**ASU | Center for Cognitive Ubiquitous Computing**
Arizona State University

# CUbiC Fall 2019 Newsletter

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## About CUbiC

The Center for Cognitive Ubiquitous Computing (CUbiC) at ASU is an interdisciplinary research center focused on cutting edge research in human-centered multimedia computing with specific focus on assistive, rehabilitative, and healthcare applications.

Please visit **cubic.asu.edu** to learn more about our work.

## Founding Director

**Dr. Sethuraman Panchanathan**

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**NRT Fellowships available for interested candidates.**

Please visit **nrt.asu.edu** for more information.

## Director's Welcome

Welcome to the Fall 2019 edition of the CUbiC newsletter. I am glad to share with you the many successes of CUbiC over this past year, as well as the ongoing developments and collaborations through which we are continuing to advance. CUbiC's commitment to the application of ubiquitous technologies focused on improving the lives of people and the global community remains strong. I hope you will share our excitement in our latest achievements.

I am happy to announce that Dr. Troy McDaniel, who served as Associate Director of CUbiC for the past several years, has recently been appointed as tenure-track Assistant Professor in the Polytechnic School at ASU's Polytechnic campus, where he now leads a haptics research team at the HAPT-X Laboratory. He will continue to Co-Direct CUbiC, along with our newly-appointed Associate Director Dr. Hemanth Venkateswara.

We recently wrapped the first year of our NSF NRT project on "Citizen-centered Smart Cities and Smart Living," and we are off to a promising start thanks to our new NRT Project Coordinator Ding Ding Zheng. Our new NRT website can be found at **nrt.asu.edu**. Our first student cohort began this semester, and consists of five PhD students, including three from CUbiC. Jordan Miller, Nickolas Dodd, and Danielle Jacobs from the Computer Science (CS) PhD program, and Joshua Massad and Jan Cordero Casillas from the Human and Social Dimensions of Science and Technology (HSD) PhD program, have joined us this Fall. Our NRT Communication Skills Training Workshops provide trainees with opportunities to enhance their technical communication proficiency and nurture professional growth along many dimensions. The Fall 2019 workshops include "Writing a Literature Review," "Introduction to the Institutional Review Board Process," "Crafting Strong Intro Emails and CVs," and more. In addition, the NRT Entrepreneurship Seminar Series, occurring twice per semester, deepens trainees' understanding of entrepreneurship promotion and pursuit in Smart Cities- and Smart Living-related fields. Topics of this series for Fall 2019, led by invited guest speakers including ASU staff, NRT faculty, and non-NRT faculty, include "Innovation and the Entrepreneurial Mindset" and "Fundamentals and Challenges for Technology Commercialization."

As a final note, I would like to extend a special thanks to all of the CUbiC colleagues who have worked together to help realize these achievements. We have several events being planned for 2019 and beyond, including co-organization of the 2nd MAHCI Workshop on October 25th, 2019, co-organization of the symposium "Signal and Information Processing for Person-centered and Citizen-centered Smart Living" at IEEE GlobalSIP on November 14th, and a special session at ICSM 2019, to be held in San Diego, CA on December 16th-18th, 2019.

If you would like to learn more about CUbiC, I welcome you to join us at these events, visit our center at the Brickyard Engineering building on ASU's Tempe campus, or visit our website at **cubic.asu.edu**.

**Dr. Sethuraman Panchanathan**
Center Director

# ASU NSF-NRT: Citizen-Centered Smart Cities and Smart Living

By Dr. Ramin Tadayon & Ding Ding Zheng

The National Science Foundation Research Traineeship (NRT) grant project, *Citizen-Centered Smart Cities and Smart Living*, at Arizona State University is an interdisciplinary training program to develop and implement bold, new and potentially transformative models for STEM graduate education.

As population growth steadily rises, cities must meet increasingly complex management and resource needs while continually improving the quality of life for their citizens. Varied backgrounds, customs and contextual factors result in diverse life experiences of a city's residents, and therefore, one-size-fits-all solutions are no longer viable. Smart City technologies are now achievable for adaptive and citizen-centered solutions, yet require further research and investigation.



Group photo of the first cohort of NRT trainees.
**Front Row:** left to right: Jordan Miller, Danielle Jacobs.
**Second Row:** Nickolas Dodd, Josh Massad, Jan Cordero Casillas.
Photo by Ding Ding Zheng/ASU.

This NRT project will train the next generation of master's and doctoral students to become future Smart City leaders through integrated and interdisciplinary citizen-centered solutions for Smart Cities and Smart Living. Under this framework, research solutions of greater public value — which take into account the diverse characteristics of citizens while considering challenges from a multitude of perspectives — can be achieved.

# Spotlight: Team wins top prize at ASURE VR Innovation Challenge

By Ramesh Tadayon & Ding Ding Zheng

The CUbiC/SBHSE Team won the top prize at the 2019 ASURE Virtual Reality Innovation Challenge Final Demonstration for their AR/VR application, "Keep Calm," in April 2019. Team Keep Calm, consisting of Dr. Troy McDaniel and Master's student Ramesh Tadayon, is using Virtual and Cinematic Realty to create effective personalized interventions for those with anxiety disorders.

In an age of quickly evolving technology, virtual reality offers an unmatched degree of immersion in an alternate reality. This is the precipice of safely studying and understanding the psycho-physiological reactions of an individual in any designed environment. During the VR Innovation Challenge, Team Keep Calm harnessed the unique opportunity of studying individuals during a heightened state of anxiety while maintaining a controlled lab-environment through the use of augmented reality and virtual reality.



Photo of Ramesh Tadayon and Dr. Troy McDaniel holding award. Photo by ASU Research Enterprise.

In their study, the researchers invited participants to play a commercially-available virtual reality game in which the individual sees themself in a virtual elevator which rises to the top floor of a skyscraper and opens up to only a wooden plank placed precariously above the simulated city below. Participants are asked to do their best to walk out to the edge of the plank and return within a time limit. During the study, EEG, Heart Rate and Skin Conductance values were recorded and analyzed.

The team ultimately won the VR Innovation Challenge because nearly every person who learned about the project immediately thought of a potential use for themselves or others they knew. Whether one is a college student who is eager to learn and understand the course material but suffers from test anxiety, or one is in the military and consistently in high-stress situations where clear cognition and decision-making skills are invaluable — anxiety takes a toll in the workplace, in social environments, and at home. If anxiety does not affect you, it affects somebody you know, and VR may give researchers the tools and understanding to finally offer better solutions to managing anxiety.

The work of Team Keep Calm, alongside other research concurrently published, explores a more innovative future of elaborate and effective environments to evaluate new intervention methods to help cope and relieve anxiety.

## Dr. Troy McDaniel

Dr. Troy McDaniel has recently been appointed a new position as Assistant Professor at FSE's The Polytechnic School on ASU's Polytechnic campus. Within this new role, Troy directs the new HAPT-X Laboratory. In addition, he continues to contribute to CUbiC as its Co-Director. His research specializes in haptic interface design with a focus on sensory substitution, haptic human augmentation, and multimodal integration. Other interests include smart living, human-computer interaction, and machine learning, especially for haptics. He has applied his research in the development of assistive and rehabilitative technologies for individuals with sensory and physical impairments. Troy is deeply exploring the paradigms of haptic interaction, including mapping between modalities for various means of information representation. In addition, he is investigating the use of citizen-centered approaches to Smart City research, emphasizing attributes such as accessibility and public health. For several years, Troy has contributed significantly to CUbiC's growth as a research center through student recruitment and mentorship; guiding CUbiC's research direction; pursuit of external funding; and building partnerships with key academic, industry and government partners, all while making significant strides in his own research and teaching.

Photo of Dr. Troy McDaniel.
Photo by Kevin Navarro/ASU.

As he makes his transition in his new position, Troy gives the following message to CUbiC students: "To my fellow Cubites — Throughout my many years and many invaluable interactions at CUbiC, I am proud to have witnessed our multimedia computing research center evolve into a place of amazing talent that produces impactful and high-quality research. I firmly believe that this is because we are a family with a clear vision and people-first philosophy, and this philosophy has guided us well. Continue to support one another, exchange ideas, evaluate one another's work, offer your unique perspectives, and maintain focus on the individuals who will use the concepts, technologies and systems you develop, and you can all be certain that CUbiC will continue to grow as a strong, cohesive entity. I wish you all the very best and hope to continue collaborating with you in the years to come!"

## Dr. Hemanth Venkateswara

Dr. Hemanth Venkateswara is the newly-appointed Associate Director of CUbiC. In addition to this role, he continues as an Assistant Research Professor at CUbiC. Hemanth's area of research includes machine learning and computer vision using deep learning. In his research, he explores applications in domain adaptation, incremental learning, active learning and zero-shot learning. Hemanth teaches ASU graduate courses, including Fundamentals of Statistical Learning and Deep Learning for Computer Vision, and he completed his PhD at ASU in 2017. Prior to his PhD, he worked as a Senior Software Engineer at Alcatel-Lucent Technologies, India. Hemanth also holds Master's degrees in Physics and Computer Science from the Sri Sathya Sai University, India. In his free time, he enjoys volunteering in social service, watching educational YouTube channels, and reading Sanskrit poetry.

Photo of Dr. Hemanth Venkateswara.
Photo by Ding Ding Zheng/ASU.

## Ding Ding Zheng

Ding Ding Zheng is the coordinator for the NRT grant program and for CUbiC. She previously served as the coordinator for the TRIO Student Support Services grant program at ASU Polytechnic, and worked with first-generation college students, low-income students, and students with disabilities. Before that, she worked as an academic advisor in the College of Technology and Innovation (which has since merged with Ira A. Fulton Schools of Engineering) helping students succeed and graduate. Ding Ding is a "triple devil," having received her Bachelor of Arts degrees in English Literature and Japanese Language, as well as her Master of Arts degree in English (Comparative Literature), from ASU. Her hobbies include reading, getting daily movement (jogging, walking, hiking, yoga), spending time with family and friends, listening to podcasts, traveling, and eating.

Photo of Ding Ding Zheng.
Photo by Allison Barton/ASU.

## Nickolas Dodd

Nickolas Dodd is an NRT trainee and a PhD student in the Computer Science degree program in CUbiC. Born and raised in Arizona, Nick studied Computer Systems Engineering as an undergrad at ASU and has worked in various roles in the tech industry over the last five years. More recently, Nick started PhD work in the Applied Mathematics program before transferring to the CS program. His research interests include Bayesian Deep Learning, transfer learning and domain adaptation, and algorithms. Nick's hobbies include hiking and playing/making music, be it on the guitar, bass, or computer. In the future, Nick hopes to innovate on interdisciplinary research teams and leverage the proliferation of data driven services to positively impact the daily lives of citizens.



Photo of Nickolas Dodd.
Photo by Ding Ding Zheng/ASU.

## Danielle Jacobs

Danielle Jacobs is an NRT trainee and a PhD student in the Computer Science degree program in CUbiC. As an undergrad, Danielle studied Biomedical Engineering at ASU, working on brain computer interface research. After graduation she took a job with Intel working on Pre-Silicon Manufacturing Design, and later Cyber Security Risk Management. Her time in industry helped Danielle better identify exciting areas she wishes to pursue, and she returned to ASU for her PhD. In her free time, Danielle runs and trains for half-marathons, and aims to try a full marathon one day. Through the PhD program, Danielle hopes to develop more technical knowledge and skills to help solve real world problems in smart cities.



Photo of Danielle Jacobs.
Photo by Ding Ding Zheng/ASU.

## Jordan Miller

Jordan Miller is an NRT trainee and a PhD student in the Computer Science degree program in CUbiC. She is from Nashville, Tennessee and completed her bachelor's degree at Austin Peay State University. Jordan came to Arizona State because it offered cutting-edge research and the opportunity for her to study Human-Robot Interaction to help the elderly Age in Place and stay independent as they age. Jordan's hobbies include running, hiking, and reading. In the future, she plans to work in industry creating robots that live and work alongside humans in their daily lives, helping people around in the home.



Photo of Jordan Miller.
Photo by Ding Ding Zheng/ASU.

# Recent Publications

## Papers in Refereed Journals

1. T. McDaniel, D. Tran, A. Chowdhury, B. Fakhri, and S. Panchanathan, "Recognition of Tactile Facial Action Units by Individuals Who Are Blind and Sighted: A Comparative Study," *MDPI Multimodal Technologies and Interaction*, Vol. 3, No. 2, pp. 1-17, May 2019.

2. Z. Tu, H. Li, D. Zhang, J. Dauwels, B. Li, and J. Yuan, "Action-Stage Emphasized Spatio-Temporal VLAD for Video Action Recognition," *IEEE Transactions on Image Processing,* January 2019 (early access).

3. H. Venkateswara, T. McDaniel, R. Tadayon, and S. Panchanathan, "Person-centered Technologies for Individuals with Disabilities: Empowerment through Assistive and Rehabilitative Solutions," *Technology & Innovation*, Vol. 20, No. 1-2, pp. 117-132, November 2018.

4. S. Panchanathan, D. Cook, F. Golshani, T. McDaniel, and S. Chakraborty, "Technologies for Disabilities," *Technology & Innovation*, Vol. 20, No. 1-2, pp. 1-2, November 2018.

5. C.H. Adler, M. Temkit, D. Crews, T. McDaniel, J. Tucker, J.G. Hentz, C. Marquardt, D. Abraham, and J.N. Caviness, "The Yips: Methods to identify Golfers with a Dystonic Etiology/Golfer's Cramp," *Medicine and Science in Sports and Exercise*, Vol. 50, No. 11, pp. 2226-2230, November 2018.

6. K. Chang, P.L.K. Ding, and B. Li, "Single Image Super-Resolution Using Collaborative Representation and Non-Local Self-Similarity," *Signal Processing*, Vol. 149, pp. 49-61, August 2018.

## Chapters/Sections in Books

1. A. Tadayon, R. Tadayon, T. McDaniel, S. Panchanathan, "Wearable Computing and Human Centricity," in *The Philosophy of Mission-Oriented Wireless Sensor Networks*, H. M. Ammari, Ed. Springer International Publishing, 2019, pp. 381-413.

2. C. D. C. Heath, T. McDaniel, S. Panchanathan, "Examining Motivational Game Features for Students With Learning Disabilities or Attention Disorders," in *Handbook of Research on Immersive Digital Games in Educational Environments*, A. L. Krassmann, É. M. Hoff do Amaral, F. B. Nunes, G. B. Voss, M. C. Zunguze, Eds., IGI Global, 2019, pp. 232-259.

## Conference Poster Presentations and Keynotes

1. R. Noziglia, T. McDaniel, D. Anderson, and S. Panchanathan, "MisophoniAPP: A Website for Treating Misophonia," *Society of Instrument and Control Engineers (SICE) Annual Conference 2019*, SICE 2019, Hiroshima, Japan, September 2019.

2. S. Panchanathan, "Person-Centric Multimedia Computing: Technology Inspirations Drawn from Needs of Individuals with Disabilities with Impacts to the Broader Population," Invited Talk at *IEEE International Conference on Computing, Networking and Communications (ICNC)*, Hawaii, February 2019.

3. S. Panchanathan, "How Person-centered Technology Partnerships Are Transforming Abilities," Keynote at *Times Higher Education, The World Summit Series, Emerging Economies Summit*, Qatar, January 2019.

## Papers in Refereed Conference Proceedings

1. V. Shah, M. Cuen, T. McDaniel, and R. Tadayon, "A Rhythm-Based Serious Game for Fine Motor Rehabilitation Using Leap Motion," *Society of Instrument and Control Engineers (SICE) Annual Conference 2019, SICE 2019*, Hiroshima, Japan, September 2019.

2. M. Moore, M. Saxon, H. Venkateswara, V. Berisha, and S. Panchanathan, "Say What? A Dataset for Exploring the Error Patterns that Two ASR Engines Make," *INTERSPEECH 2019*, Graz, Austria, September 2019.

3. P. Papreja, H. Venkateswara, and S. Panchanathan, "Representation, Exploration and Recommendation of Music Playlists," *12th International Workshop on Machine Learning and Music (MML 2019) at ECML/PKDD*, Würzburg, Germany, September 2019.

4. G. Kaplan, T. McDaniel, J. Abbas, R. Tadayon, and S. Panchanathan, "A Time-Discrete Haptic Feedback System for Use by Persons with Lower-Limb Prostheses During Gait," *Universal Access in Human-Computer Interaction. Multimodality and Assistive Environments at the 13th International Conference, UAHCI 2019, Held as Part of the 21st HCI International Conference on Human-Computer Interaction*, Orlando, FL, July 2019.

5. B. Fakhri, S. Sharma, B. Soni, A. Chowdhury, T. McDaniel, and S. Panchanathan, "A Low Resolution Haptic Interface for Interactive Applications," *Universal Access in Human-Computer Interaction. Multimodality and Assistive Environments at the 13th International Conference, UAHCI 2019, Held as Part of the 21st HCI International Conference on Human-Computer Interaction*, Orlando, FL, July 2019.

6. C. D. C. Heath, T. McDaniel, H. Venkateswara, and S. Panchanathan, "Parent and Child Voice Activity Detection in Pivotal Response Treatment Video Probes," *Learning and Collaboration Technologies. Ubiquitous and Virtual Environments for Learning and Collaboration, Held as Part of the 21st HCI International Conference on Human-Computer Interaction*, Orlando, FL, July 2019.

7. C. D. C. Heath, H. Venkateswara, and S. Panchanathan, "Are You Paying Attention? Classifying Attention in Pivotal Response Treatment Videos," *IEEE Conference on Computer Vision and Pattern Recognition (CVPR) Workshops*, Long Beach, CA, June 2019.

8. S. Panchanathan, T. McDaniel, R. Tadayon, A. Rukkila, and H. Venkateswara, "Smart Stadia as Testbeds for Smart Cities: Enriching Fan Experiences and Improving Accessibility," *International Conference on Computing, Networking and Communications (ICNC 2019)*, Honolulu, HI, February 2019.

9. Y. Li, T. Yu, and B. Li, "Simultaneous Event Localization and Recognition in Surveillance Video," *15th IEEE International Conference on Advanced Video and Signal Based Surveillance (AVSS)*, November 2018.

10. A. Tadayon, T. McDaniel, and S. Panchanathan, "Functional Case Study Evaluation of the SmartGym: An Anticipatory System to Detect Body Compliance," *3rd International Workshop on Multimedia for Personal Health and Health Care – HealthMedia 2018 held in conjunction with ACM International Conference on Multimedia*, pp. 67-71, October 2018.

11. R. Tadayon, C. Gupta, D. Crews, and T. McDaniel, "Differences in Psychophysiological Reactions to Anxiety in Individuals with Varying Trait Anxiety Scores," *3rd International Workshop on Multimedia for Personal Health and Health Care – HealthMedia 2018 held in conjunction with ACM International Conference on Multimedia*, pp. 19-24, October 2018.

12. J. Meyer, R. Jain, S. Boll, N.E. O'Connor, and T. McDaniel, "HealthMedia 2018: Third International Workshop on Multimedia for Personal Health and Health Care," *3rd International Workshop on Multimedia for Personal Health and Health Care – HealthMedia 2018 held in conjunction with ACM International Conference on Multimedia*, pp. 2116-2117, October 2018.

## Papers in Refereed Conference Proceedings, continued

13. S. Boll, N.E. O'Connor, R. Jain, T. McDaniel, and J. Meyer, "HealthMedia'18 organizers' welcome," *3rd International Workshop on Multimedia for Personal Health and Health Care – HealthMedia 2018 held in conjunction with ACM International Conference on Multimedia*, p. III, October 2018.

14. T. McDaniel, D. Tran, S. Devkota, K. DiLorenzo, B. Fakhri, and S. Panchanathan, "Tactile Facial Expressions and Associated Emotions toward Accessible Social Interactions for Individuals Who Are Blind," *1st Workshop on Multimedia for Accessible Human Computer Interface held in conjunction with ACM International Conference on Multimedia*, pp. 25-32, October 2018.

15. H. Ranganathan, H. Venkateswara, S. Chakraborty, and S. Panchanathan, "Multi-label Deep Active Learning With Label Correlation," *IEEE International Conference on Image Processing (ICIP)*, pp. 3418-3244, October 2018.

16. M. Moore, T. McDaniel, and S. Panchanathan, "Whistle-blowing ASRs: Evaluating the need for more inclusive automatic speech recognition systems," *Annual Conference of the International Speech Communication Association (INTERSPEECH)*, pp. 466-470, September 2018.

17. S. Panchanathan, R. Tadayon, H. Venkateswara, and T. McDaniel, "Person-Centric Multimedia: How Individually Inspired Research Can Benefit Broader Populations," *International Conference on Smart Multimedia (ICSM)*, pp. 51-64, August 2018.

18. B. Fakhri, A. Keech, J. Schlosser, E. Brooks, H. Venkateswara, S. Panchanathan, and Z. Kira, "Deep Reinforcement Learning Methods for Navigational Aids," *International Conference on Smart Multimedia (ICSM)*, pp. 66-75, August 2018.

19. J. Eusebio, H. Venkateswara, and S. Panchanathan, "Semi-Supervised Adversarial Image-to-Image Translation," *International Conference on Smart Multimedia (ICSM)*, pp. 334-344, August 2018.

20. T. McDaniel, S. Devkota, R. Tadayon, B. Duarte, B. Fakhri, and S. Panchanathan, "Tactile Facial Action Units Toward Enriching Social Interactions for Individuals Who Are Blind," *International Conference on Smart Multimedia (ICSM)*, pp. 3-14, August 2018.

21. C. D. C. Heath, H. Venkateswara, T. McDaniel, and S. Panchanathan, "Detecting Attention in Pivotal Response Treatment Video Probes," *International Conference on Smart Multimedia (ICSM)*, pp. 248-259, August 2018.

22. B. Duarte, T. McDaniel, R. Tadayon, S. Devkota, G. Strasser, C. Ramey, and S. Panchanathan, "Haptic Vision: Augmenting Non-Visual Travel and Accessing Environmental Information at a Distance," *International Conference on Smart Multimedia (ICSM)*, pp. 90-101, August 2018.

# CUbiC Event Highlights: Past and Upcoming

## Past CUbiC Events

### Spring 2019

CUbiC faculty Troy McDaniel, Ramin Tadayon, and Sethuraman Panchanathan, in collaboration with Yuichi Kurita (Hiroshima University), were guest editors for Haptics for Human Augmentation, a special issue of Multimodal Technologies and Interaction. **mdpi.com/ journal/mti/special_issues/ haptics_human_augmentation**

### June 6th, 2019

CUbiC faculty, staff, and students from CUbiC and the NRT grant program welcomed Miss Arizona 2018, Isabel Ticlo, to the lab. As an ASU alumna with a platform of Supporting Those With Vision Impairment, Miss Arizona was especially interested to learn about CUbiC research and assistive technologies that enhance situational awareness and support non-visual travel for individuals who are blind or visually impaired.

### July 9th, 2019

CUbiC faculty Ramin Tadayon and Troy McDaniel, in collaboration with Yuichi Kurita (Hiroshima University), co-organized the workshop Haptics for Human Augmentation and Superhuman Sports at IEEE World Haptics Conference, held in Tokyo, Japan. **worldhaptics2019.org**

### July 29th, 2019

CUbiC Co-Director Troy McDaniel organized the Parallel Session "Haptic Interfaces for Assistive, Rehabilitative, and Healthcare Technologies" in the thematic area Universal Access in Human-Computer Interaction held in conjunction with HCI International, Orlando, FL, USA. **2019.hci.international**

## Upcoming CUbiC Events

### October 25th, 2019

CUbiC Co-Director Troy McDaniel, in collaboration with Xueliang Liu (Hefei University of Technology) and Rui Min (Google), is co-organizing the 2nd Workshop on Multimedia for Accessible Human Computer Interfaces held in conjunction with ACM International Conference on Multimedia 2019, to be held in Nice, France. **xueliang.github.io/mahci2019**

### November 14th, 2019

CUbiC faculty Hemanth Venkateswara, Troy McDaniel, and Sethuraman Panchanathan, in collaboration with Abdulmotaleb El Saddik (University of Ottawa), are co-organizing the symposium Signal and Information Processing for Person-centered and Citizen-centered Smart Living, to be held at the upcoming IEEE GlobalSIP in Ottawa, Canada. **2019.ieeeglobalsip.org**

### December 16th-18th, 2019

CUbiC faculty Hemanth Venkateswara, Troy McDaniel, and Sethuraman Panchanathan, in collaboration with Anup Basu (University of Alberta) and Arnaud Leleve (INSA, Lyon), are co-organizing this year's International Conference on Smart Multimedia, to be held in San Diego, CA. **smartmultimedia.org/2019**



Group photo of CUbiC faculty, staff, and students with Miss Arizona 2018, Isabel Ticlo. Photo by Ganjana Ticlo.

**You are receiving an official e-newsletter from the Center for Cognitive Ubiquitous Computing (CUbiC) at Arizona State University.**

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