UC RIVERSIDE
Research and Economic Development

SoCal OASIS™ Internal Funding Awards

AGRICULTURE TECHNOLOGY AND FOOD SECURITY

AGLINK: Enhancing Drone-Based Remote Sensing for Digital Agriculture

Principal Investigator: Zhaowei Tan (computer science and engineering)

Co-Principal Investigator: Amir Verdi (environmental sciences)

Precision agriculture has seen remarkable advancements due to innovations in remote sensing, on-farm instrumentation, and data processing. While drone-mounted multispectral and thermal cameras have improved crop monitoring by providing valuable insights into plant health and water stress, current methods face challenges in correlating remote sensing data with physical crop conditions and capturing below-ground processes. To bridge this gap, we propose AGLINK, an end-to-end system integrating drone-based remote sensing with in situ sensors through long-range communication and a cloud-based analysis platform. This system will enhance precision agriculture by enabling real-time data collection, analysis, and decision-making for farmers.

AGLINK will incorporate low-power, long-range communication technology to link sensors distributed across fields with drone-mounted IoT gateways, ensuring seamless data transmission. The project will also develop a cloud-based platform to process and visualize agricultural data, offering predictive insights for optimizing irrigation, monitoring crop health, and improving resource efficiency. Beyond technological innovation, AGLINK supports sustainability by reducing manual intervention and optimizing resource use while fostering education and workforce development in agricultural IoT. The project will contribute to the broader field of AgTech by advancing research, generating high-quality datasets, and laying the groundwork for scalable solutions adaptable to diverse agricultural environments.

Education & Workforce Development Pathways in Digital Agriculture: Creating a Regenerative Cycle of Talent in Inland Southern California

Principal Investigator: Elia Scudiero (environmental sciences)

Co-Principal Investigators: Amit Roy-Chowdhury (electrical and computer engineering), Dana Simmons (society, environment, and health equity), and Stephanie Dingwall (biochemistry)

Agriculture in Inland Southern California is crucial to local rural prosperity and the national economy, yet it faces challenges from climate change, resource competition, and market uncertainty. Many small, family-operated farms lack the resources to adapt. Digital Agriculture—leveraging AI, automation, and precision farming—offers solutions to enhance resilience, productivity, and sustainability. However, implementing these technologies requires a skilled workforce, yet young professionals are not entering the food, agriculture, natural resources, and human sciences (FANH) workforce at sufficient rates. Additionally, Inland Southern California experiences talent migration due to limited career opportunities, weakening regional innovation and economic resilience.

To address these challenges, the research team proposes a regenerative cycle of talent, integrating education, research, and industry partnerships to develop a robust Digital Agriculture workforce. Led by the Center for Agriculture, Food, and the Environment (CAFÉ), this initiative will strengthen pathways for students from Hispanic-Serving Institutions to UCR, expand hands-on training, and align academic programs with industry needs. A key focus is enhancing transfer pathways and fostering regional collaboration to retain skilled graduates. By investing in interdisciplinary education, workforce development, and industry partnerships, this initiative aims to mitigate brain drain, support agricultural innovation, and ensure long-term economic sustainability for InSoCal's agricultural sector.

COMMUNITY HEALTH AND HEATH DISPARITY

Airborne, In-Vehicle Exposure to Tris(1,3-dichloro-2-propyl)phosphate across Diverse Microclimates in Southern California

Principal Investigator: David Volz (environmental sciences)

Co-Principal Investigators: Ajami Hoori (environmental sciences) and Roya Bahreini (environmental sciences)

The interior of personal vehicles represents a unique indoor microenvironment where chemical emissions from vehicle components can accumulate, sometimes reaching concentrations two to three times higher than typical indoor environments. Despite regulations like the Toxic Substances Control Act (TSCA), there is no direct oversight of air quality inside personal vehicles, leaving a critical gap in understanding human exposure to harmful substances. One such compound, tris(1,3-dichloro-2-propyl)phosphate (TDCIPP), is a widely used flame retardant in vehicle interiors. As a semi-volatile organic compound, TDCIPP migrates from materials like seat foam, leading to human exposure through air and dust. This compound, listed under California's Proposition 65 for its potential carcinogenic effects, has been linked to DNA methylation changes and adverse pregnancy outcomes.

This research project aims to assess the dynamics of TDCIPP exposure in Southern California commuters, focusing on how temperature variations influence off-gassing within vehicles. Building on previous studies that correlated TDCIPP exposure with commute times, this study will employ gas-aerosol samplers in used vehicles across coastal, inland, and desert locations. By analyzing air samples through advanced mass spectrometry, researchers will evaluate how climate differences impact TDCIPP levels. The findings will contribute to understanding chemical exposure risks in vehicles, informing potential public health interventions and regulatory considerations for reducing in-vehicle exposure to harmful flame retardants.

Caregiving and Academic Success: Examining the Dual Burdens of Minority Students on Educational Achievement and Health Outcomes

Principal Investigator: Chioun Lee (sociology)

Co-Principal Investigator: Rachel Wu (psychology) and Soojin Park (school of education)

The rising prevalence of family caregiving among young adults, particularly in diverse and low-income communities, has significant implications for education and long-term well-being. At UCR, where nearly half of the student body identifies as first-generation and many come from underrepresented backgrounds, caregiving responsibilities often intersect with economic and structural inequalities. This study seeks to explore the prevalence, characteristics, and consequences of caregiving among UCR students, with a focus on academic performance, mental health, and resilience. By leveraging survey data from UCR and national longitudinal datasets, we aim to assess both the immediate academic challenges and the long-term health impacts of caregiving during young adulthood, addressing an important but understudied population.

This research aligns with UCR's commitment to equity and inclusion by identifying barriers faced by student caregivers and informing policies to support their success. The findings will provide critical insights for educators, administrators, and policymakers to develop interventions that mitigate caregiving burdens and promote student retention. Additionally, by examining caregiving's long-term effects on socioeconomic and health outcomes, this study will contribute to broader discussions on intergenerational caregiving and social mobility. Through an interdisciplinary approach, our research will shed light on the resilience of caregiving students and propose sustainable strategies to enhance their educational and professional trajectories.

HUMAN DEVELOPMENT

AI+Math: Transforming Advanced STEM Education for Inland Empire Students

Principal Investigator: Patricio Gallardo Candela (mathematics)

Co-Principal Investigator: Maziar Raissi (mathematics)

UCR-Assist is an AI-powered math assistant designed to enhance STEM education by integrating Large Language Models (LLMs) with LEAN, a mathematical proof verification software. This initiative addresses critical gaps in mathematically intensive fields where expert feedback is limited, particularly for underrepresented and first-generation students. Unlike existing AI tools that rely on probabilistic methods, UCR-Assist provides precise, certifiable reasoning feedback, eliminating uncertainty and promoting logical rigor. By offering real-time, structured support for courses like Linear Algebra and Introduction to Proofs, this tool fosters advanced reasoning skills essential for research, graduate studies, and entrepreneurship. Additionally, UCR-Assist aligns with SoCal OASIS™ goals of innovation, education, and social inclusion, equipping students with cutting-edge technologies to drive regional academic and economic growth.

Developed through a multidisciplinary collaboration, UCR-Assist combines an intuitive LLM interface with LEAN's verification capabilities to deliver accurate, immediate feedback on mathematical proofs. The project emphasizes accessibility and inclusivity, involving students in content creation, debugging, and platform refinement to build workforce-ready skills. A phased implementation plan includes classroom integration, iterative testing, and expansion to regional institutions, such as CSU San Bernardino, ensuring scalability and long-term impact. By bridging equity gaps in STEM education and preparing students for leadership in technology-driven fields, UCR-Assist reinforces UCR's role as an innovation leader while contributing to broader regional and national workforce development.

Body-Word-Voice: Theatre's Role in Facilitating Human Development by Offering Language and Structure

Principal Investigator: Bella Merlin (theatre, film, and digital production)

Co-Principal Investigator: Annika Speer (theatre, film, and digital production)

Body-Word-Voice is a practice-as-research initiative that leverages theatrical storytelling to help individuals, particularly survivors of domestic violence, reclaim their voices and bodies. Rooted in embodied performance and public-speaking techniques, the project fosters personal empowerment and community dialogue through workshops, performances, and discussions. The initiative explores the transformative actor-audience relationship, using theatre as a tool to navigate complex emotions and articulate personal experiences. A key component is the performance of Tilly No-Body, a solo play examining coercive relationships, which serves as a springboard for engagement with local and international communities. By combining theatre, psychology, and feminist pedagogy, Body-Word-Voice fosters skills in communication, empathy, and self-expression, contributing to both artistic practice and social justice.

Through collaborations with local organizations and the global theatre community, the project extends beyond performance to structured engagement. A four-step community program will offer workshops and discussions with survivors, counselors, and students, culminating in performances and reflection-based activities. Additionally, international dissemination will be pursued through Tilly No-Body's participation in the Edinburgh Fringe Festival, connecting UC Riverside's performing arts research to a global audience. The anticipated outcomes include increased confidence, psychophysical awareness, and empowerment for participants, as well as academic contributions on the role of theatre in addressing trauma. By bridging research and practice, Body-Word-Voice reinforces the power of storytelling in fostering healing, dialogue, and social change.

NATURAL RESOURCE MANAGEMENT

Biomanufacturing of Fresh Irrigation Water from Saline Agricultural Drainage Water Using a Novel Algae-based Ion Pumping Membrane Process

Principal Investigator: Haizhou Liu (chemical and environmental engineering)

Co-Principal Investigator: Robert Jinkerson (chemical and environmental engineering)

This project aims to develop an algae-driven ion pumping membrane system for biomanufacturing desalinated irrigation water from saline agricultural drainage and brackish groundwater. By leveraging the natural ion transport abilities of algae, this innovative approach eliminates the need for high-pressure desalination, offering a sustainable and low-energy alternative for agricultural water reuse. The system integrates bio-membranes with photochemical oxidation processes to remove contaminants while utilizing solar energy to power key reactions. This technology has the potential to transform nontraditional water sources into viable irrigation supplies, reducing dependence on freshwater and enhancing agricultural sustainability in arid regions like the Southwest U.S.

By engineering algae to actively pump ions across their membranes, this project will pioneer a scalable, self-repairing desalination module that simultaneously produces valuable algal biomass for livestock feed. Additionally, the use of nitrate-assisted photochemical pre-treatment will degrade harmful contaminants, ensuring safe and efficient water reuse. This research aligns with the goals of SoCal OASIS™ by promoting sustainability, improving resource efficiency, and advancing innovative agricultural water management strategies. The collaboration between the Liu and Jinkerson labs will create new academic and industry partnerships, accelerating the development of bio-based water treatment technologies and fostering economic growth in the region.

Developing an Integrated Nanotechnology Platform for Comprehensive and Affordable Detection of PFAS Pollutants in Water

Principal Investigator: Yadong Yin (chemistry)

Co-Principal Investigator: Jinyong Liu (chemical and environmental engineering)

This project aims to develop a portable sensor platform for the rapid, affordable, and comprehensive detection of per- and polyfluoroalkyl substances (PFAS) in water and soil. PFAS, often called "forever chemicals," pose severe environmental and health risks due to their persistence and toxicity, with exposure linked to cancer, immune suppression, and developmental issues. Current detection methods rely on liquid chromatography-mass spectrometry (LC-MS/MS), which is expensive and time-consuming. To address this gap, the proposed sensor will integrate nanotechnology-based approaches to concentrate, break down, and detect total PFAS levels using a smartphone-compatible plasmonic nanosensor system. This work will generate critical preliminary data to support federal grant applications and advance the technology toward Technical Readiness Level 5 (TRL 5), validating its performance in real-world environments.

The platform will leverage metal-organic framework (MOF) nanomaterials for efficient PFAS adsorption and enrichment, followed by photochemical defluorination to release fluoride ions (F^-), which will be detected using colorimetric plasmonic nanosensors. This approach enables real-time, field-deployable PFAS monitoring, significantly reducing costs and analysis time compared to conventional methods. The system's ability to quantify total PFAS rather than just a few selected compounds makes it a transformative tool for environmental and agricultural applications. By enabling on-site monitoring in resource-limited areas, this innovative sensor will play a crucial role in mitigating PFAS contamination and safeguarding public health.

RENEWABLE ENERGY AND FUELS

SOLSTICE 2.0: Tackling Transmission and Land Barriers to Catalyze Clean Energy Growth in California

Principal Investigator: Alfredo A. Martinez-Morales (mechanical engineering)

Co-Principal Investigators: Fred Schwartz (CE-CERT) and Ronald O. Loveridge (political science)

The Stakeholder Collaboration on Land and Transmission Availability for Solar and Storage in Inland California's Energy Transition (SOLSTICE) 2.0 initiative builds upon the foundational work of the original SOLSTICE project, which successfully addressed critical challenges in advancing clean energy solutions in Inland Southern California. By tackling key barriers such as land availability and transmission capacity, the project supports California's ambitious decarbonization goals. This next phase leverages the SoCal OASIS™ Internal Funding Awards to expand research collaborations, engage key stakeholders, and promote actionable policy recommendations. Led by the Solar Valley Consortium—a coalition including industry leaders, utilities, and regional governments—SOLSTICE 2.0 aims to provide targeted technical assessments and policy insights that enable the expansion of solar energy, energy storage, and hydrogen infrastructure. Through white papers, public forums, and collaborative workshops, the initiative will drive progress toward a more sustainable energy future.

SOLSTICE 2.0 will focus on identifying practical pathways to overcoming regulatory and technical challenges, ensuring that proposed solutions align with regional priorities and state policies. While the funding for this phase does not directly support large-scale testbeds, the project will establish a foundation for future demonstration projects by fostering robust stakeholder collaboration and technical analysis. Expected outcomes include comprehensive technical reports, policy briefs, and engagement strategies that advance clean energy adoption. By strengthening regional partnerships and aligning efforts with California's clean energy objectives, SOLSTICE 2.0 will serve as a model for addressing land use and transmission constraints, positioning Inland Southern California as a leader in renewable energy innovation.

Transforming Geothermal Energy Sustainability and Earthquake Monitoring in the Salton Sea Region: an AI-based Approach

Principal Investigator: Abhijit Ghosh (earth and planetary sciences)

Co-Principal Investigator: Asif Salman (electrical and computer engineering)

The Salton Sea region is a critical geological and energy hub, where geothermal activity, vast lithium reserves, and seismic hazards intersect. Its proximity to the Brawley Seismic Zone and the San Andreas Fault makes it a key area for studying the relationship between geothermal operations and seismicity. This research leverages artificial intelligence (AI) and advanced modeling techniques to analyze seismic patterns, optimize geothermal energy production, and mitigate earthquake risks. By integrating AI-driven seismic monitoring with physics-informed models, this study aims to enhance real-time earthquake detection, distinguish between tectonic and induced seismic events, and provide insights into the subsurface dynamics of geothermal reservoirs. The findings will directly contribute to California's clean energy goals, ensuring responsible lithium extraction and sustainable geothermal energy expansion.

This project, led by UCR researchers in AI and seismology, will develop a cutting-edge seismic monitoring system to improve hazard assessment and resource management in the Salton Sea region. AI-driven models will enhance earthquake detection accuracy, map subsurface fluid migration, and refine stress evolution predictions in geothermal fields. The research aligns with the SoCal OASIS™ initiative, supporting sustainable resource management and renewable energy advancements. Expected outcomes include an AI-based seismic monitoring framework, an advanced earthquake catalog, and interdisciplinary training opportunities. The project's findings will provide crucial insights into optimizing geothermal operations while minimizing environmental and seismic risks, ensuring a safer and more resilient energy future.

SUSTAINABLE TRANSPORTATION AND INFRASTRUCTURE

Enabling Next-Generation Sustainable Traffic Management via Advanced Sensing and Foundation

Principal Investigator: Jiachen Li (electrical and computer engineering)

Co-Principal Investigator: Guoyuan Wu (electrical and computer engineering)

Next-generation traffic management systems must move beyond conventional signal control strategies, which rely on macroscopic or mesoscopic traffic parameters and fail to capture the complexities of diverse road users. This research leverages advanced sensing technologies such as LiDAR and high-resolution cameras, combined with Visual Language Models (VLMs) and Multi-Modal Large Language Models (MMLLMs), to extract high-resolution, microscopic traffic parameters. By enabling accurate, real-time detection of vehicle types, pedestrian movements, and road user interactions, this approach aims to enhance traffic signal adaptation, reduce congestion, and improve environmental sustainability. The proposed system will be tested at the Riverside Smart Intersection, demonstrating its potential to optimize multimodal traffic flow, lower emissions, and support safer, more equitable urban mobility.

This project advances sustainable transportation by integrating predictive modeling with dynamic signal control strategies. Using AI-driven trajectory forecasting and reinforcement learning, the system will anticipate traffic conditions, optimize green-light timing, and minimize vehicle idling. The framework prioritizes energy efficiency, emissions reduction, and accessibility, ensuring that vulnerable road users receive equitable treatment in signal prioritization. Additionally, the research contributes to workforce development by training graduate students in AI applications for traffic management. Through real-world testing, this study will provide insights into the feasibility and scalability of next-generation, AI-powered traffic control systems, ultimately promoting smarter, more sustainable urban transportation infrastructure.

SEE-V2X: Cellular Vehicle-to-Everything Communication Testbed for Connected Transportation and Infrastructure

Principal Investigator: Hang Qiu (electrical and computer engineering)

Co-Principal Investigator: Zhaowei Tan (computer science and engineering)

The rapid advancement of intelligent and autonomous transportation systems has fueled the deployment of Cellular-Vehicle-to-Everything (C-V2X) technology, a key enabler of road safety, efficiency, and sustainability. C-V2X facilitates seamless communication between vehicles, infrastructure, and vulnerable road users, with the potential to prevent hundreds of thousands of crashes annually. However, a disconnect remains between theoretical application design and real-world constraints, such as network limitations and latency. To bridge this gap, we propose SEE-V2X, an application-centric testbed that supports real-world research, experimentation, and validation of C-V2X innovations. By integrating with the Riverside Innovation Corridor and leveraging open-source 5G infrastructure, SEE-V2X will advance research in AI-driven transportation, networking, and cooperative perception.

SEE-V2X will provide an end-to-end research infrastructure encompassing real-world data collection, simulation, and deployment environments. It will serve as a vital resource for researchers in mobility, networking, and autonomous systems, fostering collaboration across multiple disciplines. Beyond research, SEE-V2X will play a crucial role in workforce development, equipping students with hands-on experience in connected vehicle technologies through integration with UCR's academic programs. Additionally, it will support sustainability by optimizing traffic efficiency and reducing congestion. With its capacity to enhance vehicle connectivity and automation, SEE-V2X represents a transformative step toward achieving safer, smarter, and more sustainable transportation systems.