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Hi-Tech Ally



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On the cover: CALIT2 is an important link in a sensor-and-communication network that provides real-time data in the fight against wildfires.

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LEADING THE SMART CONNECTED WORKER INTO THE FOURTH INDUSTRIAL REVOLUTION

🏓 🏂 Sharon Henry



Today's ever-shifting economic climate is placing increased pressure on the manufacturing industry to become more energy efficient and globally competitive. Many companies are looking toward emerging technologies to help create the next generation of smart, collaborative manufacturing.

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Technology breakthroughs in robotics, artificial intelligence, Internet of Things, cloud computing, cyberphysical systems and fifth-generation wireless technologies (5G) have ushered in a new era that's being described as the fourth industrial revolution.

In 2016, the U.S. Department of Energy established CESMII (the Clean Energy Smart Manufacturing Innovation Institute) to explore how these emerging technologies might deliver smart manufacturing solutions. Last year UC Irvine's CALIT2 was designated the CESMII Southern California Regional Demonstration Center. CESMII recently awarded \$2.1 million to the institute to develop the Smart Connected Workers program.

"The focus on workers is critical to the evolution of U.S. industrial sectors," says G.P. Li, CALIT2 Irvine director and the project's PI. "A smart, connected worker will become the ultimate manufacturing asset. Empowering skilled workers to have greater autonomy and decision-making responsibilities will result in not only a more satisfied, masterful workforce, but also factories that are more energy-efficient, productive and safer."

> The program will develop affordable, scalable, accessible and portable smart manufacturing (A.S.A.P. SM) systems that will help companies gain insight into their energy footprints and workflow activities. These data can lead to optimization and dynamic scheduling of equipment to help reduce energy costs.

Sensors and cameras will measure and characterize human activity. "We can capture information about when people are moving through the facility, where they're going and what [work] they're doing," says Richard Donovan, a UCI research development director who works hand-in-hand with Li on the grant.

Energy meters - upgraded to higher fidelity than standard

models – will be located throughout the workspace to capture precise realtime energy consumption and record the equipment's response to human activity. Researchers will use data analytics to map the captured workflow activity against real-time energy use.

The U.S. industrial sector

accounts for nearly 31 percent

of the nation's total energy

use - much of it going to manufacturing plants,

factories and mills.

Capturing, mapping and analyzing this data will allow researchers to build a data-acquisition infrastructure that provides real-time workflow energy assessment

SMART CONNECTED WORKERS PROGRAM

CALIT2 received a \$2.1 million grant to develop a program that provides valuable insight into the energy footprint and workflow activities of manufacturing facilities.

The Smart Connected Workers program will gather data about workers' activity and real-time energy use, and employ data analytics to map the relationship between the captured workflow and energy consumption.

Findings will allow researchers in CALIT2's Data Engineering ThinkTank to develop software tools that provide real-time workflow energy assessment for small-to-medium enterprises.

 Gather data on workers' physical activity in factory

Interface | FALL 2018

for small-to-medium enterprises. Of the more than 250,000 U.S. companies in the manufacturing sector, less than 4,000 have more than 500 employees, and threequarters have fewer than 20 employees. Most of these companies lack financial resources to incorporate sophisticated, advanced automation and control that could give them a competitive edge.

Analytic tools, however, can have an immediate impact on small and mid-size manufacturing firms by translating large quantities of new data into insights that can improve industrial processes. "By looking at the data, we can say, 'Hey, maybe there is a better workflow. Here's a better way for you to use your operations technology to be more efficient, use less energy and have less waste,' " Donovan says.

The Smart Connected Worker team is made up of nine UCI faculty and staff members who will join with industrial partners, including Atollogy, Aerospace Corp., General Mills, Southern California Edison, CESMII, Google, San Diego Supercomputing Center, and university partners UCLA and California State University Northridge.

Researchers will take advantage of the soon-to-open Data Engineering ThinkTank located on the fourth floor of CALIT2. The state-of-the-art, high-performance computer lab will provide access to distributed computing resources (CPU, GPU, TPU and other NvN processors), collaboration tools, visualization software and a brand new class of hardware designed expressly for artificial intelligence and deep machine learning.

The biggest challenge will be scaling up to meet the needs of large manufacturing operations. The team will need to develop effective engineering tools that can be rapidly deployed across various manufacturing sectors.

"We want to have engineers use these new methods of data analytics in an efficient way for different types of industry," Donovan says. "And because we are the 'people people,' it's about putting people in the loop, giving them decision-making capability and helping them design healthy, happy places to work."



INDUSTRIAL REVOLUTIONS

There have been four major industrial eras. Each was brought on by advancements in technology.



Cyberphysical systems, Internet of Things, networks

Future of Smart Manufacturing

CALIT2's multidisciplinary research effort is focused on developing tools and techniques that offer an infusion of intelligence to empower the smart connected worker. The institute is developing a smart manufacturing ecosystem that integrates advanced sensing technologies, robotics, data analytics and machine learning to provide edge, actionable and contextual intelligence.





• Asset utility/zero downtime

recovery and reuse

Green manufacturing

- Quality/zero defects
 - Reliable results

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AN ADVANCED ENERGY COMMUNITY PROJECT IS TRANSFORMING A LOW-INCOME NEIGHBORHOOD

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RENEW&BLE Iange

THE GREEN REVOLUTION THAT IS SWEEPING CALIFORNIA HAS SKIPPED PAST THE OAK VIEW NEIGHBORHOOD IN HUNTINGTON BEACH. UC Irvine's Advanced Power and Energy Program wants to help change that and, in the process, conduct some important research. That's why Jack Brouwer, APEP associate director, and a team of collaborators picked Oak View as the site of its \$15 million plan to build an advanced energy community. The team includes the city of Huntington Beach, the National Renewable Energy Laboratory and Altura Associates, Inc., a company focused on efficient and green buildings. The effort started nearly two years ago, funded by \$1.9 million from the California Energy Commission, Southern California Edison and Southern California Gas. Brouwer's team also partners with residents, community groups and Oak View Elementary School. Together, they will replace appliances with energy-efficient models, install smart power strips, weatherize homes, blanket the neighborhood with solar panels, add battery electric storage and replace lightbulbs with LED lights.

Additionally, the project will investigate the capability of storing wind- and solar-generated energy with power-to-gas technology. This means surplus energy from solar panels or wind farms is converted into hydrogen,



A UCI team is blending community benefits with research understanding as it helps create a \$15 million advanced energy community in Oak View, a low-income neighborhood in Huntington Beach, Calif. which can be blended with natural gas and used to power home appliances and hydrogen fuel cell vehicles. The surplus energy also can be converted to methane for use in a natural gas pipeline or storage system.

This process can enable the long-term storage of large amounts of carbon-free power. UCI has demonstrated the success of the conversion technology, but injection into the natural gas pipeline system is still in its infancy. The project will contribute to advancing this injection capability.

"Energy storage is critical to increasing the use of renewable energy," says Yuri Freedman, senior director of business development at SoCalGas. "This project is an excellent opportunity to demonstrate power-to-gas as a storage technology that can directly benefit our customers."

But first, the Advanced Energy Community project wants to bring more immediate changes to Oak View. Brouwer describes the whirring of air conditioners and hum of power lines crisscrossing the neighborhood.

"Right now, this neighborhood is consuming millions of dollars of power it doesn't need, and it's costing residents money they could use to improve their lives.

"We have all the technology to change that, to benefit them and our community – solar panels, fuel cells, low-energy appliances, heat conversion tools, electric vehicles and batteries – but they're too poor to take advantage of them," Brouwer says.

Take, for example, the LED lightbulb.

More efficient than traditional lightbulbs and less expensive over time, LEDs are unlikely purchases for residents in Oak View, a tightly packed neighborhood of 10,000 residents in a mix of single-family houses and apartments wedged into one square mile.

Seventy percent of residents age 25 or older lack high school diplomas or equivalency degrees; more than half of those over 16 are unemployed. The per capita income of \$16,700 is almost half the county average.

"Residents simply can't afford to replace a working bulb – even when the new one is more efficient, cost-saving and environmentally friendly," Brouwer says.

Rolled out over three years, the plan would reduce the community's energy needs by 25 percent and pay off the \$15 million cost in 11 years. (Some elements, like solar panels and LED bulbs, would recoup their cost in just a couple of years.)

California Electrification

Emerging technologies for a zero-emission environment



Register at www.calit2.uci.edu

To fund the effort, the team is applying for a \$10 million grant from the California Energy Commission and seeking \$5 million in matching funds from public and private partners.

But changing the physical elements isn't enough. In order to sustain the program, residents must engage, and community perceptions of green technology must evolve.

The team is connecting residents with jobs in green industries, educational opportunities and the childcare needed to allow time for classes. A booklet guiding residents to resources is in the works. Next, the team will hold workshops with residents to discuss workforce development options.

The group also partners with community groups to provide weekly science, technology, engineering and math (STEM) classes for children at the small library shared by the school and neighborhood. Classes include experiments with solar-powered ovens and photo-sensitive paper.

"When the children are excited, they share that excitement with their parents, who then want to know more about these green options," Brouwer says.

Oak View ComUNIDAD, a community support group, is excited about the project's potential, but members are also concerned the changes could price renters out of their homes, according to co-founder Oscar Rodriguez.

"We want to be sure our neighborhood keeps its character,"

Rodriguez says. "We suggested they work directly with housing nonprofits that operate in Oak View."

Rodriguez, who also works for the Orange County Community Housing Corp., says Brouwer's team listened to their concerns and reached out to the area's housing nonprofits to see how they could collaborate.

The project will do more than save energy, though. Lowering harmful emissions means residents will be healthier, reducing impacts on health services. Less greenhouse gas will float into other communities, creating a ripple of benefits. Financial savings and new jobs will bring benefits to cash-strapped families, Brouwer says.

"This project offers a terrific blend of community benefit and research understanding," he adds. "It's exactly why so many of us got into academia in the first place – to make a difference that matters."

Professor Jack Brouwer (left) and Robert Flores, senior scientist, both with UCI's Advanced Power and Energy Program, are leading the neighborhood transformation effort.





JOIN US FOR THIS IGNITING TECHNOLOGY EVENT TO:

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- Understand quantifiable benefits of electrification for consumers and industry
- · Hear best practices from utilities who must implement electrification
- · Discuss key policy, regulatory and environmental issues
- Network with industry, government and academic leaders to form collaborations and help build
 the future of electrification
- · See what CALIT2 is doing to provide unparalleled data engineering infrastructure support

WILDFIRE VALUE

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When a wildfire started in Orange County California's Holy Jim Canyon last summer, a new ally helped firefighters control it.

High atop a nearby mountain known as Santiago Peak, six cameras mounted on a Southern California Edison communication tower and connected to a long-range wireless network were broadcasting a continuous live feed of the surrounding area. Images updated every 10 seconds, and firefighters relied on those feeds to decode the fire's origin, stay apprised of its progress and plan their containment strategy. HPWREN (High Performance Wireless Research and Education Network). Four stationary cameras offer a 360-degree view from Santiago Peak that stretches for miles, and two pan-tilt-zoom (PTZ) models with remote access provide up-close, detailed views. All six are linked to HPWREN's wireless internet-connected cyberinfrastructure, which broadcasts both a live feed and condensed, time-lapse videos on YouTube and at the HPWREN web interface (http://hpwren.ucsd.edu/ cameras/).

HPWREN was created in 2000 and is managed by UC San Diego under the auspices of its San Diego Supercomputer Center and Scripps Institution of Oceanography's Institute of Geophysics and Planetary Physics. The network, originally funded by the National Science Foundation and now supported by its user community, supports internet-data applications in research, education and

> public safety. Its nearly 30 installations connect hardto-reach areas across the remote Southern California backcountry, stretching from San Clemente Island to inland valleys, mountains and deserts, almost to the Arizona border. In addition to about 200 cameras, the Southern California installations include weather sensors, which provide environmental observations including wind speed and direction, and seismometers.

Orange County got on board in April of this year. HPWREN

collaborated with the Orange County Fire Authority, Southern California Edison and the University of Nevada Reno's ALERT Wildfire.org to install and operate the six cameras on Santiago Peak, extending the network into the county and allowing for real-time fire monitoring. The project also had the support of COAST, the County of Orange

Previous page: The Riverside County Fire Department keeps watch overnight as the Holy Fire illuminates the night sky.

Right: The Holy fire burns dangerously close to the HPWREN installation atop Santiago Peak.



Not only that, but Edison used the images to monitor its transmission lines, and decision-makers in Sacramento tuned in to validate the threat to infrastructure and communities. Local citizens were watching, too.

The cameras were installed earlier this year as part of a multi-institution collaboration called ALERTWildfire/



Safety Task Force, a group established to improve wildfire safety and public awareness in the county.

Last August, after years of planning, an HPWREN router was installed in the CALIT2 Building at UC Irvine, providing additional network access. Geoff Davis, a UCSD analyst who administers the network and oversees installations across the region, credits CALIT2 Irvine Director G.P. Li. "G.P. was instrumental in getting us space at CALIT2 and worked with us to get us access to the resources of UCI," Davis says.

Li calls the new router a team effort. "The partnership among UCI's Office of Information Technology, CALIT2, CENIC, UCSD and HPWREN made it possible to bring the infrastructure to Orange County," he says. "This will help inform OC residents about wildfires and will assist firefighters' plans on how to fight fires." HPWREN uses four stationary cameras and two pan/tilt/zoom models to offer a 360-degree view of the surrounding area.

"As the network is built out across Southern California and beyond, the ability to provide real-time information will provide a significant benefit, not only to the fire community but equally important, to the public." "The situational awareness ... is tremendous. We'll be able to operate our system in a more wellinformed way, and the fire agencies will be able to respond faster and with better intelligence."

Below: A view to the east from atop Santiago Peak, which at an elevation of 5,689 feet, is the highest in Orange County.

Opposite page: Cameras and weather sensors are shown pre-deployment. The tower team gets a safety briefing before deploying the technology. The CALIT2 router is a key network connection point. It is linked to CENIC - the Corporation for Education Network Initiatives in California. CENIC provides high-performance, high-bandwidth networking services to California universities and research institutions; if the routers in San Diego lose their connection, the UCI router can function as a pathway to the internet. Additionally, researchers at UCI and CALIT2 now have direct access to HPWREN.

In the coming year, the UCI wireless network will extend out to at least four new installation sites in Orange County. "Having the ability to expand the network up to UCI has been very beneficial to expanding our ability to cover Orange County, and to a degree, Riverside County," Davis says. "As we expand the network in Orange County, UCI's CALIT2 will be the jumping-off point." As for the Santiago Peak cameras, they were installed just in time. "This is the second time we've put cameras meant for fire protection on a mountain and then had the thing burn over on us or burn right up to the edge of the tower," says Davis.

OCFA Chief Brian Norton, who relied on HPWREN during the Holy fire, is grateful for the cameras and the fortuitous timing of their installation. The Holy fire, which burned more than 23,000 acres in Orange and Riverside counties in August, could have been far more destructive.

"The Alert Wildfire/HPWREN network initially was utilized to confirm the fire and location," Norton says. "Upon initial notification of the fire, I was able to view the [stationary] HPWREN cameras, then turn the PTZ camera and zoom in on the location. This validated the location and response prior to the arrival of air and ground resources."



The SCE communications tower on Santiago Peak offered the perfect spot to mount the cameras. Originally constructed to facilitate the utility's internal radio and telemetry communications, it affords additional benefits to Edison – which provided approximately \$100,000 in funding

to bring HPWREN to Orange County – during wildfires.

"When fires occur, we can have good intelligence on what the threat is to our system," says Troy Whitman, SCE senior fire management officer. "The cameras are a benefit to us not only for managing the bulk power on the transmission lines, but also for observing distribution damage. If we know we're going to have a distribution line that's going to be impacted, that may become a safety issue for first responders or for the public, we can proactively de-energize that line before it's [too late]."

Edison is collaborating with UCSD to open additional installations throughout its 50,000-square-mile region, which covers 14 California counties from Inyo and Mono on the east and Santa Barbara on the west, all the way to the San

Diego border. Over the next couple of years, an additional 75 installations are expected to join the network.

OCFA's Norton expects HPWREN to aid firefighters in the area for years to

come. A video wall is under construction in the agency's Emergency Command Center to view cameras from all the sites as they come online. "The ability to validate the fire's location and identify when the fire crosses pre-determined decision points is very beneficial," Norton says. and weather sensors, combined with information about fuel types, topography and other data to model potential fire spread. Norton says OCFA used it during the Holy Fire. The agency could "drop a pin" on a map where cameras reported a fire, then forecast the likely fire spread for several hours ahead of its

current location. "This can provide invaluable information when determining where fire resources may be needed to protect communities as well as critical infrastructure, such as power lines," he says.

As new installations come online, the likelihood increases that fire locations can accurately be reported earlier, Norton says. The agency's plans include working with community partners, like OC Parks and the Irvine Ranch Conservancy, to monitor video walls for potential fire starts on high firehazard days.

"As the network is built out across Southern California and beyond, the ability to provide real-time information will provide a significant benefit, not only to the fire community but equally important, to the public," he adds.

SCE's Whitman agrees: "The situational awareness ... is tremendous. We'll be

able to operate our system in a more well-informed way, and the fire agencies will be able to respond faster and with better intelligence."





OCFA also will employ WIFIRE/ Firemap, an NSF-funded real-time, data-driven simulator, predictor and visualizer of wildfire behavior. The technology utilizes HPWREN's cameras

Tech 101

► Sharon Henry

Social media companies use sophisticated technology to gain insight into online user behaviors, preferences and beliefs in order to sell targeted advertising to their clients. Disinformation agents use the same business tools to target online users and develop deceptive messaging campaigns. Here's how it works.

STEP 1: TRACKING BEHAVIOR

18

to specific current events.

Social media platforms, such as Facebook, Twitter and Google, use behavioral tracking to collect data about users' online activity.



hours to correct the hack.

algorithm in a targeting strategy.



Face of CALIT2

DETERMINATION AND MOTIVATION BOOST COMPUTER SCIENTIST TO NEW HEIGHTS in the

🖻 Anna Lynn Spitzer

14



Marco Levorato has spent the last decade painstakingly reconnecting with his past. In the process, he has constructed a clearer path to his future.

Born to a furniture-store owner and a homemaker in Dolo, Italy, a small town near Venice, Levorato, UC Irvine computer science associate professor, was the youngest of three children. He remembers an idyllic childhood, which changed suddenly and drastically when he was only 7 years old. His father died in a car accident, leaving the family not only to mourn but also to struggle financially. Regardless, his mother, Leda, made sure all three of her children went to college.

"We were a poor family and she managed to have all of us get educations. We all did well; my sister is a lawyer and my brother has a software company," Levorato says. "She was a strong woman and a lot of that made me what I am today."

It was his father's absence, though, that shaped his childhood. The young Levorato was studious; he liked to read and lacked any troublemaking tendencies. "I think I was missing the protection from my father to have confidence, to explore," he says.

Instead, he focused on his studies, determined to remain in the top 1 percent of students nationwide in order to qualify for the scholarships he would need to stay in school. After earning bachelor's and master's degrees, summa cum laude, in electrical engineering at the University of Ferrara, he decided to pursue a doctorate. At the University of Padua, one of Europe's oldest universities and historical home to esteemed faculty like Galileo, he discovered his love of research. "So that's what I've been doing since then."

His Ph.D. adviser had connections in California so Levorato completed his final doctoral year at the University of Southern California. He then did postdoctoral research in a joint USC/ Stanford program.

Urbashi Mitra was Levorato's adviser at USC. The Gordon S. Marshall Chair in Engineering and professor of electrical engineering-systems and computer science, Mitra describes Levorato as a joy to work with. "He was creative, technically excellent and open-minded about trying new things and going in novel directions," she says. "I see him continuing to exhibit these qualities as he has advanced in his career. I cannot be more proud about his successes at UC Irvine."

Those years in the U.S. left an indelible mark on the young graduate student. "When I moved here, I understood how many opportunities we have here in the states," Levorato says. "It's extremely competitive and challenging, even after you become a faculty member. But in Italy, you stay and wait; it's not really in your control."

The revelation precipitated his permanent move to the U.S., the only member of his family – and his wife's family – to leave Italy. "I'm not really the type of person to wait and see if something will happen 10 years from now," he explains.

Upon finishing his postdoctoral research, he joined the UCI faculty in 2013. He researched communications and networks, but Levorato soon expanded his focus to include connected systems – the acquisition, transportation, processing and organization of information in large, complex systems. He strives to push these systems into a degree of autonomy, not only



Levorato (holding photo) and a group of graduate students teamed with USC professor Bhaskar Krishnamachari (second from right) to develop a software-defined drone at a five-day DARPA Hackfest last November. The team focused on detecting and attacking a visual target (the photo of Star Trek's Khan) using video input, while dynamically avoiding interference during flight.

Levorato poses with a group of graduate students and visitors to his lab. "I've managed to build a quite solid and articulate research group in an area that's really competitive," he acknowledges. operationally but also in the way they manage information and transform it into control. He calls his UCI lab Intelligent and Autonomous Systems.

He engaged immediately and eagerly with CALIT2, even snagging one of four CALIT2 faculty appointments earmarked for professors focusing on multidisciplinary research. His interests in connected systems – specifically smart cities, healthcare networks and smart energy grids – made CALIT2's California Plug Load Center a perfect fit. "A lot of my problems involve physical systems and information management,



and it's not easy to get the expertise to build these systems. At CALIT2, I get help and support," he says.

"I have access to residential system measurements, data collection and good examples of what these systems would look like. It's not often that a basic researcher like me is in touch with all these aspects, and CALIT2 is a good hub to get this expertise."

Levorato has recently branched out even farther, into unmanned aerial vehicles, where he focuses on offloading computation reliably from the UAV to remote servers. "We see UAV as a big part of a big system," he says.

One of his favorite experiences was participation in a five-day DARPA Software-Defined Radio (SDR) Hackfest last fall at the NASA Research Park in Moffett Field, California. Levorato and two of his doctoral students teamed up to program an SDR-equipped drone that could detect and attack a visual target using video input while avoiding interference. "This was an exciting opportunity to use a lot of our prior experience to create a complex and articulated system," he says.

In his five years at UCI, he has brought in more than \$7 million in funding from an assortment of agencies, either as a principal investigator or co-Pl. In 2016, Levorato won a prestigious Hellman Fellowship to help develop a smart community network that empowers citizens to provide feedback on services, infrastructures and neighborhoods. He is part of a \$3.7 million University of California Office of the President cybersecurity grant in electricity distribution with the goal of securing the smart grid. He is partnering with a mechanical and aerospace engineering professor on a \$500,000 National Science Foundation grant to investigate urban environment monitoring systems. He is working on secure distributed computing in UAV networks under a DARPA grant. And most recently, he and a team of multidisciplinary collaborators were awarded \$2.1 million by NSF to use

technology to enhance medical care and education for pregnant women in underserved communities.

Nikil Dutt, Distinguished Professor of computer science, is the principal investigator on the most recent NSF grant. He says Levorato combines innovativeness and rigor in approaching research problems. "While many academics find it easy to think 'outof-the-box' and brainstorm on ideas, Marco goes a step further in being able to take those ideas and define them quickly as concrete problems that colleagues and students can work on," Dutt says. "I greatly enjoy my discussions and interactions with him. He has a good sense of humor and makes collaborations engaging and fun."

While Levorato has enthusiastically and completely acclimated to life in the U.S., he returns every summer to Italy, accompanied now by his wife, Giuila, and 2-year-old daughter, Fiamma, to reconnect with his family and his roots.

He has few memories of his late father, he says, but he has gained a deeper understanding from family lore. "He was an adventurous man, he could do anything," Levorato says. "In the last 10 years, I have been trying to reconnect with him and with my past, which is why I started rock climbing."

He acknowledges that the extreme sport, which he embraced eight years ago, doesn't appear to mesh with the introverted, quiet, somewhat fearful image he paints of himself. But that's the whole point. "Rock climbing is the biggest hobby and the biggest frustration in my life," he says. "I was really scared of heights; really I was afraid of everything. I couldn't even do hikes."

The turning point came when a friend invited Levorato to join him at an indoor rock wall. "I was so bad and so scared that I really felt I had to do something about this," he says. "You learn to reason with fear. It's not that you conquer it or destroy it but you learn to live with your limits and with yourself." Levorato returned recently from a four-day rock climb in the Italian Dolomite Mountains. A few days before his departure, he says, he was filled with a mix of excitement and fear. "When I go on a rock climb, I always think, 'why am I doing this?'" he admits. "Why am I putting myself in this position? But there's something inside me that pushes me to try."

Have the lessons he's learned through climbing informed other aspects of his life? He is sure of it. "You climb mountains not to conquer anything but to have the experience of knowing yourself in a very deep way," he explains. "Going to the mall or going to play soccer isn't going to teach you what you are in a way that rock climbing does. When I'm climbing, I always have the feeling that quite solid and articulate research group in an area that's really competitive," he acknowledges.

"In the old days, faculty could be super specific and really specialize in one domain," he adds. But the type of work he's doing requires a broader approach. His group is comprised of communications specialists like himself, along with mathematicians, machinelearning experts and "people who build things and fly things."

Levorato has found his niche. "Being a researcher is really what I want to do in life," he says. "I don't see myself going to industry or not [remaining] involved in pursuing the advancement of technology. I really hope that 10 years from now, people will look at my work and see the meaning."



I'm really part of this system of things ... that I'm connected to nature. When you're in an office you don't feel that."

When he is in the office, however, he uses those lessons to ground himself and inspire his work. Levorato is understandably proud of his accomplishments, especially his research efforts. "I've managed to build a Rock climbing, which Levorato calls his "biggest hobby and biggest frustration," has given him a new confidence and a deeper sense of self.





Today's U.S. teens are more connected - to the internet. information and each other than any previous generation, with 95 percent having access to a smartphone, and 45 percent saying they are online "almost constantly," according to a recent Pew Research Center Survey.

Scientists, educators and parents may well wonder about the effects the digital age is having on the nation's youth. And, with technology changing so rapidly, can the research keep up?

That is the aim of the Connected Learning Lab (CLL) in CALIT2, where interdisciplinary researchers are putting their heads together to better understand how young people are using digital technology, and then leveraging that information to improve educational technologies and approaches. Twelve faculty - across informatics, education, anthropology, psychology and humanities - bring their own research, expertise and students to the task.

Cultural anthropologist and informatics Professor in Residence Mimi Ito directs the lab. She studies technology use by youth, examining their changing relationships to media and communications. With multimillion dollar funding from the MacArthur Foundation, Ito has spent the past 10 years building a framework around the idea of connected learning, and she has helped recruit other researchers with interests in this area to UCI, building a critical mass of expertise for the new lab.

"With these new hires, UCI has positioned itself in the forefront of national efforts to improve youth outcomes with technologically enhanced educational opportunities," says UCI School of Education Dean Richard Arum,

INTERESTS

CONNECTED

а CLL facultv **OPPORTUNITIES** member and an expert on the legal and institutional environments of schools, social stratification and digital education. "I am grateful for the opportunity to be engaged with this exceptional group of scholars."

Arum was part of the MacArthur Foundation Connected Learning Research Network, a broader coalition of experts across the country chaired by Ito. Their work has found that the sweet spot for learning is the place where a person's interests, relationships and opportunities intersect, often with the support of digital media.

"Our research shows that young people learn best when actively engaged, creating and solving problems they care about, and when they are supported by peers who appreciate and recognize their accomplishments," Ito savs.

She and a team of others are helping define the way kids use media. understanding what it means to hang out, mess around and geek out online.

Ito's observations of the first big

wave of social media and digital media adoption shows that young people are a couple paces ahead of defining what everybody ends up doing, such as text messaging, Facebook, etc.

RELATIONSHIPS

Ito explains that researchers from the lab will look at everything from social, emotional and cultural factors, to the technology and big social structural issues like educational inequality. "We do a lot of work in the education sciences, technology studies and human computer interaction and so on to understand learning dynamics, but we also bring in a lot of social science to look at issues of equity, inclusion and barriers."

Another CLL faculty member, Candice Odgers explains that researchers want to determine how to leverage new technologies and build supportive environments in ways that will reduce inequality instead of amplifying it. "We have the largest world population ever of adolescents: 1.8 billion. And this group is very digitally connected," says Odgers, a developmental psychologist who

studies adolescents' mental health and development. She points out that although one in three users of the internet is younger than 18, the online world wasn't designed with them in mind. "We really need to think about how youth are not only shaped by their experiences in the online world but how the online world can be designed in ways that could be more supportive or that could reduce these inequalities that we are seeing."

Ito and Odgers, along with collaborators from UC Berkeley and University of Toronto, recently received funding (\$65,000) from the Canadian Institute of Advanced Research to lead a series of think tank workshops focused on reducing digital inequality and enhancing inclusion via smart design and developmental science.

According to Odgers, who started tracking kids with cell phones 10 years ago, many kids are actually thriving in the digital age. "We see high rates of high school graduation, and declining rates of things like teen pregnancy, alcohol consumption and violence. So most kids are doing well. Even in cases where young people seem to be struggling a bit more, like with mental health, we don't find evidence that smartphones are to blame. People really want to blame the devices, so it's important to understand what the real effects are."

She says there are better data today on digital technology and kids, and the information is becoming more nuanced. For instance, all young people, but especially those from low-income families, are increasingly connecting to the online world and their social networks via smartphones and mobile devices. These children spend on average three more hours a day on a device than children from high-income families, and that time is spent a little bit differently. The children in high-income environments spend a larger portion of their time searching for information or doing things that are considered educational as opposed to entertaining.

Another interesting finding, from Ito, is that young people today have grown up consuming the media of their choice (self-selecting their news), unlike previous generations who grew up watching the evening news on live television. This has implications for how people form political opinions or decide what is factual and who is an authority. "This trend has been going on for some time, and it means that interpersonal and social relationships drive belief systems in a much more profound way than an environment where you still had this bull pen of common media culture," says Ito. "Often these broader implications are things that are difficult to anticipate until you've seen the ripple effects play out."

Odgers characterizes the phenomenon this way: "The genie is out of the bottle." The digital revolution, the information age and the ultra-connected, socially networked teen are all part of today's world. She hopes that with the new CLL at CALIT2, "We can forge new collaborations, advance research faster than we would be able to in our own school environments and serve as a real resource for this campus, the UC system and the world more generally, on a topic that is just exploding and the science is struggling to keep pace."

Ito calls CALIT2 the ideal home. "Our work is very much aligned with the mission of CALIT2, both being interdisciplinary and bringing technology into conversations with others. It's about research in the real world and partnerships with industry, nonprofits and educational organizations. Plus pragmatically, because we have so many faculty from different schools across campus, we need a place that feels like a Switzerland, a place that's neutral."

MEET ABIGAIL: A CONNECTED LEARNER Source: www.clalliance.org

INTERESTS

Abigail is an avid fan of popular culture. She loves Harry Potter and the boy band One Direction.



RELATIONSHIPS

Abigail discovers One Direction and Harry Potter fanfiction and a supportive community on Wattpad, an online publishing app. She begins writing her own fanfiction on there, gaining a following and confidence.



OPPORTUNITIES

Based on her experiences writing online, Abigail decides she wants to become a professional writer. She applies and gets accepted to a specialized creative writing program at a magnet high school.

Entrepreneurial Spirit



UCI STARTUP GROWS REHABILITATION BUSINESS AND PRODUCT OFFERINGS

RECOVERY



Nizan Friedman first demonstrated entrepreneurial skill in the fourth grade. After learning origami from his grandfather, the young Friedman shared his enthusiasm for the Japanese art by selling folding papers at 50 cents each to his classmates.

Today, Friedman and his partner Danny Zondervan, both UC Irvine engineering alumni and former CALIT2 TechPortal occupants, are proud owners of Flint Rehab, a 15-employee device company that makes products to help survivors recover from stroke. Flint's "tools that spark recovery" are the next generation of physical therapy equipment, light years ahead of traditional exercise balls and resistance bands. The two engineers, both musicians, use technology and music to gamify the process and motivate people to exercise.

Friedman and Zondervan were doctoral students in 2011 when they founded Flint. They designed, created and tested their first product, the MusicGlove, in CALIT2's eHealth Collaboratory under the guidance of engineering professors Mark Bachman and David Reinkensmeyer. The MusicGlove helps stroke patients with hand paralysis regain function; it can be used at home or in a clinic to augment traditional physical therapy. The fledgling company has sold about 6,000 devices so far, mostly to individuals.

Its success inspired Friedman and Zondervan to develop new products based on the MusicGlove model. They wanted to take "the essence of why people enjoy the MusicGlove – the connection between music, the brain and the addictive qualities of game playing – and distill that, then convert it into a way that can be used on other parts of the body," explains Friedman. That determination led to their next offerings and to their growth. Flint hired fellow biomedical engineering alumnus Justin Rowe to serve as lead engineer on the new products.

After several years of research and development – Flint develops custom hardware, firmware and software for its products – they launched FitMi in 2017. The full-body home-therapy tool helps patients retrain their brains and improve

movement

MusicGlove is a hand therapy device that works by motivating users to perform hundreds of hand and finger exercises while playing a musical game. through repetitive exercises set to music. It includes two wireless pucks and a therapy software app (Rehab Studio), which guides patients through workouts to improve strength and dexterity for various parts of the body: arm raises, toe taps, torso twists, etc. It offers 40 different exercises specifically for people with a neurologic injury. The pucks contain multiple sensors and algorithms, and movements are tailored to a patient's stage of recovery. As they improve, the FitMi exercises and difficulty levels increase to enhance recovery. FitMi comes with a customized tablet called the Flint station; patients also can use it with their own personal computers.

Tina Orkin, 62, suffered a stroke two years ago, and she has been using the FitMi once a day for about six months.

She really likes it. "It's an extremely easy product to use. You don't have to be tech savvy, and it's very compact. You can use it



anywhere; I can take it with me to my grandkids' house."



Danny Zondervan (left) and Nizan Friedman co-founded Flint Rehab as doctoral students at UCI. The company has grown to 15 employees and now offers four devices, including FitMi (above), a full-body home-therapy tool designed to help people with a neurological injury improve strength and dexterity.



Cycli is a Bluetoothenabled, low-profile portable cycle that tracks reps and calories burned and lets users join groups to support or compete with each other. Orkin lets her grandson in on the fun. She says therapy can be boring, but this system is self-rewarding, making dinging noises and releasing balloons on screen when a goal is reached. "It's like a game, and I really like that it gives you feedback. My grandson will say, 'Push harder!'"

The former nurse practitioner practices multiple forms of therapy, including the FitMi. She is expecting two more grandchildren soon and wants to be able to bend, twist and lift things easily. All those movements translate into living a better life after stroke. "It's been very helpful in getting me closer to my end goal, which is to have more use of my arm and more balance in my life," says Orkin. She has plenty of incentive, including encouragement from the 4-year-old grandson. "Grandma, when do you think you'll be using that arm? I'd like to hold your hand," he told her.

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With active Facebook support groups for stroke patients and a popular blog, Flint is not short on endorsements. FitMi is selling three times as well as the MusicGlove. This has inspired the two founders to develop even more products. "Our first two products gave people the ability to quantify their movement and engage in a more fun way to do therapy," explains Friedman. "With our next two products - Cycli and MiGo - we are making rehab more social, by allowing people to join groups and compete."

Flint held a Kickstarter campaign in June 2016, raising more than \$130,000 to manufacture and sell Cycli, an underthe-desk, Bluetooth-enabled portable cycle. The high-tech, low-profile cycle tracks reps and calories burned, sending data to an app for the iPhone or Android. In addition to tracking exercise, it allows users to compete against each other in public or private groups.

Flint's fourth product, MiGo, is a wristband activity tracker designed specifically for rehab. Flint has sold about 100 pilot units. Unlike most activity trackers, MiGo counts more than just steps, an important factor for people with disabilities who may be using a wheelchair, walker or cane, or just have a unique gait pattern.

The MiGo tracks every move a patient makes, including arm, trunk and leg movements. It is also smart enough to rule out unintentional

movements, like a tremor.

Knowing the "rep count" is incredibly important in rehab, but unfortunately, most stroke survivors are not aware

of their daily movements. Research shows that if patients receive feedback



on how much they are moving, they have a much better chance at recovery.

Intricate algorithms are built into MiGo, and every day, users see a new smart goal right at the top of the screen, based on their history. It pushes patients to do more and more exercise by upping the goal, and it offers encouragement in the form of text messages. MiGo has 50 different programed messages, and when users reach 100 percent, fireworks explode on screen.

Friedman and Zondervan have been successful at securing small business government grants to fund their innovations, raising about \$8 million so far for research and development. And they're working with Kaiser Permanente to try to get their products covered by insurance so these tools can become part of the continuum of care. They're also branching out into other areas, such as orthopedic rehabilitation for post-hip and knee replacement, as well as cognitive rehabilitation for those with Alzheimer's Disease.

Reinkensmeyer, professor of mechanical and aerospace engineering and biomedical engineering, can't wait to see what his former students do next. He says that after 20 years of research showing that robotics, computer gaming and sensing technologies can enhance movement recovery by facilitating intensive movement practice, only a handful of companies have been successful making clinic-based robotics technologies. Most of these devices remain expensive and are mainly used by a relatively small number of flagship rehabilitation facilities. "Flint is driving a new model, which is to produce technologies that can be purchased out-of-pocket directly by consumers who have had a stroke," Reinkensmeyer says. "These technologies are simple, yet engaging and effective."

MiGo

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Friedman's advice to other entrepreneurs, which probably goes back to fourth grade, is to "do something you really believe in rather than just something that will make you money. Starting a company requires an incredible amount of dedication and work."

He adds: "It's been an amazing experience. I feel really fortunate."

"It's been very helpful in getting me closer to my end goal, which is to have more use of my arm and more balance in my life."

An activity tracker designed specifically for rehab patients, MiGo tracks all movement, not just steps, to assist people in their recovery from neurological injury. Twitter

Shelly NazarenusDebbie Morales

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ICYMI, THIS SUMMER A DOZEN UNDERGRADS CONNECTED IRL TO ENGAGE IN INNOVATIVE RESEARCH PROJECTS AND PRESENTATIONS. **BTW,** THE FOCUS WAS IOT-RELATED. HERE, THE **PPL** SHARE EXPERIENCES FROM THEIR **POV**.

Interface | FALL 2018

#nice @ChenMo

We discovered the fundamental goal of our project through lots of reading and research. Before that, we were kind of lost. Team management and time management are key.

#TOP10THINGSHAVE TODOSUMMER2018 @YangCao

I'm having fun with data! Developing new features is easy, however integrating them is painful. My mentors gave me a lot of insightful advice on design and coding.

Cloudberry

Cloudberry is a middleware system designed to retrieve data quickly from enormous datasets. The goal of Cloudberry is to provide reliable and efficient API to data-analyzing Twittermap is a web application that visualizes huge numbers of tweets, demonstrating the powerful features of Cloudberry. During the summer, Cao worked on maintaining and developing new features for Twittermap. He refactored its code base, making it more general and easier he developed new features for the web

EV Intelligent Charging System

According to the California New Car Dealers Association, the state is the largest plug-in car regional market in the country, with over 365,000 plug-in electric vehicles registered through 2017. The operational load for these vehicles can create localized strain on the power grid and requires planning for long-term energy sourcing. In this SURF-IoT project, Mo was part of a research team working on the development of a demonstration electric vehicle intelligent-charging system. The team hopes to produce a robust system prototype that can provide a clear example of effective energy negotiation and management to meet the goals of utilities, ratepayers and local

#BetterPlanBetterMeal @LingJin

小动物

I found that both food scarcity and food waste are serious worldwide problems. The app I developed helps people make better meal plan decisions. This is a really important thing.

Healthy and Affordable Meal Planning

A 2017 U.S. Department of Agriculture report indicates that 26 percent of food waste occurs at the consumer level, while 12.5 percent of Americans do not have enough food on a routine basis. Given these findings, Jin set out to develop an application to encourage healthy and affordable meal planning. She targeted university students, who have limited budgets and time. The interactive app provides easy, affordable and healthy recipes, enabling users to set a budget and make weekly meal plans. In the future, Jin hopes to develop different functions suitable for various types of users.

#summertimelearning @AndrewChio

The most challenging part was the code writing. It was difficult to find a balance between investing too much time learning one API and investing too little time to be able to efficiently use it.

Distributed Mediator Placement

As IoT devices proliferate, so will the number of protocols employed by these devices to support direct internet connectivity. This, in turn, introduces newfound diversity and fragmentation in IoT systems, requiring a solution, such as mediators, to enable interoperability. In this research project, Chio focused on where and how mediators should be placed in the cloud (edge versus fog) and on which physical IoT device. Finding better placement of distributed mediators for IoT data exchange is particularly valuable in a scenario where time is a critical resource - for example, firefighting, where every lifesaving second counts.

#Act_Like_A_Pro @YongxiLi

We bought the smallest RFID kit in the world and tried to modify its circuit to make it chemiresponsive, and then insert the chip in an organoid. It's so cool, right?!

Single Cell Radio

Using organoids is a traditional method for detecting malfunctioning cells; these organoids are usually observed under a microscope, which can be time-consuming and indistinguishable. This research proposes a chemiresponsive nanomaterialintegrated RFID-based technology to identify each unique organoid and track its physiological phenomenon without using a microscope. Initial results indicate that this single-cell radio approach is useful for detecting chemical gases.

#LearningNeverStops @DanielMardirousi

Even though I had no prior experience working on drones or hardware, it was a very interesting project and I am glad I got a chance to be a part of it, learning new things along the way.

Drone Rescue Project

This project focused on the autonomous flight of drones for various purposes, including search-and-rescue missions. The goal is to make a more efficient drone that only weighs 100 grams, has a flight time of an hour and a flight range of 100 kilometers. Researchers are using the open-source software Ardupilot, which runs on expensive, bulky, non-customizable boards. Mardirousi's role in the project is to port Ardupilot to much smaller, cheaper and customizable boards. The new flight controller he is developing will be better in every way and make this type of drone a possibility.

#autoDiary @PooyaKhosravi

I created an app that automatically tells you what you do throughout the day. As the project evolved, opportunities to expand and enhance the app grew, so I will continue to work on it.

Personal Chronicles for Cybernetic Health

With the advent of the smartphone and wearable devices, researchers can monitor multimodal data streams from sensors to analyze people's behavioral patterns and lifestyle. The goal of this project is to extend the Personicle model to Apple users by creating an iOS app that uses common sensors for monitoring and chronicling an individual's activities throughout the day. Users will be able to connect their smart devices, no matter how many, to get insight into their lifestyle, health status and disease estimation.

#TechSURFingSummer @BarbaraMartinezNeda

SURF-IoT and the OASIS project gave me the opportunity to gain experience outside of my scope of knowledge. I loved using my abilities to help others!

OASIS

OASIS is a mobile application that aims to help people affected by California's extreme heat conditions, providing them with necessary tools to stay safe and hydrated. The app provides a map with the location and information of nearby cooling centers so people can utilize those services. Users receive weather and heat-wave warnings so they can properly prepare, and the app lists information to prevent, detect and treat heat-related illnesses. OASIS will also incorporate an alert system to remind users of the dangers of leaving a child or pet in an unattended vehicle. The target audience for this app is low-income residents who are often the most affected during extreme heat conditions.

#invaluablesurf @RobinCristobal

There are a lot of cameras in buildings. What if you could tell them to hide your face so no one will know you were at certain locations? Well, you can with my research project.

You Shall Not Pass

Bluetooth beacons, Wi-Fi access points, HVAC sensors and other IoT devices have created smarter, more efficient buildings, but these technologies are often installed with little regard for privacy. The goal of this project is to give people who enter an IoT-equipped building the ability to specify their privacy preferences, and based on the provided preferences, apply policies on the incoming system data. Serving as an enforcer engine, TIPPERS is an IoTmanagement system that collects data from different sensors and ensures data are modified before they are sent to the server. Cristobal's research focused on image processing and developing an enforcer architecture for camera sensors.

#fastpacelearning @SiboWang

The ability to quickly familiarize with unknown knowledge and acquire adequate skills to do certain things is the most rewarding part of this program.

#LearnByPractice @BolinChen

This summer, I learned how to work in a group environment and how to effectively communicate with our team members to solve technical and functional challenges.

#Timeconsuming @YuranYan

It is ok that you know little about the project, but you want to ask questions as often as possible or you might find the summer is over before you completely understand what is going on.

Texera Interface

These three SURF-IoT fellows worked on improving the Texera interface that enables non-computer scientists to conduct powerful IoT data analytics. The system is designed to help people easily construct a data-analysis workflow and interact with it. The team evaluated various big-data computation and scientific workflow engines and software to find the ideal system that can achieve the mechanics and performance that Texera requires. By the end of the summer, they found that the Actor system might meet their goals and are moving forward to implement the Texera backend with that system.

A Parting Shot

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An astonishing new material is under development in the lab of CALIT2 affiliate Alon Gorodetsky.

Based on the reflective properties of squid skin, the thin swatches can become invisible or control their own temperatures, quickly changing how they reflect heat. After being stretched or zapped by electricity, the material smooths or wrinkles itself in less than one second. "Basically, we've invented a soft material that can reflect heat in similar ways to how squid skin can reflect light," says Gorodetsky, a UC Irvine engineering professor and manager of CALIT2's Bio-Nano Lab.

Assembled like sandwiches of aluminum, plastic and sticky tape, the bioengineered prototype – created after trial-and-error processes involving thousands of attempts – can be scaled up into large sheets of commercially useable material. Potential applications include camouflage and insulation.

A combination of nature and Hollywood magic influenced the material's creators.

"We were inspired both by science fiction and science fact – seeing dinosaurs disappear and reappear under an infrared camera in 'Jurassic World' and seeing squid filmed underwater do similar things," Gorodetsky says. "So we decided to merge those concepts to design a really unique technology."





Under the direction of By integrating academic digital transformation of



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