The University of Texas Rio Grande Valley
Center for Multidisciplinary Research Excellence in Cyber-Physical Infrastructure Systems (MECIS)

Drones in Industry and Workforce Development

National Science Foundation
NSF Award No. 2112650

Javier Becerril, Diego Gutierrez, Qi Lu, Ph.D., Constantine Tarawneh, Ph.D.

Abstract

Drones are being utilized across various industries including delivery, agriculture, construction, telecommunication, and surveillance, with opportunities for expansion. This study reviews research on how aligning educational curricula with industry demands through hands-on drone experiences can enhance workforce readiness. Additionally, this work explores drone kit development, CAD-based structural optimizations, and flight testing to improve drone applications in education and industry. By combining findings from prior studies on student engagement with drone prototyping, this research provides insights into both educational and technical advancements in drone technology.

Introduction & Background

- Industry demand: Growing need for drone-trained agriculture, construction, and logistics

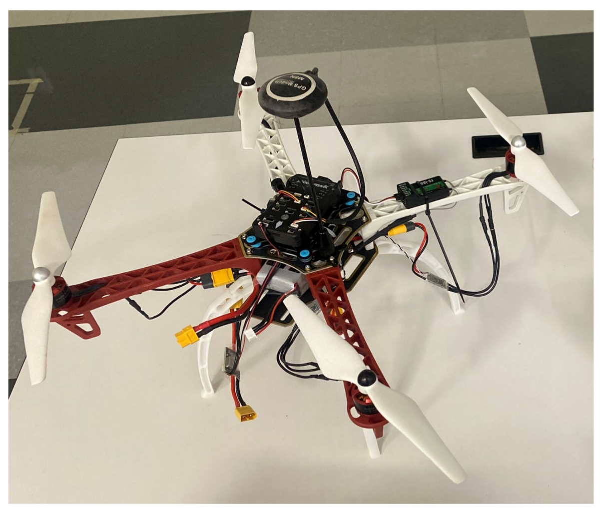

Figure 1: Drone kit

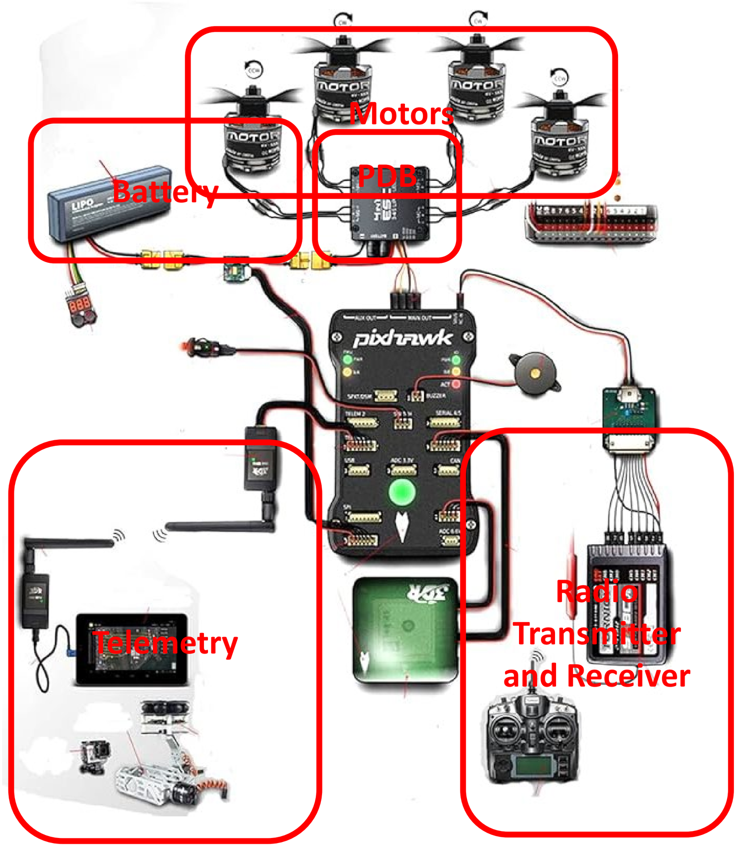

Figure 2: Drone components

- Student engagement review: Prior research suggests that hands-on UAV learning improves engagement and enhances STEM comprehension.
- UAV Optimization Work: This study further develops and tests UAV kits, integrating CAD-based designs and stress simulations to refine drone applications.

Methodology

- Student Engagement Review:
  - Analysis of prior research on drone-based learning in STEM education
  - Summarization of study findings on pre/post-test score improvements and engagement levels
- Hands-on Drone Development:
  - Custom drone kits were designed, assembled and optimized
  - CAD-based stress simulations were performed to refine structural integrity

Data and Results

- Students were introduced to 4 workshops to introduce mathematical topics (Scratch and DroneBlocks programming, drone basics, study of trigonometric function of the sine, and study of the cosine)[2]

Pre-test and post-test scores of SG students

Study Group (SG)		Pre-test			Post-test		
Student	Sex	Score	Deviation	Duad. deviation	Score	Deviation	Duad. deviation
SG01	M	2,00	0,26	0,07	6,10	−0,38	0,14
SG02	M	2,40	0,66	0,44	5,90	−0,58	0,34
SG03	M	2,90	1,16	1,35	9,10	2,62	6,86
SG04	F	1,20	−0,54	0,29	3,50	−2,96	8,88
SG05	M	1,50	−0,24	0,06	6,60	0,12	0,01
SG06	F	3,70	1,96	3,84	8,10	1,62	2,62
SG07	M	2,40	0,66	0,44	4,50	−1,98	3,92
SG08	M	2,50	0,76	0,58	7,20	0,72	0,52
SG09	M	2,20	0,46	0,21	5,00	−1,48	2,19
SG10	F	0,70	−1,04	1,08	7,40	0,92	0,85
SG11	F	0,70	−1,04	1,08	4,30	−2,18	4,75
SG12	F	1,40	−0.34	0,12	8,70	2,22	4,93
SG13	F	0,40	−1,34	1,80	9,00	2,52	6,35
SG14	F	1,40	−0,34	0,12	2,40	−4,08	16,65
SG15	F	0,70	−1,04	1,08	9,40	2,92	8,53
		μ: 1,74		**∑: 12,54**	**μ: 6,48**		**∑: 67,54**

Figure 3: Pre-test and post-test scores of SG students

Pre-test and post-test scores of CG students

Control Group (SG)		Pre-test			Post-test		
Student	Sex	Score	Deviation	Duad. deviation	Score	Deviation	Duad. deviation
CG01	M	1,70	0,35	0,12	3,70	−0,94	0,88
CG02	F	2,40	1,05	1,11	6,40	1,76	3,10
CG03	M	1,70	0,35	0,12	5,70	1,06	1,12
CG04	M	1,20	−0,15	0,02	4,90	0,26	0,07
CG05	F	0,40	−0,95	0,90	5,40	0,76	0,58
CG06	F	0,00	−1,35	1,81	2,00	−2,64	6,97
CG07	M	1,80	0,45	0,21	8,30	3,66	13,40
CG08	F	1,20	−0,15	0,02	8,50	3,86	14,90
CG09	F	2,00	0,65	0,43	2,50	−2,14	4,58
CG10	M	0,80	−0,55	0,30	3,70	−0,94	0,88
CG11	F	2,40	1,05	1,11	3,70	−0,94	0,88
CG12	M	0,20	−1,15	1,31	5,30	0,66	0,44
CG13	M	1,40	0,05	0,00	1,90	−2,74	7,51
CG14	F	0,50	−0,85	0,72	5,30	0,66	0,44
CG15	M	2,50	1,15	1,33	2,30	−2,34	5,48
		μ: 1,35		**∑: 9,52**	**μ: 4,64**		**∑: 61,22**

Figure 4: Pre-test and post-test scores of CG students

General frequency of test scores by range

Range	Study Group				Control Group			
	Pre-test		Post-test		Pre-test		Post-test	
	f_i	f_{ri}	f_i	f_{ri}	f_i	f_{ri}	f_i	f_{ri}
0 |-- 2	8	0,53	0	-	11	0,73	1	0,07
2 |-- 4	7	0,47	2	0,13	4	0,27	6	0,40
4 |-- 6	0	-	4	0,27	0	-	5	0,33
6 |-- 8	0	-	4	0,27	0	-	1	0,07
8 |-- 10	0	-	5	0,33	0	-	2	0,13
	15	**1,00**	**15**	**1,00**	**15**	**1,00**	**15**	**1,00**

Figure 5: General frequency of test scores by range

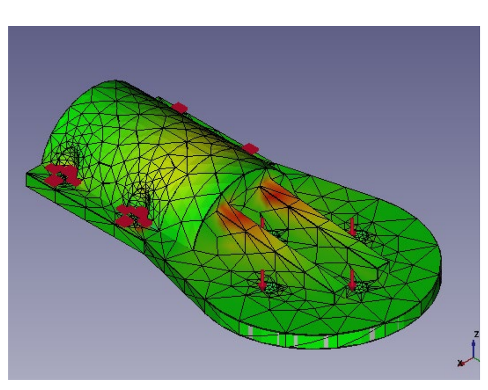

Figure 6: Motor holder CAD stress simulation

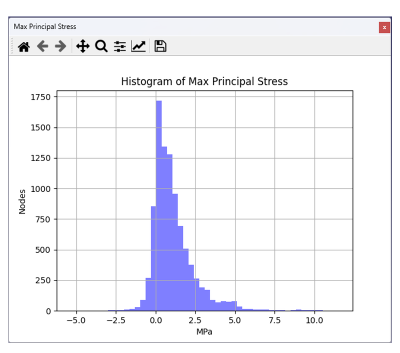

Figure 7: Motor holder stress analysis dispersion

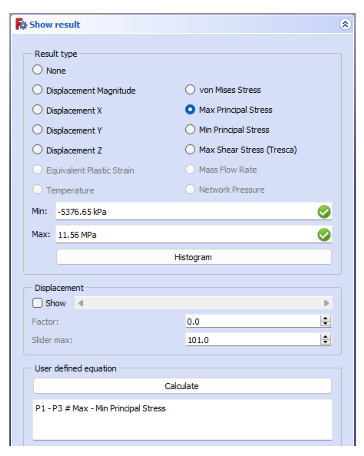

Figure 8: Motor holder maximum stress

Figure 9: Drone kit with necessary upgrades

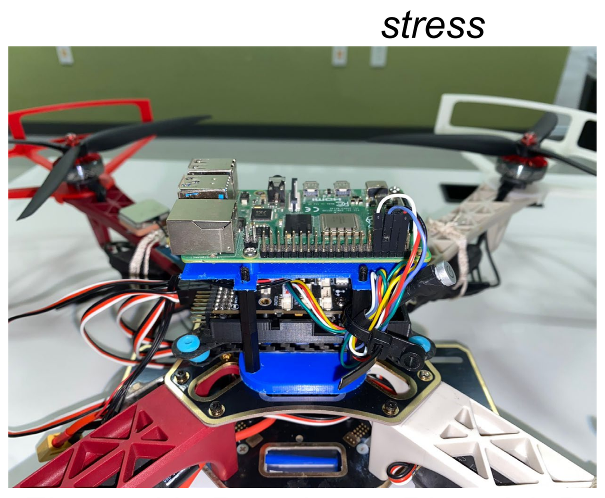

Figure 10: Raspberry Pi and 3-D printed component implementation

- Students scored similarly in the pre-test, SG scored higher than CG in post-test, frequency of higher scores in SG is also greater
- CAD stress tests optimized drone structure

Conclusions & Future Work

- Drone integration into STEM curricula enhances engagement and learning outcomes
- CAD modeling and stress simulations improved drone durability and abilities
- Future work:
  - Expanding drone-based research in advanced topics such as autonomous flight, AI, machine learning
  - Implementing drones in Gazebo simulations to test at larger scale more efficiently

Figure 11: CAD 3-D rendered drone kit with upgrades

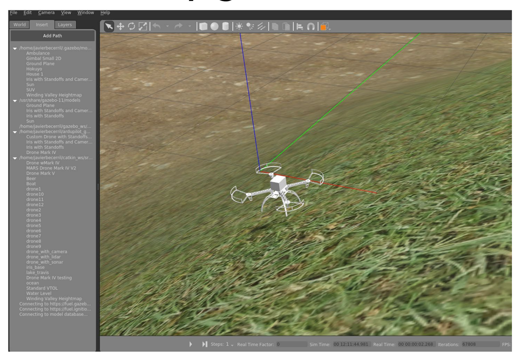

Figure 12: Drone with upgrades Gazebo implementation

Acknowledgments

The authors would like to acknowledge funding provided by the National Science Foundation CREST Center for Multidisciplinary Research Excellence in Cyber-Physical Infrastructure Systems (MECIS) under NSF Award No 2112650.

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