Summer Exchange Program: A Unique Platform to Broaden Exposure and Address Several Dimensions of Learning

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Dr. Lei Zhang received his Ph.D. Degree in Electrical Engineering on 2011 from the University of Nevada, Las Vegas. Since 2012 he is working in the Department of Engineering and Aviation Sciences, University of Maryland Eastern Shore. His main research interests include image processing, autonomous system, optical SoC/NoC architecture, and on-chip optoelectronic device design.

Dr. Madhumi Mitra Ph.D., University of Maryland, Eastern Shore

Dr. Madhumi Mitra is currently a professor of environmental sciences in the department of Natural Sciences at the University of Maryland Eastern Shore. She is also the coordinator of Biology and Chemistry Education. Dr. Mitra is actively involved in teaching and research in the areas of biofuels and renewable energy; applications of algae in food and environment; and water quality. She has published several peer-reviewed articles in journals and conference proceedings, and is the recipient of various awards and competitive grants. Dr. Mitra received her baccalaureate degree from Presidence College in Kolkata, India with honors in Plant Biology, Geology, and Physiology. She received her master's degree from University of Calcutta, India, and her doctoral degree from North Carolina State University, Raleigh, NC in 2002.

Mr. Blake Prout, University of Maryland, Baltimore County

Blake Prout is a sophomore at the University of Maryland, Baltimore County (UMBC) and is studying Mechanical Engineering.

Mohsin Mehmood

21 years old working on a general engineering degree with specialization in Aeronautics.

Ms. Kalah A. Cross, Morgan State University

Hello my name is Kalah Cross and I attend Morgan State University and plan to graduate May 2019. I am originally from St. Louis, Missouri and I came to Baltimore, Maryland to pursue my dreams of going to college. I love robotics and space science. I have always interested in learning about the stars and the creations we send out of space. One day I hope to work for a great company that will allow me to pursue my passion.

Dr. Matt Collinge, Johns Hopkins University

Matt Collinge received his Ph.D. in Astrophysics from Princeton University in 2010. He taught interdisciplinary science for four years as a Science Fellow at Columbia University. His celestial interests range from modern astrophysics to amateur astronomy and the history of cosmology. Matt joined Johns Hopkins University as Deputy Director of the Maryland Space Grant Consortium (MDSGC) in 2017. In that role, he manages the day to day operations of MDSGC, oversees its programs, coordinates with member institutions and prospective partner organizations, and investigates new ways to leverage Maryland's Space Grant for the maximum benefit to the state.

Mr. Hafeez Temitope Shittu
Mr. Habilou Ouro-Koura, University of Maryland, Eastern Shore

Senior engineering student with mechanical specialization. With an Associate Degree in mechanical engineering from Montgomery College, MD, Mr. Ouro-Koura is interested in robotics and applications. He has been spending time in the robotics lab at the University of Maryland Eastern to learn and code different robots. He has published one paper on his experiential learning in robotics.

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Abstract

CAUTION: *Catamaran-type Autonomous Underwater-sensing Twin-propped Instrumented Ocean Navigator* is an active learning and design project that has been ongoing at University of Maryland Eastern Shore. CAUTION efforts are integral to the AIRSPACES (*Autonomous Instrumented Robotic Sensory Platforms to Advance Creativity and Engage Students)* project that is supported through funds made available to UMES by Maryland Space Grant Consortium (MDSGC). Besides CAUTION the AIRSPACES project also involves students with design activities and experiential learning endeavors in the UMES Robotics Laboratory with robotic arms (Microbots, 4- Degree of Freedom SCARA and 6-Degree of Freedom anthropomorphic arms) and mobile platforms such as Create 2 (IRobot) and Go Pi Go (Dexter Industries), as well as field based efforts involving multispectral aerial imaging with drones and ground robots for acquiring field measurements to validate remotely sensed data.

This paper is based on experiential learning and research efforts in the 2017 summer on selected aspects of the AIRSPACES project, undertaken by undergraduate engineering students during the Summer Exchange Program (SEP) under the supervision of participating UMES faculty. SEP is an exchange program among universities that are affiliated with Maryland Space Grant Consortium (MDSGC). For the 2017 summer, Mr. Blake Prout, a sophomore mechanical engineering major at UMBC and Ms. Kalah Cross, a junior industrial engineering major at Morgan State University (MSU) spent 10 weeks at UMES. Mr. Blake Prout was assigned to the CAUTION project and worked closely with Mr. Mehmood Mohsin, an engineering senior at UMES. Ms. Cross worked with two other junior engineering students at UMES (Mr. Habilou Ouro-Koura and Mr. Hafeez Shittu) to set up some of the robotic devices in the new robotics facility for future K-12 outreach efforts.

In addition to project efforts the exchange students also got an opportunity to experience student life in a new campus as well as to visit NASA Wallops Island Flight Facility. They also presented their work at a Summer Exchange Symposium held at the Johns Hopkins Conference Center in Baltimore.

1.0 Introduction

Higher education in general and engineering education in particular stems from the vision of the future and strives to integrate appropriate lessons from the past. Competing visions of the future

introduce uncertainties and necessitate the need for a consistent public policy that not only responds to market forces in the present, but rather shapes the market forces for sustainable growth and workforce development needs.

"E" of engineering sits in the very middle of the string of letters "STEAM" and is the glue that integrates science, technology, agriculture, and mathematics disciplines to provide an interdisciplinary framework that can not only adapt to rapidly changing technologies, but also make creative discoveries that usher in prosperity and growth. Academic leaders and policy makers are looking into the uncertain landscape of the future to forge a vision for engineering education for the coming years [1-4]. Engineering education will need to lay the foundation for the challenges that lie ahead for engineering professionals of the future in their practice of engineering in the real world, as well as engineering research in graduate school, industry, and government laboratories. Mastering the engineering and scientific fundamentals will be necessary but will not be sufficient. An ability to engage in life-long learning and discovery will be a cornerstone for professional growth to remain relevant in the dynamic world order of the future, where economic realities, global competition [5-6], climate change, national security, and sustainability issues will continue to play a significant role.

While classroom education that emphasize mastery of scientific and engineering fundamentals is essential, it is not sufficient preparation for students. Academic institutions have to strive to provide out-of-classroom experiential learning and research experiences not only for graduate students but also undergraduate STEM students as they learn to work together in vertically integrated multidisciplinary teams, to gain valuable life-skills and learn civic responsibility. Collaborations, partnerships, and participation of personnel from local industry and federal government laboratories, as well as a transdisciplinary team of faculty members as guides and advisors for these multidisciplinary endeavors, can provide rich educational experiences for students that not only engage them but also provide a platform to advance creativity and innovation.

Robotics, mechatronics and remote sensing were initiated by funds from Connectiv Power [7] and NASA [8] at UMES and sustained through support from the University System of Maryland (USM) by way of proposals developed by the primary author. Subsequently, the efforts have been expanded and integrated with agricultural automation and remote sensing with support from National Institute of Food and Agriculture (NIFA/USDA) and MDSGC/NASA. The current framework of AIRSPACES project as outlined by the expanded form *Autonomous Instrumented Robotic Sensory Platforms to Advance Creativity and Engage Students* not only reflects the earlier iteration of the project title -- with the acronym AIRSPACES^2 that combined experiential learning and research efforts titled **A**erial **I**maging and **R**emote **S**ensing for **P**recision **A**gri**c**ulture and **E**nvironmental **S**tewardship and **A**ir-propelled **I**nstrumented **R**obotic **S**ensory **P**latform for **A**ssateague **C**oastline **E**nvironmental **S**tudies -- but provides a broader umbrella that includes the robotics laboratory development efforts for the new engineering facility at UMES . These projects have provided a multidisciplinary platform for a team of faculty, students and staff from across the Science, Technology, Engineering, Agriculture, and Mathematics (STEAM) disciplines to explore exciting and innovative ideas that promote the core values of the land grant mission of University

of Maryland Eastern Shore (UMES) [9,10]. As in the past, synergy with United States Department of Agriculture (USDA) supported project(s) has continued to provide additional impetus and breadth to these endeavors. Besides supporting graduate students as well as undergraduate students at UMES, these efforts have continued to be integrated with UMES component of the Summer Exchange Program among UMCP, UMES, UMBC, Capital Technology University, and MSU initiated in summer of 2009 with support from NASA HQ and continued through all subsequent summers so far with MDSGC funds [11,12]) .

For the exchange program two student interns are identified from each of the five participating campuses in the state and supported by MDSGC funds, for 10 weeks of the summer to work on ongoing experiential learning and/or research projects at one of the other four participating campuses, with due consideration of student interest and other administrative logistics. Students who have taken part in the exchange programs have gained valuable life-skills and professional experience through involvement with these efforts which have enhanced their resumes and helped them during job interviews. For those students who have gone on to graduate school the experiential learning and research exposure has been looked upon favorably the recruitment authorities.

For the 2017 summer, three different project ideas consistent with the framework of the ongoing AIRSPACES project were offered to the exchange students. The three projects involved (i) drone based aerial imaging and analysis for the precision agriculture project (ii) autonomous boat development and water quality monitoring effort (CAUTION) and (iii) K-12 outreach components of the new robotics laboratory development efforts at UMES.

MDSGC directors at Johns Hopkins University (JHU) matched student interest and projects as best they could, and identified Mr. Blake Prout, an UMBC sophomore engineering student, to work on the CAUTION project, and Ms. Kalah Cross, a junior engineering student at MSU, to work on the robotics laboratory development efforts at UMES.

In the following sections a brief outline of the efforts undertaken by the exchange students working in concert with UMES engineering students is provided.

2.0 CAUTION Efforts During 2017 Summer Exchange Program

Agricultural and environmental issues are some of the most important concerns in the eastern shore region of the state of Maryland. Water quality concerns are integral to the Chesapeake and other coastal bays and aquatic bodies in the region. Evidences of nutrient enrichment in some of the water bodies resulting in eutrophication and algal blooms have raised the anxiety levels among environmentalists and researchers involved with food safety. Design and development of a low cost small autonomous boat, equipped with appropriate sensors for monitoring water quality and other scientific investigations, is relevant for the region and is aligned with the grand challenge related to “Engineering Tools for Scientific Discovery” for the new millennium, as identified by National Academy of Engineering (NAE) (http://www.engineeringchallenges.org).

Figure 1 outlines the ecological problem in the region that gives rise to high risk of eutrophication. Based on this issue and in consultation with a faculty member in the department of natural sciences,

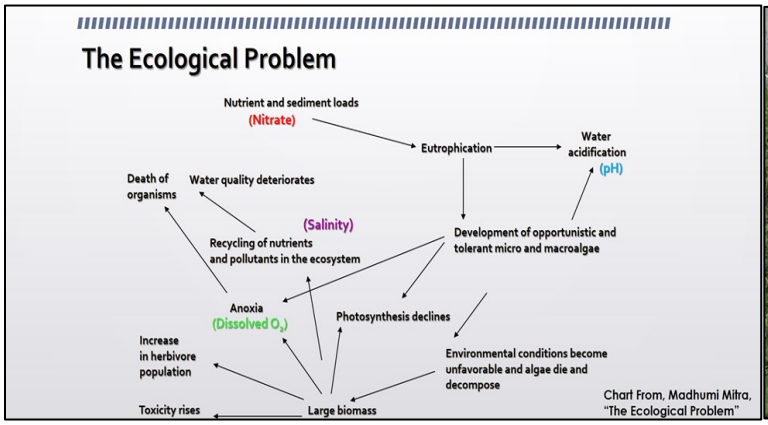

Figure 1: Ecological Problem and Water Quality

Figure 2: CAUTION Platform

the primary water quality sensors such as salinity, acidification(pH), dissolved oxygen (DO), oxidation reduction potential (ORP) and nitrate were identified and integrated into the CAUTION platform. A depth sensor and a GPS were also provided in the platform to record the depth and location information. The water quality sensors were mounted on a winch that could be programmed to deploy the sensors to collect data at the surface of the water body as well as other specified depths. Figure 2 shows a catamaran type autonomous boat (CAUTION) that was originally developed at UMES by an exchange student from UMCP during the 2014/2015 summer exchange program under the supervision of the primary author [12].

Mr. Blake Prout, the exchange student who came to UMES from UMBC in 2017 summer, was then a sophomore mechanical engineering major who had little exposure to electronics, embedded systems, and computer programming that are integrated in design of mechatronic systems such as CAUTION. Lack of use, proper maintenance, and wear and tear required some upgrading of the platform. Lack of proper documentation also required repeating some of the efforts that were undertaken in the past, particularly related with the integration of electronics, sensors and associated coding and tuning of control gains. Some alteration and redesign were also undertaken to improve the servo-mechanism and rudder design for the steering system; other than that the basic mechanical platform of the original design [12] was retained. An UMES senior (Mr. Mohsin Mehmood) who had some prior exposure to the CAUTION platform design and operation was assigned to work with Mr. Prout with the goal of deploying CAUTION in an UMES pond with all modifications and repairs, to demonstrate improved functionality and all operational capabilities of the original platform. Towards the end of the exchange program the two students also initiated efforts to integrate an underwater camera to the platform with the eventual goal of capturing frames and stitching them together to map submerged aquatic vegetation (SAV). The CAUTION platform provided an excellent learning experience for the students during the exchange program. Such experiences are seldom possible to provide in a structured course in a classroom environment and complement the overall the educational experience for undergraduate engineering major.

Mechatronics and embedded systems applications are growing and are likely to play a dominant role in the future engineering innovations. Figure 3 shows the electrical and electronic system

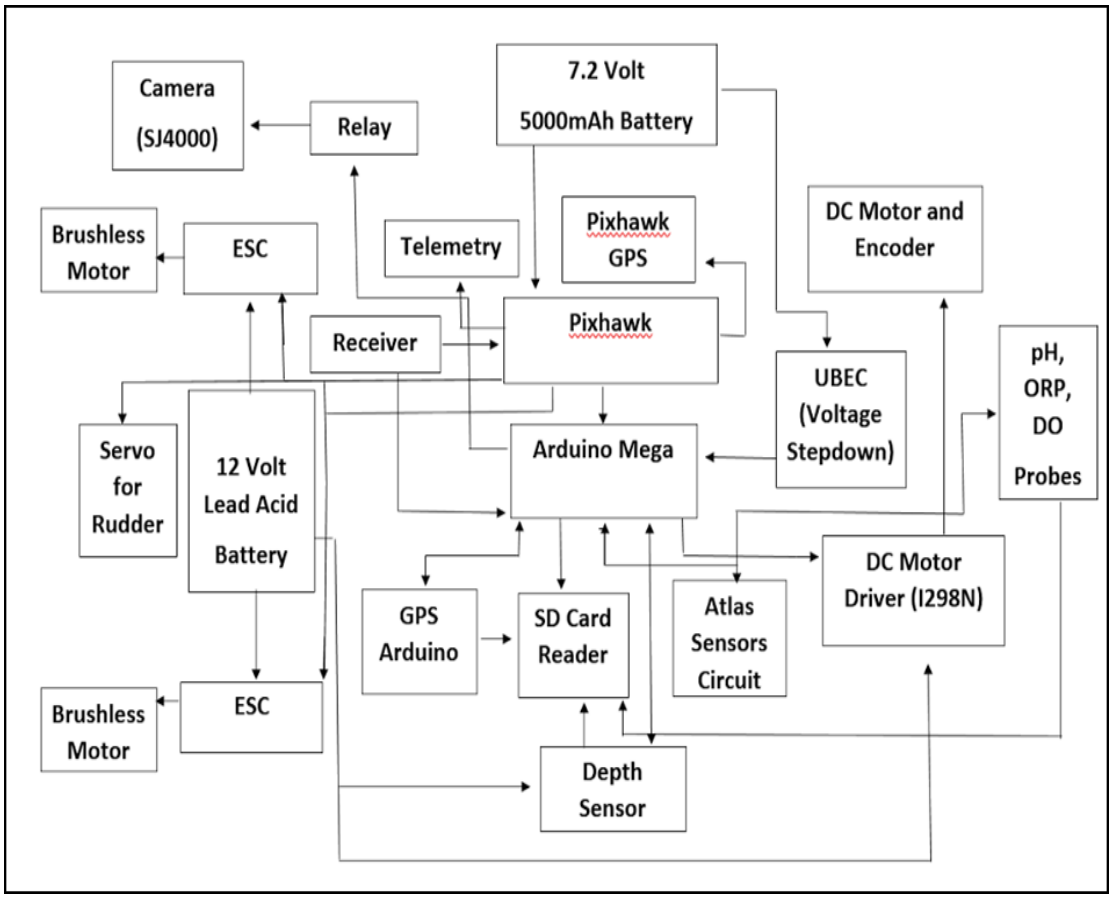

Figure 3: CAUTION : Schematic of Electrical and Electronics Layout

block diagram for the CAUTION platform. CAUTION utilizes PIXHAWK, an industry standard self-contained autopilot system with its own processor and motion sensor, utilized mainly for small unmanned aerial systems (sUAS). The propeller motors, the servo for the rudder, and the winch motor are controlled by the PIXHAWK and were powered by a12 Volt Sealed Acid Battery (SLA). An additional Arduino Mega microprocessor board is embedded in CAUTION for the water quality, GPS, depth, and SD card data logger, powered independently by 7.2 Volt 5000 mAh Lithium Polymer (LIPO) battery pack. The CAUTION platform carries enough power to last for at least 1.5-2 hours in water before it needs recharging.

Mission planner, an open source software environment is utilized with the PIXHAWK to set up and execute a mission plan for the autonomous boat. Mission planner and PIXHAWK are mostly utilized by academia, industry, and hobbyists for sUAS and ground robots (i.e., rovers). The ground robot settings were adapted for use with CAUTION. It allows user to plan, save, and load

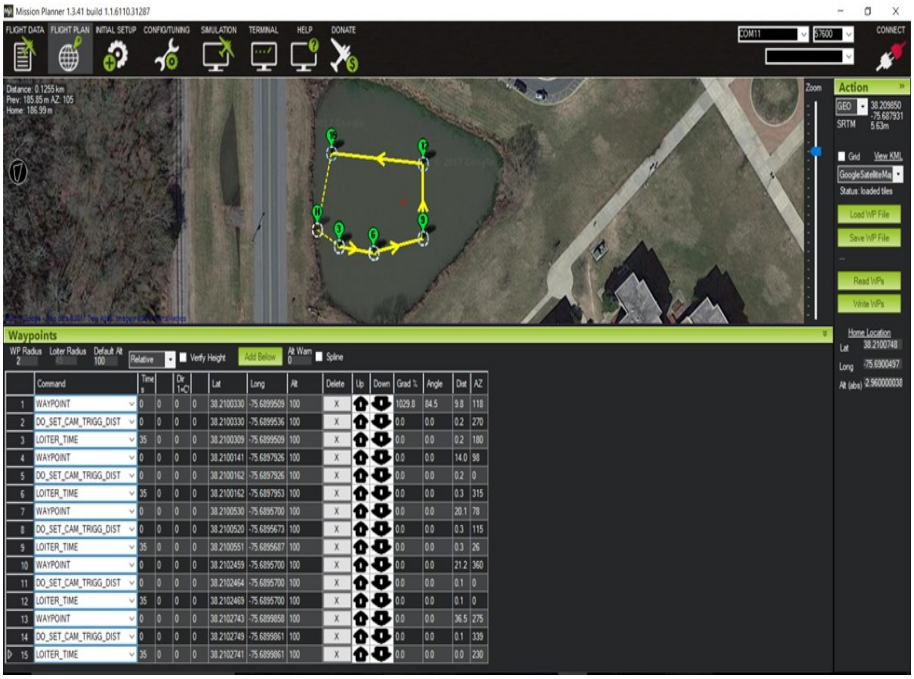

Figure 4: Mission Planner Way Point Settings

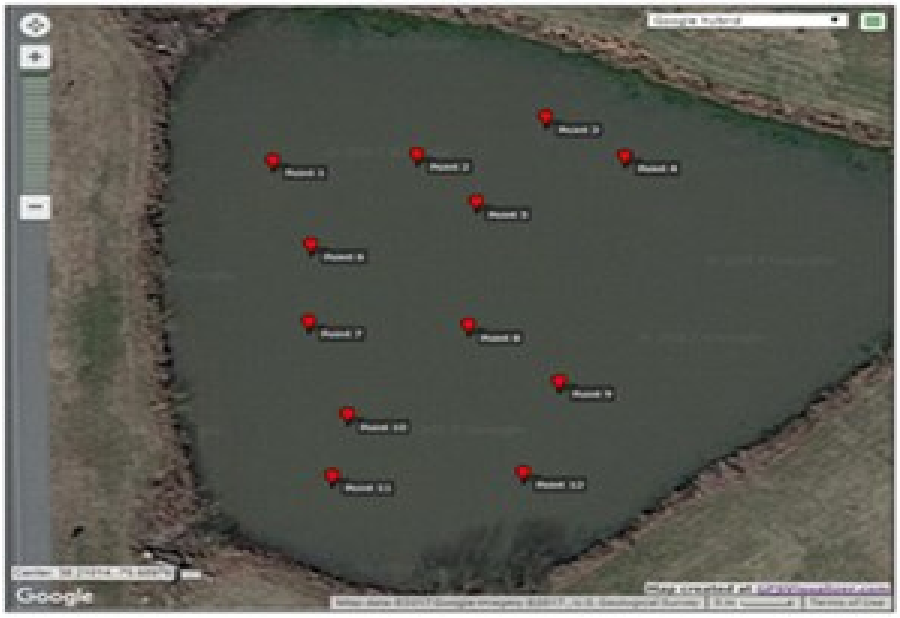

Figure 5: GPS visualizer Way Point and Data Display Environment

autonomous missions on PIXHAWK with simple point-and-click waypoint entry on Google Earth or other maps from within Microsoft Windows (see Figures 4 & 5). CAUTION can navigate to these waypoints autonomously once proportional, integral, and derivative gains (PID) are appropriately tuned in the Mission Planner pull-down menus or by remote control using a Fly-Sky radio-controller. With appropriate telemetry, navigation data for the mission can be logged and visualized. When each of the waypoints is reached (autonomously or by remote-control), appropriate commands are sent to the winch-motor to lower or raise the sensors to pre-specified depths, and the Arduino Mega interfaced to the water quality sensors is activated to record the

GPS location and associated sensory data on the SD card. Figure 5 shows the planned mission way points in the GPS visualizer, and Figure 6 shows a sample data set downloaded from the SD-card on CAUTION after a trial run during 2017 summer exchange program. The pH measures the acidification level with 7 as neutral, lower values being acidic, and values higher than 7 being alkaline (on a logarithmic scale); ORP is in millivolts and measures the bacterial activity in the water; and DO is in milligram/liter and measures levels of dissolved of oxygen, which is essential for sustaining aquatic life.

Date	Time	Latitude	Longitude	Depth(ft)	pH	ORP	DO
8/2/2017	19:34:30	38.210285	-75.689949	0	8.74	233.37	7.12
8/2/2017	19:35:28	38.210292	-75.689796	5.3	8.741	233.42	6.89
8/2/2017	19:37:47	38.210332	-75.689659	5.1	8.664	233.33	6.92
8/2/2017	19:39:44	38.21029	-75.6895754	0	8.756	233.39	6.98
8/2/2017	19:41:36	38.21024	-75.6897336	6.2	8.798	233.4	7.04
8/2/2017	19:45:27	38.210193	-75.689908	6	8.646	233.49	7.14
8/2/2017	19:45:28	38.210109	-75.6899107	2.9	8.787	233.24	7.04
8/2/2017	19:47:44	38.210105	-75.6896451	6	8.689	233.37	6.92
8/2/2017	19:49:24	38.210044	-75.6896451	4.3	8.659	233.41	6.99
8/2/2017	19:50:59	38.210008	-75.6898704	0	8.785	233.39	6.94
8/2/2017	19:52:55	38.20994	-75.6898865	5.6	8.762	233.36	7.01
8/2/2017	19:54:19	38.209945	-75.6896827	0	8.587	233.43	7.06

Figure 6: Sample Water Quality Data Collected with trial run with CAUTION

3.0 Robotics Laboratory Set Up Efforts in 2017 Summer

Robotics, Automation, and Mechatronics (RAM) laboratory is among the many new engineering laboratories that are in various stages of development in the new "Engineering and Aviation Complex" at UMES (see Figure 7). The laboratory will be used for K-12 outreach, undergraduate

Figure 7 : Recently completed Engineering and Aviation Complex

engineering courses, and experiential learning and research projects. Ms. Kalah Cross, a junior industrial engineering major at MSU, who was selected for the exchange program, worked with two other undergraduate engineering juniors at the host institution to set up some of the equipment in the laboratory that will be utilized for K-12 outreach program in 2018 summer and beyond.

A 4 degree of freedom (DOF) SCARA robot and a 6-DOF industrial robotic arm with an integrated vision system are among the various advanced robotic devices in the process of being installed in the UMES RAM laboratory. These robots will be utilized for undergraduate engineering courses and experiential learning and research projects at both undergraduate and graduate levels. The laboratory also includes Microbot Teachmover, iRobot Create2, Go-Pi-Go platform with ultrasonic sensor equipped with a Raspberry Pi single board computer, PhantomX Pincher Robotic Arm embedded with a Arduino like micro-processor board, and NXT LEGO Mindstorm Robotic Invention System (RIS), primarily for K-12 outreach activities and introduction to robotics and embedded systems to undergraduate STEM majors at UMES.

For the summer exchange program in 2017 it was decided to work with iRobot Create 2, Dexter Industries Go-Pi-Go, and Microbot Teachmover platforms with the intent of involving summer exchange students and engineering undergraduates at UMES through engaging learning experiences, in concert with identifying appropriate K-12 outreach activities for the future. Besides fundamentals of robotic arms and mobile robots with embedded processors, the platforms allowed students to be introduced to programming using *Scratch, Python, MATLAB* as well as C++.

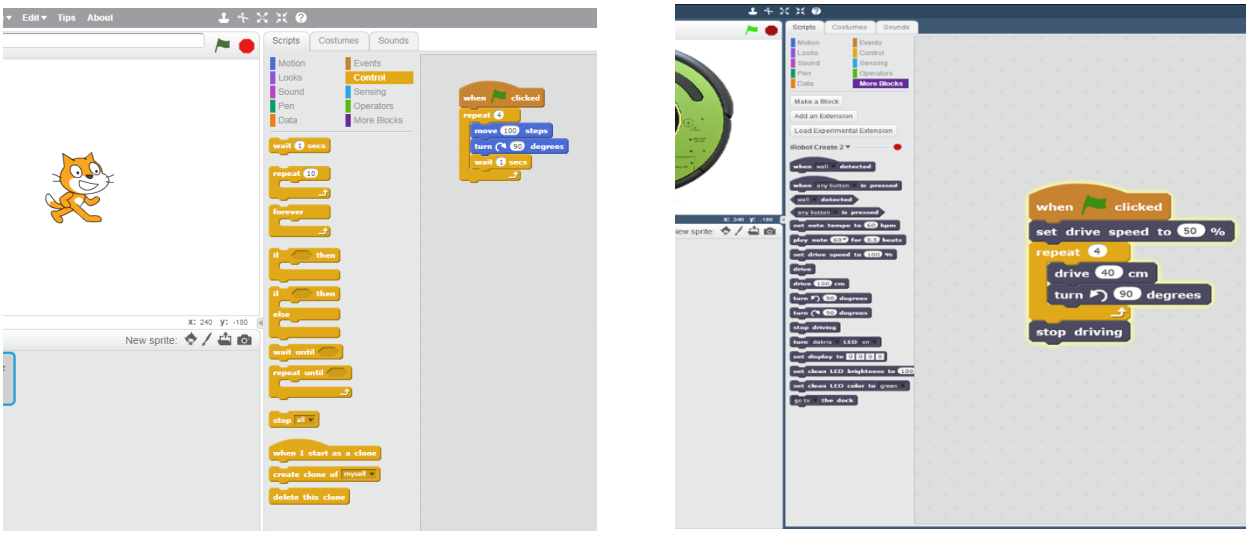

Figure 8: Scratch codes for a Sprite and Create 2 developed during the SEP

The iRobot Create® 2 or Create 2 is a programmable mobile robot made by iRobot, well known for developing robotic vacuuming device called "Roomba". The iRobot Create® 2 is the base platform for Roomba that the company markets for education and experiential learning projects (see Figure 9). Create2 was utilized for basic motion commands that were written in *Scratch, Python, and MATLAB.*

Scratch is a drag and drop programming environment developed at the Massachusetts Institute of Technology (MIT) for introducing programming at the K-6 level. Scratch can also be utilized to introduce the students at high school or college level not familiar with computer programming to the logic and structure of coding. During the summer 2017 SEP at UMES, the MSU exchange student was introduced to Scratch and developed programs for basic movements with the Create

2 platform such as driving, turning in a square, and moving in a circle (Figure 8). Basic Scratch environment allows visualization by allowing movements of animated sprites that execute motion and control commands. Scratch extensions can be downloaded and interfaced with several hardware platforms and robotic devices including the Create 2. Two UMES undergraduate students who had worked with the primary author during Spring 2017 in the robotics laboratory assisted the exchange student. The students also incorporated Raspberry Pi, a popular single board computer to the Create 2, and created a Virtual Network Connection (VNC) from which they could run Scratch codes remotely to control the robot (Figure 9). While setting up Raspberry Pi the students were also introduced to the fundamentals of the Linux (Unix) operating system and *Python* programming language.

Following Scratch the exchange student worked with the UMES undergraduates to learn basics of *Python* programming language. The resources and codes freely available over the internet were used extensively to accelerate the learning process. Students used Python to code the Create 2 to move around while being connected to a desktop computer using a communication cable, as well as remotely by executing Python programs on an embedded Raspberry Pi over a VNC.

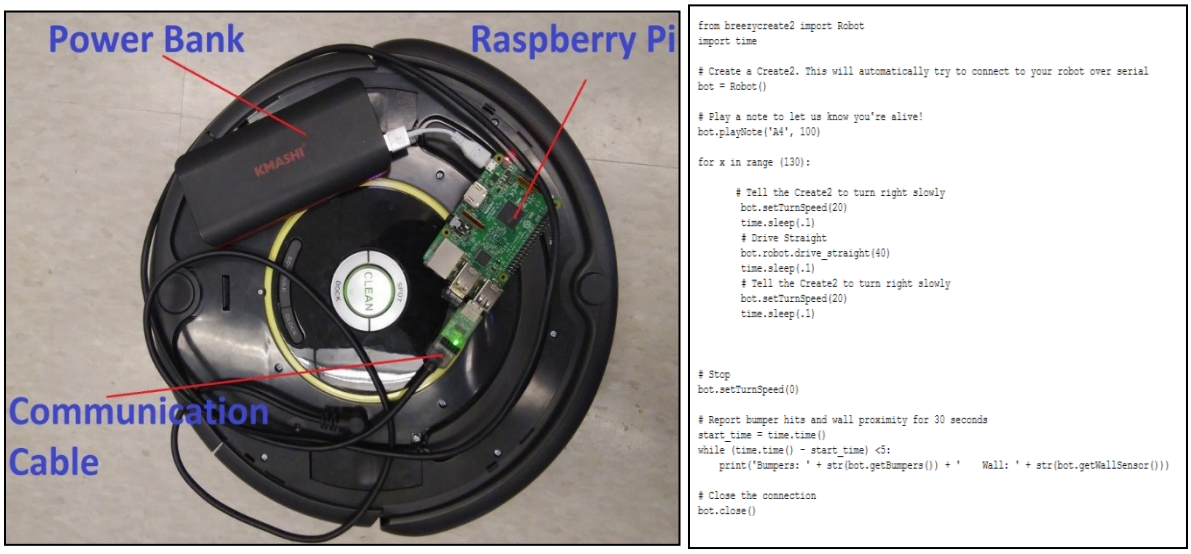

Figure 9: iRobot Create® 2, Communication Cable, Raspberry Pi and example Python code

Matlab programming environment was also introduced during the exchange program. The students used the Matlab Toolbox for iRobot Create 2 (MTIC2), created by Professor Joel Esposito at the Naval Academy in Annapolis, Maryland. Using the MTIC 2, the students managed to control the Create2 but in some instances ran into some interfacing problems that need to be investigated in the future in consultation with Professor Esposito.

A Go-Pi-Go kit was also acquired during the exchange program. Go-Pi-Go (Figure 11) is a mobile robot with two wheels developed by Dexter Industries. During summer 2017, the exchange student had the opportunity to assemble it and program it for various motion patterns using Python. The students also integrated an ultrasonic sensor to the mobile platform and programmed the robot to demonstrate basic operations related to obstacle avoidance using sensor feedback. Go-Pi-Go was

also remotely controlled via a VNC. A Scratch extension is also available for the Go-Pi-Go to work under commands from a Scratch programming environment.

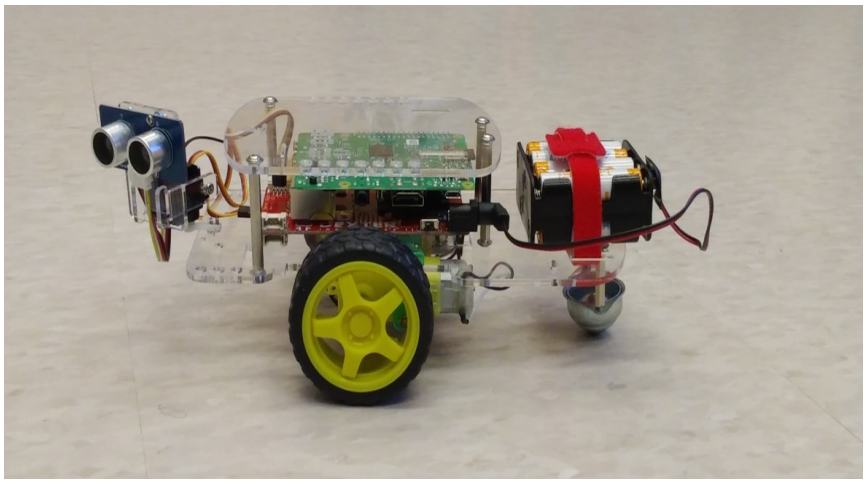

Figure 10: GoPiGo robot by Dexter Industries

The UMES RAM lab has also acquired several Microbot Teachmover robotic arms as well as a 4 –DOF SCARA and 6-DOF articulated robotic arms developed by ADEPT (Omron) extensively used in industry. The Teachmover robot is easy to use and can be programmed using a teach pendant and a simple programming interface. The Teachmover provides a user friendly platform to introduce basic pick and place operations with robotic arms. During the SEP the students took time to read through the instructions for controlling the Teachmover robotic arm using both the teach pendant as well as a computer program. The students worked to set up the workspace for simple pick and place experiments that will be used in the future.

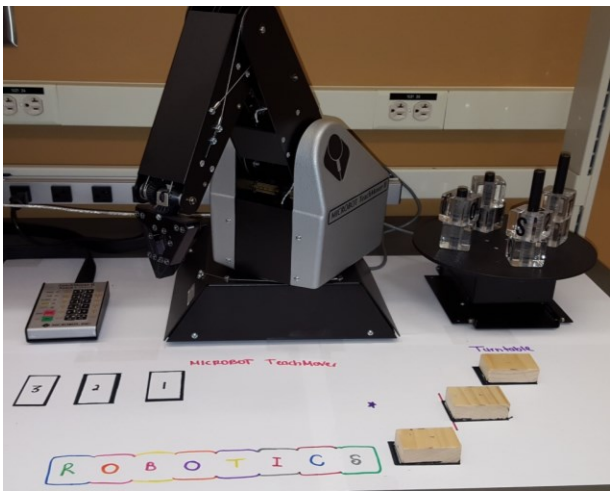

Figure 11: Microbot TeachMover

4.0 Student Feedback and Learning Outcomes

Besides project efforts highlighted above, the exchange students participated in weekly meetings that were attended by all undergraduate students and graduate students as well as participating faculty members that work and collaborate in the project team led by the primary author. Along with other students who are working on other ongoing projects, the exchange students made weekly presentation of the progress made during the week and plans for the forthcoming week. One of the faculty collaborators with expertise in environmental sciences and phycology provided instructions to the students on technical writing and power point presentation basics (seen in the left with the two exchange students on the right in Figure 12). She also provided the scientific underpinnings for the applications related to CAUTION project with regard to environmental considerations in the coastal bays in the eastern shore region. The exchange students at UMES also had the opportunity to visit the NASA Wallops Flight Facility (WFF) of the Goddard Space Flight Center (GSFC) and the associated visitor's center (Figure 12).

Figure 12: Visit to NASA WFF during SEP

Traditional undergraduate engineering curricula are being challenged to address all aspects of the growing field of robotics or broadly speaking "Mechatronics". Almost all the traditional majors are incorporating courses related to design, instrumentation, control, and programming aspects of the field to attract students that fit within the thrust and credit limitations of the individual curricula. However, classroom instruction in most cases is falling short of providing undergraduate students with a holistic perspective. Robotics and automation solutions to defense, transportation, energy, health care, environmental protection, manufacturing and agricultural productivity, space and underwater exploration, and other endeavors are likely to play a significant role in the future, and engineering curricula have to adapt accordingly. Abilities to assimilate knowledge to achieve success in engineering projects while working in multidisciplinary teams with strict deadlines are

attributes of a successful professional. By participating in the exchange program, the students recognized the benefits and necessity of team-based out of classroom learning experiences that integrate knowledge from a variety of courses that they may take in structured classroom environments. Feedback from the exchange students indicate that the SEP provided an excellent learning platform that integrated academic and life skills outcomes in addition to providing a glimpse into the professional work environment that they may encounter in the future. Besides adjusting to an unfamiliar campus and getting exposed to new engineering endeavors, they learned to work in teams with students and faculty from diverse educational backgrounds and ethnicity. In addition the exchange program also contributed in identifying robotics related activities that will be integrated for a 2 week long summer bridge program to be held at UMES in the 2018 summer for freshman engineering students that will join the UMES engineering program in fall of 2018.

Both exchange students at UMES agreed that the SEP was one of the highlights of their educational experience thus far.

Provided below are excerpts from their reports related to summer experience at UMES:

Mr. Blake Prout wrote "While at UMES I worked with students who had backgrounds in multiple different fields. I was challenged to learn a variety of different skillsets, most of which were not taught in the classroom. I learned different skills from each person who worked on the project as well as gained experience working with a diverse team of engineers. The biggest challenge while working with CAUTION was determining causes of malfunctions and finding solutions to them. Working with students who have experience with mechatronics and have worked with CAUTION in the past allowed us to fix malfunctions faster and prevent them for the future……"

Ms. Kalah Cross commented "During the summer I was given the opportunity to do research at University of Maryland Eastern shore. Which was funded through Maryland Space Grant Consortium. I worked on a project called AIRSPACES which include several different projects but mine individually dealt with K-12 grade outreach. I did work on three different robots which were the GopiGo2, MICROBOT Teach Mover and the Create 2. I grew very close to being that they were all I worked on all summer. I did not know I had a passion for working with robots until I came to this program. During this time, I also learned three programming language, some more than other but I plan to use all in my future endeavors. One programming language I used the most was Python. Python is simple to learn and easy to use. I came into this program knowing C++ but gained more knowledge with Python and it was an easy transition. Overall this summer program opened my mind to some of the different things I want to do in life and without the help of my mentors and Dr. N that would not be possible, and I am very appreciative. I have shared my story with other engineers at my school and encourage them to apply. One thing I learned about research is that you can call what you created your own. Research id for the creative mind and actually experiencing it myself was life changing…."

The deputy director of MDSGC who is also a co-author of this paper coordinated logistics, online application processing, selection and project assignments for the interns for the 2017 Summer Exchange. All ten internship offers extended to students in 2017 summer were accepted, reflecting the desirability of the experience in the minds of the students. All student interns presented results from their work at the MDSGC symposium held in the Johns Hopkins

Conference Center in late July, approximately 8-9 weeks into their 10-week internships. The presentations were evaluated by MDSGC Program Committee members.

Near the end of the summer internship period, MDSGC deputy director distributed a web-based survey to all the ten summer interns that participated in the exchange program. The survey was voluntary and anonymous and aimed to capture overall impressions from the interns while the experiences were fresh in their minds. At least seven of the ten interns responded. All of the responses indicated positive experiences: specifically highlighting progress in skills such as computer programming or PCB design; expressing new or rekindled interest in science and engineering topics; acknowledging the value of new professional relationships. Because the survey was anonymous it is not possible to directly attribute quotes to individual students; however, a sample of quotes is as follows:

"My time as an intern provided me with amazing work experience in the field of aerospace engineering."

"Maryland Space Grant Consortium definitely has affected my career path tremendously. Being here has helped me understand my likes and dislikes and also what I would want to do for future studies. It has also exposed me to the different aspects of engineering and connected me with other engineers as well."

"It broadened my horizons by placing me in a job that I normally wouldn't have the opportunity to do."

"Going forward, I believe that I will be able to apply what I have learned this semester in the classroom and also in any future positions that I have. I am now much more confident in my abilities to work with printed circuit boards, work in team settings, and handle challenges that arise. I enjoyed this experience very much and would like to thank every person who made this experience possible for me."

"This internship has been incredibly superb. The mentors and the coordinators were all fantastic and the experience itself was one like no other. I am so grateful to have been offered this internship as it has helped me narrow down my career goals and aspirations by introducing me to research I am interested in."

"Maryland Space Grant Consortium internship has provided me valuable knowledge and experiences in my field. It has shown me real world projects in my field of study and expanded my education beyond the classroom. It has also given me great networking opportunities."

"It has given me a boost as far as relevant work experience. Also, many of the contacts I made during my internship promise to be helpful later in my career."

5.0 Conclusion

The Summer Exchange Program(SEP) was initiated in the summer of 2009 with funds made available to the Johns Hopkins University(JHU), the MDSGC lead institution, through a competitive grant from NASA. The initial exchange program was among students at UMES, MSU and UMCP with a focus on minority institutions among the affiliates of MDSGC throughout the state. Recognizing the success of the initial year, the MDSGC directors and program committee members decided to continue the program using MDSGC funds in the subsequent years. In 2017 the number of participating institutions were expanded to include UMBC and Capital Technology University. The primary author serves as MDSGC Program Committee member at UMES and has participated in all of the exchange programs conducted by MDSGC. In this paper, only the highlights of the exchange program component at UMES have been mentioned; however, almost all exchange students that participated in 2017 SEP readily acknowledged the benefits of the program as evidenced by the online survey conducted by MDSGC deputy director. In the past, participating exchange students have indicated that the participation in the SEP not only enhanced their learning experiences but also helped them with their resumes, job interviews, and graduate program applications. Exposure to faculty outside the student's home institution and NASA scientists and engineers also helped them with identifying additional professional references. As in previous years, the logistics of 2017 SEP were handled by the MDSGC directors at JHU. All aspects of the 2017 exchange program with expanded participation were very well coordinated and the same format will be utilized in 2018.

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