the program manager, the funds are transferred. Four reports should be about right for a project of this nature. Therefore the cost schedule will be

Project initiation fee - $18,000
1st Report – $25,000
2nd Report - $25,000
3rd Report - $25,000
4th Report - $25,000
Residual administrative costs fee - $2,000 (fully refundable)

Note: the last expense item is purely for administrative costs on our end. It has no bearing on the technical matters, but it does set the stage for further success with future and follow on technology.

INITIAL PROJECT BUDGET BREAKDOWN:

This is really a business issue and as such we have people at JAMCORP who are well qualified to handle these matters. What is important for The Government to understand, is that as a FFP contractor we cannot and should not be required to provide detailed financial information. It slows down the work and adds to the expense, and reduces the overall value to the taxpayer.

That said, if The Government wishes to conduct a financial audit, at their own expense, they are welcome to do so. If the program manager needs to understand how we manage to do so much for so little, that's a different story. Most of these issues can be worked out during the course of work, and only become a problem when techincal and administrative efforts start interfering with one another.

CONTRACTING/ADMINISTRATIVE ISSUES:

We need to be assigned a Program Manager, a Technical Point of Contact (TPOC), an Administrative Point of Contact, and a Business Point of Contact. It is DARPA's responsibility to select the four specific individuals who will take on these roles. We are happy to make suggestions for the positions of Program Manger, there are many excellent PM's I have worked with before on a wide variety of projects and programs over the last 30 years.

For TPOC I suggest we use someone with a deep knowledge of optics, opto-electonics, and a solid general physics background. If you do not have somoene in mind, I can find someone from NSWC Carderoc Labs in Bethesda, MD who can take on that job. I know many people there and I won't have any trouble finding someone approriate.

LEGAL ISSUES/NOTICE:

The entire contents of this paper are the intellectual property of (1) the authors, (2) Jonathan Aerospace Materials Corporation (JAMCORP), a Massachusetts, New Hampshire, California, and Oregon company, with primary corporate headquarters at 736 Fourth Street, Springfield, OR 97477, (3) Dr. Jonathan North Priluck, PhD, and (4) Mr. Ulf Dunberger.

This paper contains a wide range of marketable concepts and ideas which JAMCORP intends to pursue for commercial gain, either immediately and/or at some later date. DARPA is hereby explicitly authorized to make copies for it's own internal administrative and technical purposes.

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SUMMARY AND CONCLUSION:

The technology is feasible. The need is obvious. DARPA is the right agency for this project becuase it is the only agency at DOD that can ensure this technology propagates to all the service branches. This is just a seed, the very beginning of a very large and importaqnt new technology and industry.

The last time Mr. Priluck came up with an invention of this magitude, it spawned a $300,000,000,000 global industry and revolutionized mateirlas science.

None of this is all that hard to imagine. It happened once with Lattice Block Materials, it can happen again. Not only is this program going to be good for DARPA and JAMCORP, it is going to be good for the overall U.S. Economy. It will be good for America. The potential for job creation, on a national level, is significant. This speaks to the very heart of what makes this country so great.

Final note to the reader: Any additional information that may have been overlooked will be provided upon request. Additional information may include, but is not limited to, questions of both a technical and nontechnical nature, as well as business, contracting, legal, and administrative issues. Thank you for your time and attention.

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