CALIFORNIA STATE UNIVERSITY
FULLERTON
COLLEGE OF ENGINEERING
AND COMPUTER SCIENCE

TITANS OF TRANSFORMATION

# BIG IDEAS

## Engineering Wildfire Mitigation Initiative

# Big Ideas to Transform Tomorrow

## The Titans of Transformation: Big Ideas initiative is focused right here in our region, tackling adaptive challenges that affect the health, stability, and quality of life of people in our communities.

The College of Engineering & Computer Science recently embarked on this bold and disruptive initiative, which features Big Ideas – built from the ground up – that inspire collaborations, investments, and positive impacts that position the college at the nexus between challenges and opportunities.

Purpose-driven, community-connected, investment-worthy research defines our inaugural Big Ideas. These projects, led by faculty champions committed to a deeper engagement with our communities and enhanced opportunities for our students, seek to address fundamental societal challenges through transformative collaboration and innovation.

Through private support, Big Ideas will take ideas from good to exceptional, drive innovation, and spark next-level collaborations that will generate new knowledge, powerful solutions, and positive change.

**Susan Barua**
Dean of the College of Engineering & Computer Science

*"At its purest state, Big Ideas is about creating a better future... tackling deep-seated problems, responding to our communities, establishing access to innovative curriculum, and preparing the next generation of culturally competent engineers and computer scientists."*

# Big Idea: Engineering Wild ire Mitigation Initiative

**Nearly one-third of California's population lives in areas susceptible to fire. Destructive wildfires over the last few years have had a devastating human and environmental impact, while costing billions of dollars.**

Wildfire detection technologies are in place. But these systems have many limitations, including non-exhaustive surveillance coverage, the need for human vigilance, expense, misdiagnosis of natural phenomena as fires, and an inability to detect young fires.

## A TRANSFORMATIONAL OPPORTUNITY

Engineering solutions that mitigate wildfires and protect human life is complex. It's a space ripe for innovations that will help protect the men and women who battle these fires, as well as lessen property and environmental impacts.

"Our interdisciplinary research will serve as a foundation for the many directions this Big Idea can take us, and we look forward to expanding our research to engage more students and engineer the best possible solutions," says Ankita Mohapatra, assistant professor of computer engineering at Cal State Fullerton's College of Engineering & Computer Science.

Wildfires produce carbon emissions that are equal to six coal plants running for one year

for every **500,000** acres of fire

or, in total, emissions comparable to driving nearly every vehicle in the state over one year.

In 2020 alone, nearly

**10,000**

fires burned more than

**4.2M**

acres in California, making 2020 the largest wildfire season recorded in California's modern history.

These fires killed

**31**

people and released an estimated

**112M**

metric tons of carbon dioxide into the atmosphere.

Mohapatra is lead researcher for the Engineering Wildfire Mitigation Initiative, which will employ a smart wireless solar-powered sensor hub. The sensors are designed to continuously monitor for changes in temperature, humidity, particles in the air, and carbon dioxide and carbon monoxide levels in order to detect fires before they flare up. Once a young fire is detected, or an area is identified as being high-risk, fire responders can get to the area quickly, set up posts close by so they're ready to act at the first sign of trouble, or take preemptive measures such as spraying fire deterrents.

"Human vigilance has limitations," Mohapatra explains. "Volunteers like OC Fire Watch keep an eye out for signs of a wildfire and report them to emergency responders, but you can't always have people surveying areas late at night or in remote locations far from roads."

Currently, California also has a network of more than 600 cameras installed throughout the state to spot the first flames, but these also come with limitations.

"People or advanced processing algorithms must go through each of these images, so there is still significant room for error," Mohapatra says. "These algorithms can also misidentify tree foliage or even clouds during sunset as fires, and they can't diagnose young fires creeping along the forest floor under foliage.

## WHAT WE'RE DOING

Bearing witness to these fires year after year, Mohapatra, her faculty collaborators – computer engineering faculty members John Faller and Rakeshkumar Mahto; Jidong Huang, professor of electrical engineering; and Dan Curtis, associate professor of analytical chemistry in the College of Natural Sciences & Mathematics – and eight undergraduate students knew an ultra-sensitive early detection system could make a big difference.

The smart wireless solar-powered sensor hub proposed by the group employs a "smarter node" design that uses an array of gas detectors to quickly identify probable young fires.

To make the design work, the team knew they needed rechargeable solar panels that could power the nodes day and night. They also had to consider what would happen if one of the panels was obscured by tree debris or even wildlife. Mahto's team has conceptualized a smart grid of smaller solar panels that work together to optimize power input even if one of the individual panels is blocked. The smart sensor nodes are also designed to "talk" to one another and then transmit data to a central processing center that will keep track of and predict fires and send alerts to local authorities. Huang is focusing on this wireless communication protocol.

"If the sensors detect sparks or high winds and low humidity, they can help alert responders to potential hot spots. And by detecting where exactly a fire started and conditions in the area, we might be able to predict its potential path," Mohapatra says.

At the suggestion of a local fire chief, the team is also exploring the inclusion of infrared sensors to detect humans in proximity to the fires. These sensors could provide critical information on how these fires begin and also alert responders to rescue people and animals in the danger zone.

*"If we could reduce wildfires, we could make a significant impact. It's about protecting lives, resources, our state, and our world."*

**Ankita Mohapatra**

Additionally, working with Curtis, Mohapatra's team is exploring the possibility of including particulate sensors to measure AQI, an index for reporting air quality, in order to guide environmental interventions.

Right now, a team of students is working on an algorithm to determine the best sensor locations using GPS coordinates. Another team is working on a sensor board prototype. Faller is working to develop a mobile app that could transmit data from the central processing station to responders, as well as potentially share emergency responder-directed evacuation protocols with the public.

Mohapatra's team is currently collaborating with two fire chiefs – Chief Tim Shackelford of Chino Hills and Chief Adam Loeser of Brea and Fullerton – as well as Chino Hills City Council Member Cynthia Moran on the design and potential applications of the sensor hub. They've also reached out to various nonprofits to launch potential partnerships.

The researchers are still working on prototypes, but once they have a solid prototype developed and get into the implementation stage with current partners, Mohapatra says the team looks forward to collaborating with other communities and nonprofits to identify areas where the smart sensor hub could provide the most value.

"This is such an important issue affecting so many people who live in this state," Mohapatra says. "Thirty percent of houses in California are close to wildfire areas, which drives up insurance costs. Studies show lower-income communities and communities of color are more susceptible to wildfire damage and take longer to recover. Carbon emissions continue to affect the health of our planet, and if we could reduce wildfires, we could make a significant impact. It's about protecting lives, resources, our state, and our world." ●

**Ankita Mohapatra, assistant professor of computer engineering, has long sought solutions to create a healthier, greener environment, and collaborating with expert researchers at CSUF provided the resources to devise a solution to California's wildfire problem.**

# Related Research on Campus

### PREDICTING AND TRACKING FIRES BY DRONE

A team of Cal State Fullerton mechanical engineering students – under the advisement of Sagil James, assistant professor of mechanical engineering – is developing a system called "Wildfire Aversion by Forecast and Early Response System," which uses smart drone technology to predict and track the spread of wildfires, and ultimately prevent fires from growing to an uncontrollable size. The team won second place in the Pix4D Climate Contest. ●

### PREVENTING POST-WILDFIRE MUDSLIDES

Binod Tiwari, professor of civil and environmental engineering, and Xenia Wirth, assistant professor of civil and environmental engineering, are focused on soil stability and wildfires as a triggering factor for devastating mudslides and landslides usually due to vegetation loss. Through their research, they hope to help mitigate these dangerous events in Southern California and across the globe. ●

### FIRE DETECTION FROM SPACE

Under the guidance of Sagil James, assistant professor of mechanical engineering, and Kiran George, professor of computer engineering, a team of Cal State Fullerton engineering and computer science students is designing, manufacturing, and building a cube-shaped, miniaturized satellite, known as a CubeSat, to observe Earth from space to predict and detect wildfires. Their prototype, dubbed "TitanSat," incorporates infrared cameras and solar power to monitor Earth's climate and detect hot and dry zones that pose a wildfire risk. The team has been recognized as a 2021 CSUF Student Research Competition Finalist. ●

> *"We all have the same goal. The big picture is to reduce wildfires, and we're all working on small sections of the problem so we can share our data and expertise."* – **Ankita Mohapatra**

# Let's Get Started Today

Mohapatra's Engineering Wildfire Mitigation Initiative is divided into three phases. The first phase is focused on identifying parameters that indicate the presence of fire and developing smart-sensor hub prototypes in the lab. The second phase includes continuing prototype development, topographical modeling of areas where the sensor network would be most impactful, and research into optimal sensor placement. The final phase will include testing prototypes in local areas, conducting community outreach and training necessary for the implementation of the system, and establishing a database for wildfire prediction.

Each of these phases requires interdisciplinary collaboration; continuing innovation; significant engagement between faculty, students, and community partners; and financial support. Through your investment, we will:

- Support field- and campus-based research
- Fund student research fellowships
- Expand essential partnerships with the community
- Test and develop various equipment and materials
- Build interest and student engagement to improve STEM retention

Your contribution will help seed potential innovations in engineering wildfire mitigation efforts, leading to increased student engagement and stronger community-connected solutions.

For partnership and investment opportunities, please contact **Michael Karg** at **mkarg@fullerton.edu** or **714-519-8160**.

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