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INVENTION REPORT AND RECORD

PRIVILEGED AND CONFIDENTIAL

Information herein is submitted for purposes of seeking legal advice concerning patentability, copyrightability, etc. Such information is subject to legal and other review and confirmation.

OFFICE OF THE GENERAL COUNSEL
COLUMBIA TECHNOLOGY VENTURES

TECHVENTURES OFFICE USE ONLY	
IR#:	
DATE REC'D:	TLO:
OGC:	OLC:

INVENTION REVIEW (PICK ONE):

☐ NO REVIEW NECESSARY
REASON: _____

☐ STANDARD IRM:
☐ WITH CTV/PLG/OLC ☐ WITH CTV/PLG ONLY

☐ URGENT IRM (WITHIN 48 HOURS):
☐ WITH CTV/PLG/OLC ☐ WITH CTV/PLG ONLY
REASON: _____

☐ NO ASSESSMENT NEEDED
BECAUSE: _____

SECTION I: REQUIRED INFORMATION

A. Potential Inventor(s): *(inventorship subject to legal review)*

Full Name	Leon Aharonian	Full Name	Sunil Agrawal
Position	Intern	Position	Director
Department(s)	MechE	Department(s)	MechE
Center(s)	RoAR Lab	Center(s)	RoAR Lab
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CU email / UNI	NA	CU email / UNI	sunil.agrawal@columbia.edu
Permanent Address	735 W 183rd st apt 4E	Permanent Address	
City, State, Zip	NY, NY, 10033	City, State, Zip	
Full Name	Rosemarie Chiara Murray	Full Name	
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City, State, Zip		City, State, Zip	

Please use additional copies of this page for more than four names

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B. Title of the Invention: *(should be brief and descriptive)*

PoMS: Posture Monitoring Shirt

- If any disclosure of the invention is anticipated, please provide details in Section E -

REQUIRED INFORMATION (cont'd)

C. State, as fully as possible, what the invention is:

(including materials and components used; operative and preferred ranges of process parameters and concentration of chemical compounds; and foreseeable uses of the invention. Please also describe the commercial opportunity that this technology addresses, either below or in sections N-T. Supplemental material, such as publications, protocol, presentations, or images, may be included/attached when the form is submitted.)

The invention is a comfortable, highly informative, accurate posture monitoring shirt, which does not limit the wearer's natural range of motion.
Materials included a regular compression shirt for maximum comfort, and inexpensive sensors so that ultimately the product can be easily mass-produced. The sensors do not limit the wearers' natural range of motion.
The Posture Monitoring Shirt (PoMS) consists of a tightly fitting garment with twelve stretch sensors whose electrical resistance changes with their length. The resistance of each sensor was recorded with an Arduino circuit. To help account for the hysteresis in the sensors, the change in resistance over time (derivative) was also recorded. Posture was defined as a set of three coordinate transforms: pelvis to sternum, sternum to left shoulder, and sternum to right shoulder. An experiment was conducted to determine the accuracy of PoMS. During the experiment, the ground truth posture was recorded with a Vicon motion capture system and retroreflective markers strategically placed on appropriate anatomical landmarks. The coordinate transforms were generated with Matlab using the Vicon recorded position of the markers. Subjects (n = 5) performed six cyclic movements, using specific degrees of freedom. Afterward, they incorporated movement in all six degrees of freedom into one minute of random torso motion. Four Machine Learning (ML) regression models were created to predict the torso posture based on the resistance input data: Linear Regression, K Nearest Neighbor, Random Forest, and a Neural Network. The algorithms were trained with the single degree of freedom movements and used to predict the freestyle, random movements. The results were very promising and show that the developed methodology works. The PoMS can be used for an extremely wide variety of medical and athletic applications. Since almost everyone tends to have bad posture and back problems are very common, the PoMS can help millions of people nationwide.

The creation of PoMS enables scientists to easily and accurately record body posture making studies of various diseases, such as scoliosis, much more efficient. The shirt could also help millions of individuals who experience back pain as a result of habitually assuming a hunched posture when sitting. This will especially improve the lives of programmers and construction workers. It would also give athletes, in practically every sport, the opportunity to review their movements, allowing them to efficiently improve their technique. The PoMS can also be transformed into a biofeedback device to help wearers improve their posture in real time while jogging, walking or sitting.

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SECTION II: CRITICAL INFORMATION

Note: Please complete Sections D and E to ensure compliance with federal regulations.

D. Federal Grant/Contract or Subcontract Funding: *(Include applicable center grants, e.g. MRSEC, NSEC etc.)*

Was the invention conceived or first actually reduced to practice in the performance of work funded, in whole or in part, by any federal grant(s), contract(s) or subcontract(s)? If yes, list below. ☐Yes ☐No

Will any federal sponsoring entity be acknowledged if information related to this invention is published or disseminated to the scientific community? If yes, list below. ☑Yes ☐No

Sponsor(s):	Grant/Contract Number(s):	Principal Investigator:	Administering Dept/Center:

If any grants, contracts or subcontracts were awarded to an entity other than Columbia University, please specify which entities:

Commented [GU1]: Technically, the supplies were purchased on the spine brace NSF grant, and they should be acknowledged in publications.

E. Publication, Public Disclosure & Other Activities:

Note: If the answer to any of the following questions is YES, please provide detailed information and attach any grants, abstracts, manuscripts, articles, presentations, etc. Please keep your Technology Licensing Officer informed of any future submission or acceptance for publication or other possible public disclosure of any manuscripts, abstracts or oral presentations describing the invention.

Has the invention been described in any publication(s) (including abstracts)? ☐Yes ☑No

Name of publication, journal or website	Date of publication

Has a manuscript describing the invention been submitted for publication? ☐Yes ☐No

If yes, has it been *accepted* for publication at this time? ☐Yes ☐No

Name of publication, journal or website	Date of publication

Has a description of the invention *appeared online* (including conferences and abstracts)? ☐Yes ☐No

If yes, please note the date(s) and details of the online disclosure:

Was a grant application describing the invention submitted for review? ☐Yes ☐No

If yes, please note the date(s) and details of the grant application:

Was the invention disclosed publicly, such as in a poster session, presentation, or lecture? ☐Yes ☐No

If yes, please note the date(s) and details of the poster session, presentation or lecture:

Was the invention or any derivative product sold, offered for sale, or used in public? ☐Yes ☐No If yes, please note the date(s) and details of the derivative product:	
Were any materials (biological or otherwise), documents, information or software related to the invention provided or disclosed to any third party (including academia, industry or government)? ☐Yes ☐No If yes, was there a confidentiality agreement in place? ☐Yes ☐No If yes, please note the date and circumstances of the disclosure:	
Are any of the above disclosures or activities contemplated in the near future? ☐Yes ☐No If yes, please provide the details of any potential disclosures in the near future:	

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SECTION III: THIRD-PARTY OBLIGATIONS

F. Columbia Resources:

Please list all Columbia administrative units under whose auspices the inventors' research activities have been conducted which resulted in the invention:

Columbia University Dept/Center/Institute/etc.	Recipient Inventor	Type of Support (i.e. salary, space, other financial, in kind, etc)

Was the invention developed at the Shapiro Center for Engineering & Physical Science Research (CEPSR)?	☐Yes ☐No
Was the invention developed at the Russ Berrie Medical Science Pavilion (Audubon II)?	☐Yes ☐No
Was the invention developed in a NYSTEM funded facility at Columbia?	☐Yes ☐No

G. Is the invention related to any third party agreements <u>not</u> identified elsewhere on this form?

Materials obtained from a third party, e.g., under a Material Transfer Agreement (MTA)?	☐Yes ☐No
Did your invention utilize any materials that were created by or utilized the 'TET-System,' a tetracycline (or tetracycline analog) regulated gene expression technology, including both the overall system and any of its individual components?	☐Yes ☐No
Equipment from a third party?	☐Yes ☐No
Sponsored Research Agreements (SRAs)?	☐Yes ☐No
Other? (such as Consulting Agreements)	☐Yes ☐No

If yes to any of the above, please provide details including agreement number and department:

H. External Resources & Funding:

Was any part of the invention developed in a non-Columbia owned facility?	☐Yes ☐No
Were St. Luke's Roosevelt resources used in the development of the invention?	☐Yes ☐No
Were any of the inventors funded by Howard Hughes Medical Institute (HHMI)?	☐Yes ☐No
Were any of the inventors funded by NY State Psychiatric Institute (NYSPI)?	☐Yes ☐No
Were any of the inventors funded by the Center for Advanced Technology (CAT)?	☐Yes ☐No
Were any of the inventors funded by a company based in the state of New York?	☐Yes ☐No
Was the invention developed using other funding sources, not previously described herein?	☐Yes ☐No
Were any of the inventors funded by NYSTEM?	☐Yes ☐No

If yes to any of the above, or if awards and/or support was provided by another source not listed above (non-federal grants, gifts, etc), please provide details:

Award Source/Sponsor	Award #	PI	Date Funded	If awarded to an entity other than CU, please specify

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I. Inventor Affiliations:

At the time of making an inventive contribution, were any potential inventors employees, officers, or students of an entity other than Columbia University? ☐Yes ☐No

If yes, please provide details:

At the time of the inventive contribution, were any inventors salaries paid by more than one entity or department/center concurrently (i.e., shared salaries)? ☐Yes ☐No

If yes, please specify which entity and the approximate percent of employment and relevance:

Inventor	Entities/departments/centers	Percent employed at each

J. Other Contributors

Did any person other than those named in Section A contribute any of the following to this invention? For software and other forms of copyrightable material, the University requires a list of all authors of code/text. We realize this may be wholly/partially redundant. It is necessary for legal reasons. ☐Yes ☐No

If yes, check all that apply

☐ Software ☐ Data/database	☐ Text (document, questionnaire)	☐ Audio/Video recording ☐ Other copyrightable work

If yes, please provide the following details about your selections above:

Details, including origin:

Website(s) and/or descriptions of the above materials:

Author Full Name (if an individual)	Institution/Company (at time of authorship)	Current Institution/Company (if different)	Email	Phone

Please deliver a complete/working copy of the above materials to: TechVentures@columbia.edu.

This may include source code, executables, screen shots, technical documentation, manuals, permissions, or license agreements governing your use of third party code and materials. If the material is too large to be emailed, please email TechVentures@columbia.edu to arrange for delivery.

Were any Biological Materials (e.g. plasmids, vectors, genetically engineered animals) from an outside party with whom Columbia has an agreement associated with the invention? ☐ Yes ☐ No

If Yes, please provide a copy of the relevant agreement(s) if available, i.e., MTA or Purchase agreements.

SECTION IV: CONCEPTION DETAILS

K. Fill in the following dates (*if known*):

Conception (Month/Day/Year):

First experiment demonstrating the invention (Month/Day/Year):

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L. Records Supporting Invention:

Please identify records that establish dates of conception and reduction to practice, including the records' present location and the identity of the person who prepared them. Attach copies, if possible. Note additional supporting evidence. If the invention or a significant aspect of the invention is not supported by written records, briefly describe how the date of invention can be established and identify the earliest written record.

First experiment in September

M. Is the invention related to a prior invention reported to Columbia Technology Ventures or elsewhere? *If yes, please provide the information requested below.* ☐Yes ☐No

Ownership (if not Columbia):	IR# / Internal Ref # or Title:

SECTION V: COMMERCIAL POTENTIAL

N. Is research continuing on this invention at Columbia? ☐Yes ☐No

If yes, please describe research plans:
May be

O. What critical commercial problem does this invention solve?

This methodology can be developed further to create a biofeedback wearable system which evaluates the posture in real time and provides verbal feedback to the wearer, for example, through a phone application. Furthermore, AI algorithm can be developed, allowing the PoMS to become more "intelligent" as it collects more data and provide more reliable and relevant feedback with time. Additionally, when PoMS is mass produced, all the shirts can be wirelessly linked, collectively learning and improving, allowing for even more accurate feedback. All the collected data can also be used by scientists for an enormous variety of studies.

P. Does the invention have relevance to an existing or emerging technical standard? A technical standard is a set of requirements for ensuring interoperability among devices or promoting reliability, productivity, efficiency, or safety of devices.

If yes, which standard(s)?: No. All of the existing studies have severe limitations, either in efficacy or accuracy, and all have a narrow range of application. The goal of the PoMS was to provide a comprehensive measurement of the entire upper body (including torso and shoulders), remain comfortable and versatile, accommodate the wearer's entire range of natural motion, and provide a high tech wearable device invisible to others.

Q. Specify the closest technologies or references known to you currently:

R. How does the invention differ from the closest technologies or references described above?

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S. What advantages does the invention provide?

This study has demonstrated that inexpensive stretch sensors can be sewn into comfortable clothing to monitor the posture of the wearer. There can be an infinite number of sensor configurations and they could be used in various parts of the body, depending on the application.

T. Other possible commercial applications for the invention include:

The PoMS can be used for an extremely wide variety of medical and athletic applications. Since almost everyone tends to have bad posture and back problems are very common, the PoMS can become a popular wearable device helping millions of people nationwide and beyond.

U. Which companies or investors are most likely to be interested in this invention?

If you can provide personal contacts at relevant companies, please list their name(s) and email(s) below:

SUBMISSION ACKNOWLEDGEMENT – *Please sign or type name below*

Columbia University Inventor(s): Columbia University requires all potential inventors who are its faculty, officers, employees or students to sign or type their names below.

I/We submit this Invention Report and Record Form pursuant to Columbia's Statement of Policy on Proprietary Rights in the Intellectual Products of Faculty Activity, as amended (the "Policy"). I/We agree to assign, and do hereby assign, to Columbia all my/our rights, title, and interest in any invention described herein and agree to render such assistance as Columbia may reasonably request to obtain patents and develop the commercial value of such invention, including signing such documents as may be required for this purpose. I/We understand that Columbia will adhere to the terms of the Policy, which can be found in The Faculty Handbook or on Columbia Technology Ventures' website, www.techventures.columbia.edu, and will distribute any proceeds attributable to the invention according to those terms. I/We also understand that if Columbia decides not to seek protection for the invention, it will release its rights in the invention specifically described herein and to the extent actually developed as of the date of submission of this Invention Report and Record Form; provided, however, that I/we have met the obligations under the Policy with respect to disclosure of the invention and cooperation with Columbia. Any release of Columbia's rights in such invention may be subject to applicable restrictions or requirements imposed by the terms of any grant, contract or cooperative agreement to which Columbia is a party, or by applicable law, rule, or regulation.

Signature or typed name of each potential inventor listed in Section A	**Date**

(Please use additional copies of this page if more signatures are required)

Please return this form to your Technology Licensing Officer or TechVentures@columbia.edu

You may also view information relating to your Invention Reports, Patents and Patent Applications here:
https://portal.techventures.columbia.edu/FacultyPortal/login.cfm
Instructions for accessing the CTV Inventor Portal:

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- Recommended browsers: Firefox or Chrome
- Login with your UNI and university password. Note: CTV does not have access to your UNI/password details. If you have any trouble, contact CUIT or visit **http://cuit.columbia.edu/cuit/manage-my-uni**
- Once logged in, you will be presented two links: IRs and Dockets
- To view the information, click on the "+" to the left of the table titles
- Information may be downloaded into an Excel spreadsheet