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Final Report: The Empathic Operating System (emOS)

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5c. PROGRAM ELEMENT NUMBER

6. AUTHORS
Robert Goldberg, Neha Keshav

5d. PROJECT NUMBER

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5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES AND ADDRESSES
Neumitra, Inc.
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Boston, MA 02111 -

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The views, opinions and/or findings contained in this report are those of the author(s) and should not contrued as an official Department of the Army position, policy or decision, unless so designated by other documentation.

14. ABSTRACT
Physiological measurements have typically been limited to expensive and cumbersome clinical research equipment, causing the relationship between how stress and rest affect performance to be poorly understood. To solve this gap, Neumitra develops wearable technologies with continuous monitoring of stress and rest during daily life demands. Our mobile software incorporates users' physiology with their contextual data, including phone calls, locations, and events, to help mitigate the effects of stress on daily life. This approach offers novel opportunities to inform computing with personal biological needs.

15. SUBJECT TERMS
empathic, stress, wearable device

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	15. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Robert Goldberg
UU	UU	UU	UU		19b. TELEPHONE NUMBER: 617-858-1816

Report Title

Final Report: The Empathic Operating System (emOS)

ABSTRACT

Physiological measurements have typically been limited to expensive and cumbersome clinical research equipment, causing the relationship between how stress and rest affect performance to be poorly understood. To solve this gap, Neumitra develops wearable technologies with continuous monitoring of stress and rest during daily life demands. Our mobile software incorporates users' physiology with their contextual data, including phone calls, locations, and events, to help mitigate the effects of stress on daily life. This approach offers novel opportunities to inform computing with personal biological needs.

This proposal extends our technologies and those of third parties to apply personalized physiologic computations with self-learning software to enhance continuous performance and productivity. The "Empathic Operating System" fosters a symbiosis between biology and technology throughout daily life demands. The interactive relationship between physiological data and software that we develop will empower cognitive performance based on real-time human needs. This empathic software will respond to how you feel with insights and recommendations to help us all perform at our best when we are most limited. By developing this approach for third party devices, we will foster a wide variety of integration capabilities in a mobile applications library to foment radically new approaches in personal physiologic computing.

Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

Received Paper

TOTAL:

Number of Papers published in peer-reviewed journals:

(b) Papers published in non-peer-reviewed journals (N/A for none)

Received Paper

TOTAL:

Number of Papers published in non peer-reviewed journals:

(c) Presentations

Number of Presentations: 0.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):

(d) Manuscripts

Received Paper

TOTAL:

Number of Manuscripts:

Books

Received Book

TOTAL:

Received	Book Chapter

TOTAL:

Patents Submitted

Patents Awarded

Awards

Graduate Students

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Names of Post Doctorates

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Names of Faculty Supported

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Names of Under Graduate students supported

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period: 0.00

The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:..... 0.00

Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):..... 0.00

Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense 0.00

The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields: 0.00

Names of Personnel receiving masters degrees

NAME
Total Number:

Names of personnel receiving PHDs

NAME
Total Number:

Names of other research staff

NAME	PERCENT_SUPPORTED
Project Manager	1.00
Clinical Engineer	0.30
Lead iOS Developer	1.00
User Integration Designer	1.00
User Experience Designer	1.00
FTE Equivalent:	**4.30**
Total Number:	**5**

Sub Contractors (DD882)

Inventions (DD882)

Scientific Progress

See attachment.

Technology Transfer

FINAL TECHNICAL REPORT

Contract number: W911NF-16-C-0043
Proposal number: 62850-LS-DRP
Project title: "The Empathic Operating System (emOS)"
Contract performance period: January 1, 2016 – April 7, 2016

Total contract amount: $140,967.88
Funds paid to date: $0.00
Total amount expended: $140,967.88

Number of project employees: 5
Number of new employees this month: 0

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The Problem Studied

Physiological measurements have typically been limited to expensive and cumbersome clinical research equipment, causing the relationship between how stress and rest affect performance to be poorly understood. To solve this gap, Neumitra develops wearable technologies with continuous monitoring of stress and rest during daily life demands. Our mobile software incorporates users' physiology with their contextual data, including phone calls, locations, and events, to help mitigate the effects of stress on daily life. This approach offers novel opportunities to inform computing with personal biological needs.

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Statement of Work

From January 1 to April 7 ('pre-award period') we focused our efforts on putting together the emOS team such that building out the emOS mobile application would begin immediately upon award of the grant. We on-boarded with several recruiters and candidate sourcing websites, from which we interviewed and on-boarded a Project Manager, a Lead iOS Developer, and a UX Designer. We also interviewed over 50 Android candidates and identified four viable Lead Android Developers; however, we put their offers on hold due to delay on grant award. We have identified and secured a backup Android development shop, Raiz Labs, to ensure timelines and budgets are followed if Android resources cannot be secured. Raiz Labs is a local collaborative mobile application group that does two-week sprints, delivers builds every one to two weeks, and holds face-to-face meetings with collaborators multiple times a week.

We also focused our efforts on optimizing hardware options for the emOS mobile application. To de-risk our own hardware, we validated Microsoft Band 2 data streams, as this device is the only commercially available wearable with the appropriate sensors for compatibility with our analytics. We sourced and began validation with Ineda IoT and Wearable SoC platform for Neumitra's in-house hardware as well.

As requested by ARO, during the pre-award period we have updated our IRB to reflect the current grant proposal with specifications for privacy and consenting concerns. Lastly, with the on-boarded emOS team members, we created a design/product discovery and validation process, as well as a roadmap for iOS and Android development with privacy and data architecture. All activity during the pre-award was documented to DARPA through regular emails or phone calls, as well as in-person during our kick-off meeting.

Work Schedule for Project Tasks

January 2016

The Project Manager for the emOS team was hired on January 1, 2016, and began work with Neumitra on January 4, 2016. The Project Manager began an intensive search for project staff while concurrently carrying out a deep-dive and knowledge transfer for technologies and previous approaches and implementations. The Project Manager began interviewing Android and iOS developers, and began the

interview process with the Lead iOS developer that was ultimately hired in February. As requested by the DHRPO, the Clinical Engineer began incorporating the emOS grant into an IRB proposal. Additionally, the pre-existing User Interface designer and Junior iOS developer furthered development of iOS app based on a previous approach.

Deliverable: Project Manager hired and integrated with existing efforts

February 2016

February started with an informal kickoff meeting between the DARPA team and Neumitra employees. The Lead iOS developer was hired on February 10, 2016. Following this, the part-time User Experience designer was hired on February 15, 2016.

Deliverable: Lead iOS Developer and part-time UX designer hired

March 2016

The Lead iOS developer and User Experience designer began at Neumitra, and the Project Manager held an internal kickoff with the emOS team – the Project Manager, User Interface designer, User Experience designer, and iOS developers. The emOS team began the design process for iOS and Android joint design and development. Additionally, knowledge transfer between the User Interface designer and User Experience designer began, which consisted of a review of three years of designs and rationale. The emOS team investigated Spotify and IFTTT APIs and reaffirmed the expected level of effort. The team created a Microsoft Band 2 data pipeline for iOS, providing a third party ecosystem to de-risk our own hardware. After carrying out a User Interface/User Experience brainstorming session with the emOS team, the team began engagement personas research for design for iOS and Android. User Experience concepts were abstracted and tested, with anecdotal evidence providing a cardinal direction for app development.

Deliverable: Lead iOS Developer and part-time UX designer integrated with existing and new efforts

Deliverable: Designed modular and proper iOS architecture and design and tested third party integration strategy (Spotify, Facebook, Box, Nest, Dropbox), app database (Realm), and location services

April 2016

April began with significant movement on Android pipeline, and we began to see highly qualified candidates. By the first week of April, paper prototypes for a new User Interface for iOS were complete. The User Interface/User Experience survey, developed in March, was fielded with over 30 responses and 3 in-person interviews. We received a 'Stop Work' notice on April 7th.

Deliverable: Paper prototypes of new UI framework for completed

Deliverable: UX/UI survey fielded and analyzed