SCIRE

Center for **S**patial **C**omputing, **I**nformatics, and **R**emote sensing for **E**arth science

SCIRE: Latin for to know, understand

We propose a new center that focuses on remote sensing and spatial analysis for Earth Science. Remote Sensing data are the *de facto* standard in observing the Earth and its environment, and it finds applicability in many areas of Earth Science. The center will have a strong focus on disasters, and bring together expertise that are currently distributed across many Departments and Units at Penn State. Although there is a significant expertise in remote sensing at Penn State, it does not get recognized both internally and externally because efforts are spread across different units, and there is a lack of coordination amongst them. This center promises to become a central hub for remote sensing research, fostering research efforts, and giving more visibility to individual researchers as well as to Penn State.

Remote Sensing Satellite remote sensing technology evolved rapidly since its development in the 60s and 70s. By the late 80s enough data were collected to study the changing planet. Nowadays, observations are available from a network of Earth observing satellites that collect data at a much finer spatial, temporal, and spectral resolution. Crucial providers for this diversity of data has been the deployment of sensors by multiple space agencies and by the commercial sector. These developments have led to new understandings of the planet, and allow for the study of changes at a much finer resolution. Furthermore, whereas satellite remote sensing was at first relegated to scientific and military applications, it has found its way into people's daily activities. Remote sensing data are used by the general public to make decisions when buying homes, exploring new sites, and it is the de facto news standard to show changes using imagery taken before and after major disaster events.

A new major development is the availability of inexpensive UAS that can be quickly deployed by citizens to collect high resolution imagery and videos, paired with the ability to share them with free and reliable mechanisms. These data have been shown to provide unique views to assess damage, and in turn, can prove to be crucial in the validation and calibration of models.

Because of advances in remote sensing, the rate at which geospatial data are being generated exceeds our ability to analyze them. These developments are quickly leading towards a data-rich but knowledge- poor environment. New challenges arise from an unprecedented access to massive amounts of data. New algorithms are needed to address these scientific and computational challenges and provide innovative and effective solutions to analyze these large, often multi-modal, spatiotemporal datasets generated by high resolution sensors or computational models. Traditional computational frameworks are specialized to serve a single science application, and are not flexible to drive diverse models on changing computational platforms.

Research Questions and Center Focus

The general goal of remote sensing is to identify with confidence surface solid materials, liquids, or atmospheric gases, typically acquired using airborne or spaceborne platforms. The current state-of-the science approach to remote sensing data analysis derives from algorithms and tools developed in early 1990s, and continues to pervade both operational and research and development. The current approach applies many simplifying assumptions or expedient processing steps. We know that these solutions are expedient, but also, error inducing. Another significant shortcoming is the general inability of current algorithms to analyze multiple images simultaneously.

These concepts and solutions have demonstrated operational success and their methods are ensconced in existing algorithms and software. While these existing solutions are based on sound physics, mathematics, and statistics, they lag behind the revolution in computational power, artificial intelligence, bid data, and agile sensors and platforms. Most importantly, they have been shown to fail under varied environmental conditions, obscuration, and target material conditions. Many simplifying assumptions are made in this process and it can be said that today's analysis is effective in optimal collection conditions. It can also be said that in non-optimal conditions, cloudy scenes, shadows, intimate mixtures of materials, liquid spills and residues, or any combination of the above, remote sensing observations of solids, liquids, or gases is ineffective, unrepeatable, or subject to unknown levels of uncertainty.

The focus of the center will be on the use of remote sensing and informatics to study natural hazards and disasters within an Earth Science framework. These events pose a significant threat to the development and sustainment of our society. Rapid population growth, the emergence of megacities, and high risk facilities such as dams and nuclear power plants have increased the risk posed by natural hazards at unprecedented levels. A single catastrophic event in a populated area can pose unacceptable risk.

The Center will concern itself with:

- Cyber coordination
- Research coordination across campus, especially as it applies to larger-scale projects
- Common instrumentation (e.g. the core faculty have an NSF MRI currently pending focused on drone-based hyperspectral imaging)
- Curricular and educational resource coordination across campus.
- Agility and rapid response capabilities

Core (alphabetical order):

Guido Cervone, Geography, Meteorology and Atmospheric Science / EESI / ICDS
Helen Greatrex, Geography / ICDS
Steven Greybush, Meteorology and Atmospheric Science / ICDS
Timothy Kane, Electrical Engineering, MAS / IEE
Doug Miller, EESI
Luke Trusel, Geography
Christelle Whautier, Geosciences / ICDS
Manzhu Yu, Geography

Affiliated Members: Faculty who have shown interest or whose research is identified as related to the main activity of the center

Eugene E. Clothiaux, Meteorology and Atmospheric Science
Kate Zipp, Agricultural Economics, Sociology and Education
Erica Smithwick, Geography / EESI/ IEE
Andrew Carlton, Geography
Alan Taylor, Geography / EESI
Karen Schuckman, eDutton
Julio Urbina, Electrical Engineering
Sven Bilén, SEDTAPP / EE / Aero
David Hughes, Entomology and Biology
Jesse Lasky, Biology
Klaus Keller, Geosciences / EESI
Sarah Ivory, Geosciences /EESI
Jose Duarte, Landscape Architecture
Lisa Iulio, Landscape Architecture
Guangqing Chi, Population Institute / SSRI
Pete La Femina, Geosciences

Director / management structure

We plan to setup a very dynamic center to promote remote sensing and informatics research for the entire campus, and not heavily centered on the research of a single faculty.

Initial setup
We propose that the core faculty will elect a Director and associate Director to serve for a two-year term. The Director and Associate Director have not been identified yet, but they will be selected among the members of the Core faculty.

Elections
Every two years in the Spring semester the center will run elections to repopulate and potentially expand the core faculty, and elect an Associate Director for a two-year term.

Core Faculty
Everyone in the PSU community can aspire to become a SCIRE core faculty, although the group will be initially limited to eight members (this can beexpanded as needed in future years). The Director and Associate Director are considered core faculty voting members. The core faculty help in the management of the center, and actively participate in the center activities, promoting it and helping funding it. New core faculty are elected by current core faculty members, with a simple yes/no secret vote. A new core faculty is accepted if they receive no more than ¼ negative votes (more than two negative votes in case of eight core faculty voting members).

Associate Director
At the end of the two year-term, the Associate Director becomes the Director of the center for a new two-year term. So, when someone is elected to be Associate Director, this is for a 4 year commitment, two years as Associate Director, followed by two years as Director. Therefore, Directors cannot serve consecutive terms, although they can become Associate Directors after serving as Directors.

To be elected as Associate Director, a candidate must have 50% of the votes, with a quorum of at least 50% of the people eligible for voting casting a vote. If candidates do not reach the minimum number of votes, a second of elections will be run among the two candidates who had the highest number of votes during the first term, with the winner being the one who has more votes. In the unlikely case of a tie, the current Director will be asked to choose the new Associate Director. The EESI Director will be asked to approve the election results, and has the discretion to refuse accepting a director and ask for new elections.

Director
The director's prime responsibility is to promote the center, identify research directions, lead funding efforts (e.g. lead grant submissions, identify opportunities, group forming), and build ties with PSU research institutes as well as units outside of Penn State. As a general rule, no more than 1/3 of the center budget can be used to fund activities directly linked to the Director without approval by more than 50% of the core faculty (four votes assuming eight core faculty group, and excluding the Director's vote that it is assumed to be positive. In other words, there can be no more than three negative votes).

Budget

We expect this center to start as an EESI center, and to receive additional buy-ins from other institutes and units as it is serving a large portion of the PSU community. Initial talks were made with the Directors of IEE, ICDS, and SSRI, and they all showed interest after the initial center is setup through EESI.

We request an initial funding of $15K, which will be used to setup the center. $5K will be used by the Director (e.g. travel if allowed within the lifetime of the center or the Director, equipment), and the remaining $10K to fund a student or postdoc to help with research aimed at attractiing future funding.

Funding

The core faculty have received combined budgets of millions of dollars from civilian and DoD agencies. The primary source of funding will likely continue from these agencies, and will build on past successes:

DARPA: Micro-technology Office for hyperspectral remote sensing target detection.
ONR: Next generation warfare program to blend remote sensing and social media.
AFRL: Airborne hyperspectral remote sensing division for efficient computation of real time data.
NASA: Natural disasters and new sensor development. Generally, many programs fund fundamental and applied remote sensing research, as well as coordination of teaching and training the next generation scientists.
NSF: Geoscience directorate – Applied science using remote sensing data.
NSF: CISE directorate – Computational solutions for the analysis of big data.
DOT: Commercial remote sensing for transportation infrastructure program.
NRO: Director's initiative (primarily focused towards funding of graduate students).
MDA: Initial talks on using remote sensing for the detection of mobile launch sites.
DTRA: Identification of potential treats using UAVs. Initial team created with the US Military Academy in West Point.

Maybe mention the likelihood of industrial buy-in, especially if we exercise agility across our broad expertise base.

PennState

Earth and Environmental Systems Institute 814-863-7091
College of Earth and Mineral Sciences Fax: 814-865-3191
The Pennsylvania State University www.eesi.psu.edu
2217 Earth-Engineering Sciences Building
University Park, PA 16802

April 15, 2020

Re: EESI Remote Sensing Center Proposal, Letter of Support

Dear EESI Center Proposal Review Committee,
I am very pleased to provide a letter of support as a collaborator and active participant in the proposed "Remote Sensing Center" within EESI.

Among all current PSU faculty, I may have the longest association with previous efforts to organize remote sensing research, outreach and instruction at Penn State. The initiation of the US Landsat program in the mid-1970's led to the creation of the Office for Remote Sensing for Earth Resources (ORSER), initially a center within in the Space Sciences and Engineering Lab in the College of Engineering and then subsequently moved to the Institute for Land and Water Resources (the forerunner of the current Institutes Energy and the Environment) in 1982.

As a work study undergraduate from 1978 to 1981 and a graduate student from 1982 to 1987, I was part of a vibrant and energetic organization that was developing cutting edge software (the ORSER System) for the processing and analysis of the first earth satellite remotely sensed observations. Penn State had nearly 2 dozen faculty members in 4 colleges involved in ORSER and its successful interdisciplinary programs. Through faculty attrition and the commodification of remote sensing and geospatial technology, Penn State has had, until relatively, recently a diminished presence of "remote sensing science" faculty.

Recent hires in multiple colleges have provided a critical mass of faculty and a new opportunity to build a strong interdisciplinary community of remote sensing scientists to foster collaboration around research and education using an ever-growing and increasingly available suite of earth-observing platforms. With the addition of these new faculty and a renewed sense of energy to collaborate, there could be no better time to establish a remote sensing center at Penn State. Across the entire University, EESI is the most logical location for such a center and I heartily endorse this proposal.

Sincerely,

Douglas A. Miller
Research Professor
Departments of Geography and Ecosystem Science and Management

Director, Center for Environmental Informatics and the Mobile Geospatial Systems Group

PENNSTATE

1855

Tim Kane
Professor
Depts. of Electrical Engineering and Meteorology

PHONE: (814) 863-8727
FAX: (814) 865-7065
E-MAIL: tjk7@psu.edu

121 Electrical Engineering East
The Pennsylvania State University
University Park, PA 16802

April 20, 2020

Earth and Environmental Systems Institute
2217 Earth-Engineering Sciences Building
University Park, PA 16802-6813

Re: EESI Remote Sensing Center Proposal

Dear EESI Center Proposal Review Committee,

I am excited to provide a letter of support for the proposed "Remote Sensing Center" within EESI. I will gladly be serving an active role in this Center as I strongly believe that Penn State is long overdue in coordinating and thereby leveraging on the vast remote sensing skillsets we have dispersed across campus. From engineering to instrument development to data analysis to, ultimately, scientific application (the latter being the most important and therefore the prime reason to be housed in EESI), we are all poised to do innovative work with far reaching impact. As someone who's been here at PSU for a while now, I'm especially excited to see how the formation of this center will energize our newer faculty in the area as well as enable us to attract fresh talent.

We are stronger together!

Please feel free to contact me with any questions. Seriously.

Sincerely,

Tim Kane

PennState

Christelle Wauthier
Assistant Professor
Department of Geosciences

The Pennsylvania State University
311 Deike Building
University Park, PA 16802-2714

814-863-36649
cuw25@psu.edu

April 17, 2020

To: Whom It May Concern

It is my pleasure to provide a letter of reference in strong support for the creation of a Remote Sensing Center at Penn State. Currently, remote sensing initiatives and expertise are disseminated at Penn State without much connection nor synergy amongst Faculty and researchers across campus. There is however a lot of potential for Penn State to become a leader in remote sensing if better synergy and connections are developed. I believe that a Center would fill this gap and allow remote sensing developers, users, researchers, and students to truly connect with each other leading to a dramatic increase in funding and cross-disciplinary projects.

I have been using satellite images for my research for over a decade and published a total of 27 peer-reviewed journal articles and book chapters. In particular, my expertise lies in Interferometric Synthetic Aperture Radar (InSAR) which is a powerful technique allowing us to obtain surface deformation maps over broad areas with a centimetric accuracy using multiple satellite radar images acquired at distinct times. InSAR has a spatial coverage way superior to all ground-based techniques (GPS, etc.). I use InSAR surface deformation maps, combined with ground deformation modeling, to image subsurface processes related to GeoRisks such as volcanoes, landslides, and earthquakes. I am involved in various national and international remote sensing community efforts and steering committees related to volcano monitoring and volcanic eruption response, in collaboration with space agencies, local volcano observatories, and USGS.

Since my arrival at Penn State in 2014, I have been able to secure a total of six grants as PI or co-PI: three grants with the National Aeronautics and Space Administration (NASA) and three with the National Science foundation (NSF). I am the lead PI on a Earth and Surface Interior (ESI) NASA grant aiming to image flank instability processes at Pacaya Volcano, Guatemala. Additionally, I am an institutional PI on a NASA ESI project aiming to image surface deformation with InSAR along the Central and South American arc, and co-PI on another ESI project focusing on deformation processes in Nicaragua. I am the single PI on a NSF Geophysics project focusing on volcano crater deformation at African volcanoes. I am also the single-PI on a NSF CAREER proposal (recommended for funding) aiming to model volcanic flank instability at ocean island volcanoes including Kilauea (Hawaii), Piton de la Fournaise (France), and Anak Krakatau (Indonesia). Finally, I was also a co-PI on a NSF RAPID grant focusing on volcanic eruption response assessment at a volcano in Nicaragua.

Sincerely,
Christelle Wauthier