



# **REU Site on UAV Technologies: Impact of the Program on Participants' Career in Industry or Graduate School**

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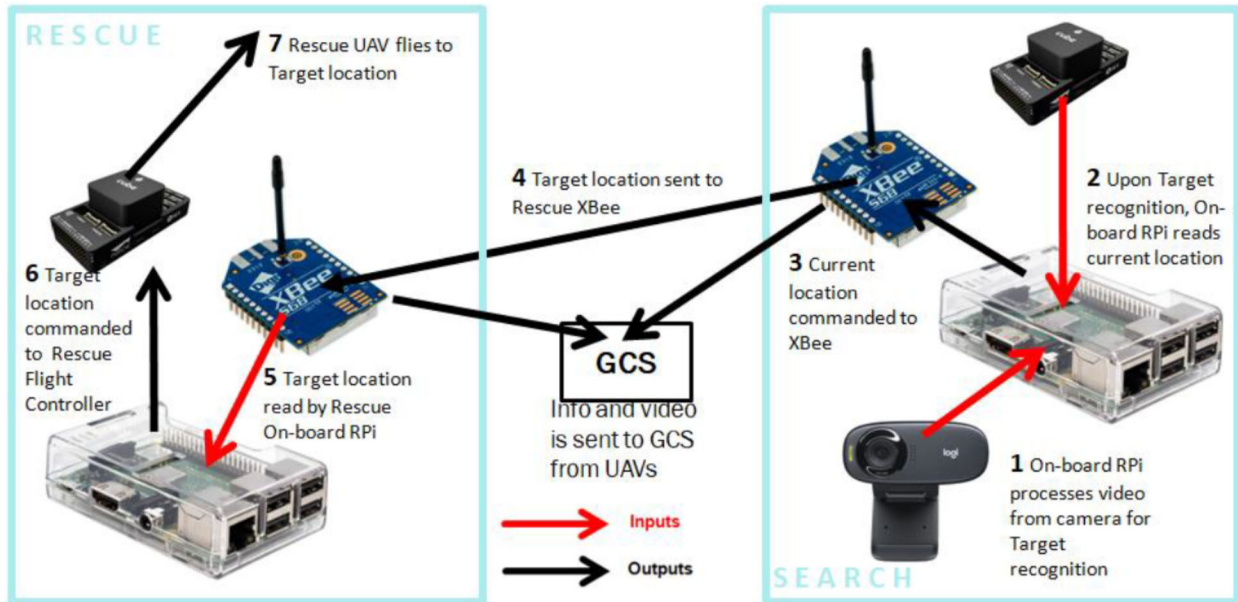
## **Abstract**

This paper discusses the impact of the REU Program at California State Polytechnic University, Pomona (Cal Poly Pomona) on the success of Participants in industry or graduate school. The REU Program titled "Research Experience for Undergraduates in UAV Technologies" has been funded by the NSF's EEC Program. The main goal of the Program is to increase undergraduate students' participation and interest in research on unmanned aerial vehicles (UAV) technologies. Undergraduate students from 2- and 4-year institutions have been involved in a multidisciplinary research projects at Cal Poly Pomona. The REU Site has so far hosted a total of 43 diverse group of students for 8-10 weeks of summer research since 2017, with the projects focusing on research on the Dynamics and Control of UAVs, Collision Detection and Avoidance System for UAVs, Artificial Intelligence, Computer Vision, Navigation in GPS-Denied Environments, application of UAVs for search and rescue missions, object detection and tracking, and Flight Test experience. Another goal of the Program is to attract students from community colleges to STEM programs at 4-year institutions and encourage the participants to pursue their studies for graduate degrees.

The Program has been tracking the past Participants. Most of the participants are now pursuing their educational or professional career in the area of UAVs and other related areas. The program has also been successful in motivating the Participants to graduate degrees in STEM disciplines. Some of the participants are already pursuing their studies for Master's or PhD degrees or are planning to do so. Information about the Participants' current employment or graduate school enrollment and relevance of current work to aerospace and/or UAV technology was gathered using a follow-up survey that also included open-ended qualitative feedback from the Participants about the long-term impact of the Program on their career. The paper presents the results obtained from the data collected from the Participants of the first three cohorts of the Program who were hosted during summers of 2017 to 2019. The paper focuses on the impact of the Program on the Participants' career choice, career advancement, and motivation for graduate degrees. The paper also presents written feedback/comments from the Participants.

## **Introduction**

The goal of this REU Site is to provide research experience to undergraduates and expose them to state-of-the-art in the area of UAV technologies in a multidisciplinary environment. UAVs have been used for remote sensing, precision agriculture, package delivery, traffic monitoring, search & rescue, and surveillance of fire-, earthquake-, flood-, and hurricane-affected areas. Lack of desired level of autonomy and safety concerns have prevented the mass adoption of UAVs for these applications. The research focus of the REU Site is increased autonomy and safety of UAVs for accelerated integration into the National Airspace System (NAS) for mass adoption. The Participants learn to do both hardware integration and develop algorithms for the increased autonomy of UAVs as shown in Figure 1.



**Figure 1. Hardware Integration Diagram for Search and Rescue Missions.**

The Participants test the developed algorithms and methods in simulation prior to testing them in flight as shown in Figure 2.



**Figure 2. Simulation Environment for UAV Autonomy Research.**

Finally, the participants test the developed algorithms in flights of UAVs as shown in Figure 3 for example.



**Figure 3. Flight Test for Research on UAV Collision Detection and Avoidance.**

Despite being the fastest growing sector of aerospace industries, there is a lack of professionals entering the workforce for the UAV related jobs and lack of interest among undergraduates to pursue their studies for advanced degrees in this area. The REU Site's objectives are to prepare a strong workforce for the needs of industry and academia in this area.

The REU participants were mentored by an interdisciplinary team of faculty members from various departments within the Colleges of Engineering and Science in a multidisciplinary environment. They learned to use computational tools and computer programming needed to engage in multidisciplinary research projects on UAV autonomy and UAV dynamics. They also learned to do the scientific literature review, and had an opportunity to improve written and oral communication skills. The participants were required to present a poster, give an oral presentation of the research, and submit abstract (s) to student and/or professional conferences [1].

In addition, the students participated in a series of research symposium and seminars designed to expose them to a range of research topics, and engaged in professional development activities. Several workshops were conducted throughout the 8- or 10-week periods that included Ethics in Engineering and Science, Graduate School Application Process and Financial Support, Resume Building, Improving Oral and Written Presentation Skills, and Industry Careers [1]. Moreover, the participants of 2018 and 2019 summer Programs had an opportunity to tour the facilities of Northrop Grumman Corporation (NGC), NASA Armstrong Flight Research Center (AFRC), or Lockheed Martin Corporation (LMC) [2].

This paper presents the results obtained from the data collected from the Participants of summer 2017, summer 2018, and summer 2019 Programs. A follow up survey was conducted in December 2021-January 2022 to assess the long-term impact of the Program on the Participants' career in industry or academia.

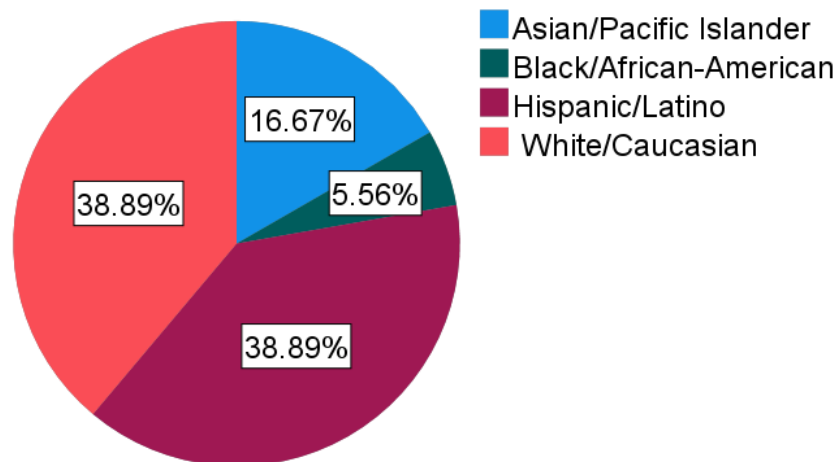


## Impact of the Program on Student Career in Industry and Academia

The survey questionnaire included the following questions.

1. Are you currently employed? If yes, is your current position related to what you learned in the UAV REU Program? How?
2. Did you pursue graduate study? If yes, please tell us what graduate degree you pursued and where you are in your degree (e.g., applying to PhD program in computer science or engineering, in my first year of MS in aerospace engineering, finished my MS in biochemistry, etc.).
3. Please tell us about the short and/or long-term impact of the UAV REU Program for you.
4. If you participated in the Program as a Community College student, did you transfer to a STEM major? If yes, what is your current academic standing? (junior, senior, graduated, etc.)?

Thirty participants from the 2017-2019 summer REU Program were invited to participate in the survey. Eighteen (60%) Participants completed the survey. Follow-up survey participants were diverse with regard to ethnicity. Seven participants identified as Hispanic or Latinx, seven identified as White/Caucasian, three identified as Asian/Pacific Islander, and one identified as Black/African-American. Figure 4 shows the demographics of the 2017-2019 Participants who responded to the survey.



**Figure 4. Ethnicity of 2017-2019 Participants who Responded to the Survey.**

Thirteen Participants identified as men and five identified as women (no Participants identified as trans/gender-fluid). Of the respondents, approximately 26% ( $n=5$ ) indicated that they have pursued graduate study. Five Participants indicated that they were whether the first in their family to graduate college ( $n=2$ ) or the first in their family to attend graduate school ( $n=3$ ). Participants also remarked on the fact that the program encouraged them to pursue or persist in the field. Some sample responses include:

1. "I am interested now in pursuing a master's degree in computer engineering."

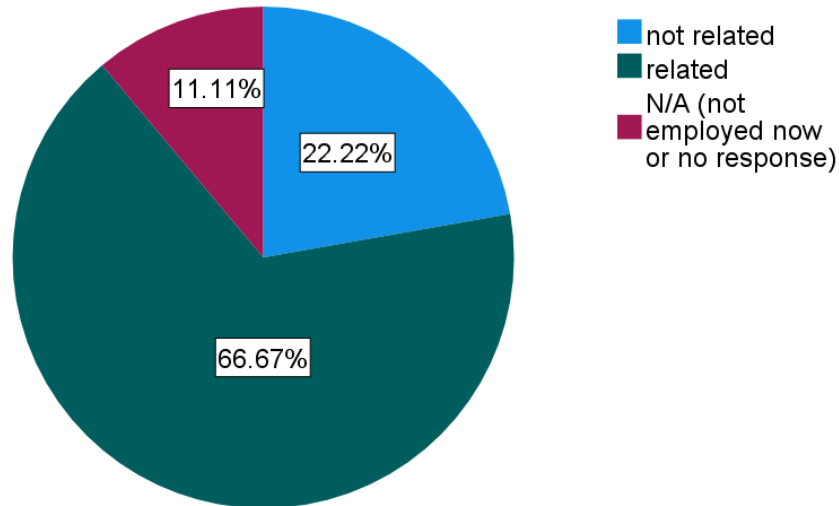
2. “The UAV REU program encouraged me to pursue a MS degree and helped me with research opportunities while in grad school.”
3. “REU encouraged me to transfer to a STEM major.”
4. “The UAV REU program helped expose me to the research career path and led me to pursue it.”

The vast majority ( $n=17$ ) indicated that they are currently employed, and most participants ( $n=12$ ) indicated that their current position was related to what they learned in the UAV REU program. Examples of related positions described by the Participants included “drone pilot and UAV design contractor,” “software engineer,” “launch service industry,” “systems engineer with focus on guidance navigation and control,” and “work on space flight missions.” Many Participants commented on the professional value of the interpersonal and technical skills they learned in the Program. Sample responses include:

1. “The program helped me practice team assignments and communicating in a professional setting.”
2. “The program boosted my programming skills significantly. I learned C++ and hardware interfacing. This played a large role in gaining skills that help me in my career today.”
3. “The program gave me critical skills that I use today in industry such as team collaboration and presentation skills.”
4. “The skills learned in the UAV REU program are sought after in the industry.”
5. “The UAV REU helped me obtain a job by building a foundation on the concepts of guidance, navigation, and control.”
6. “The UAV REU has certainly been a strong contributing factor in my path to my current position. Much of my current work is an elaboration of the principles I discovered during the REU Program.”

Figure 5 shows the response of the Participant’s to the survey Question 1 above. As can be seen, a majority of the Participants who responded indicated that their current employment was related to what they learned during the Program.

Is your current employment related to what you learned in the UAV REU?



**Figure 5. Participant's Response on their Career Choice and Area.**

All the Participants presented their work during Student Conferences and most of the Participants have presented their work at Professional conferences [3-9]. This has helped the Participants improve their written and oral communication skills [10-12].

### **Conclusion**

A total of 31 participants were hosted by the REU Site during the course of three years. Six of the participants were from 2-year institutions. Each summer Program included development of technical expertise and professional development of participants.

The REU Program has been successful in meeting its goals and objectives. The Program has been able to well prepare the Participants for the career in industry or graduate school in the important area of UAV technologies and related areas. All six Participants from Community Colleges transferred to 4-year institutions.

### **Acknowledgement**

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