Engineering Student Technology Committee

http://www.engr.colostate.edu/ESTC

College of Engineering

Colorado State University

1. Title of Proposal: Robotic Platforms

2. Proposal Participants:

Primary Contact for Proposal

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Department/Major: Electrical and Computer Engineering_____

Check One: _____ **Faculty** _____ **Staff** __X__ **Student**

Additional proposal participants

Name: Tony Maciejewski_____E-Mail: aam@colostate.edu _____

Department/Major: Electrical and Computer Engineering_____

Check One: ___X__ **Faculty** _____ **Staff** _____ **Student**

3. Proposal Abstract (limit to 100 words):

This proposal requests funds to purchase small, versatile robotic platforms. These platforms will be used in several undergraduate classes, allowing students to engage in a growing field of interest and, hopefully, attracting K-12 students into engineering areas through an active outreach program. The total amount of funding requested is $4000.

4. Proposal Budget

The following information is simply a list, along with quantities, prices, and sources, of the requested equipment. The next section will illustrate how the equipment will be used. The numbers of the items will not be consistent; replacement components are included in this proposal for items subjected to failure in the laboratory or outreach arenas.

From www.parallax.com

15 Robot Shield with Arduino (Product ID 32335): unit cost $150.00

Cost: 15 x $150.00 = $2250.00

15 Board of Education Shields (for Arduino) (Product ID 3500): unit cost $35.00

Cost: 15 x $35.00 = $525.00

15 USB A to Micro B serial cable (Product ID: 805-00016): unit cost $6.00

Cost = 15 x $6.00 = $90.00

16 433 MHz RF Transceiver (Product ID: 27982): unit cost $40.00

Cost = 16 x $40.00 = $640.00

Subtotal from www.parallax.com: $3505.00

From www.sparkfun.com

5 Arduino Uno – R3 SMD (DEV 11224): unit cost $30.00

5 x $30.00 = $150.00

20 Triple Axis Magnetometer Breakout - HMC5883L (SEN-10530): unit cost $15.00

Cost = 20 x $15.00 = $600.00

20 Triple Axis Accelerometer Breakout - ADXL335 (SEN-09269): unit cost $15.00

Cost = 20 x $15.00 = $300.00

20 Jumper Wire Kit (PRT-00124): unit cost $7.00

Cost 20 x 7.00 = $140.00

30 Mini Photocell (SEN-09088): unit cost $1.50

Cost = 30 X $1.50 = $45.00

Subtotal from www.sparkfun.com: $1235.00

From www.robotshop.com

20 Sharp GP2Y0A21YK0F IR Range Sensor - 10cm to 80cm

Cost = 20 x $10 = $200

20 SIRC-01 Sharp GP2 IR Sensor Cable - 8" (Product Code: RB-Onl-11): unit cost $2.00

Cost = 20 x $2.00 = $40.00

20 Parallax PING Ultrasonic Sensor (Product Code: RB-Plx-7): unit cost $30.00

Cost = 20 x $30.00 = $600.00

Subtotal from www.robotshop.com: $840.00

Subtotal from the three vendors: $5580.00

Shipping and Handling at 10% of total: $558.00

Anticipated Total: $6138.00

Dollar or percentage amount requested from ESTC: ***$4000***

If funded, the ECE Department will also provide:

1) Computers with installed software for programming the robots,

2) Miscellaneous components such as resistors (330 Ω, 1 kΩ, 4.7 kΩ, and 10 kΩ), capacitors, and LEDs.

3) Personnel and room for providing three K-12 workshops and periodic workshops targeting CSU engineering majors.

4) Developed material specific to the purchased equipment for the workshops.

The main bodies of the robots are the 'Robot Shield with Arduino'. These robots use two servo driven wheels for motion on smooth surfaces. The Arduino is a version of microcontroller, the 'brains' to the robot. The Arduino has become very popular for beginning robot development due to its simplicity and readily available on-line support. For example, the sensors provided by www.sparkfun.com have sample test code written for the Arduino, easing the interfacing of these sensors to the main robot.

The programs executed by the Arduinos are written in C++, providing students with an appealing application of computer skills and experience in a common industry language. Depending on the use, the students will either be modifying provided software or writing complete programs. Again, the units are versatile.

To allow for the expansion of robots, for example when using additional sensors, this proposal also includes the 'Board of Education Shields' which stack above the control system of the Robot Shields. Additional Arduino microcontrollers are included in the rare event of damage to a robot. These additional boards can also be used for stand-alone projects designed by students.

Each robot needs an assortment of sensors to allow it to move (safely) through an environment such as a classroom. The Sharp IR Range Sensor, Mini Photocell, and Parallax PING Ultrasonic Sensors will allow the robots to detect obstacles in their paths. The Triple Axis Magnetometers are basically digital compasses, allowing the robots to determine their orientation as they move. The Triple Axis Accelerometers indicate the robots tilt and movement. Finally, the 433 MHz RF Transceivers will be used for communication between robots.

An important, basic sensor is not included in the budget – a 'bump' sensor which will be constructed by students as an introduction to the Arduino and circuit boards on each robot.

5. Full description of proposal:

Whether accurate or not, Hlollywood movies have already given people an introduction to robotics. A consequence of this 'information' is a high interest among younger people in robotics. While science fiction movies and reality often have little in common, the growth and interest in robotics truly is significant. "From now on, the robot industry will maintain an annual

growth rate of 40% for a long period of time," said Song Ziaogang, president of the Chinese Robot Industry Association. This growth is not just a Chinese phenomenon. In October, Oxford University published a study of the application of robotics in the US labor force concluding that as much as 47% of the current labor force could be replaced with robots over the next two decades. http://www.therobotreport.com/news/40-annual-growth-forecast-for-chinese-robotics.

In the USA, news stories of drones and self-driving cars are common. Known to fewer people is the increased use of service robots which perform tasks ranging from milking cows to aiding in surgeries. "Turning to the projections for the period of 2013 to 2016, sales forecast which were provided by companies worldwide indicate an increase to about 94,800 [service robot] units with an estimated value of US$ 17.1 billion". http://www.ifr.org/news/ifr-press-release/considerable-increase-of-medical-robots-and-logistic-systems-552/ Currently, there is a very large gap between the need, driven by industry, and the attraction of young people to this area. In part, this proposal will provide seed money for the demonstration of an outreach program to attract K-12 students into robotics. Once the feasibility has clearly been documented, grants from the larger federal programs will allow CSU to strengthen and expand this outreach. The requested funds will also strengthen CSU's ability to provide current engineering students hands-on experience with developing mobile robots.

While CSU offers courses in industrial robotics, ECE 481A2 – Introduction to Robot Programming and Simulation (enrollment Spring 2015: 40 students) and ECE 555 – Robot Motion Planning (enrollment Fall 2014: 25 students), these courses already require considerable pre-requisites and hence are not accessible by the vast majority of students. Further, the courses are currently focused on simulation rather than physical implementations of robotics concepts. The funding of this proposal will provide equipment to allow people with a very minimal engineering background to explore their interest in this growing field. Periodic workshops will be provided to CSU students to introduce them to the robotics field and provide an introduction to the terms, concepts, and challenges.

At the same time, the equipment is versatile enough that it will be incorporated into current robotics courses, thus providing students with physical platforms on which they can apply class material. The flexibility of the equipment can extend one step further by providing open-ended research platforms for very challenging and significant problems.

The requested equipment is predicted to have a life-time of at least five years, allowing an evaluation of the success of the department's efforts in increasing the number of students interested in engineering and specifically robotics. Repairs and replacement of parts will be necessary. Fortunately, the general interest in robotics makes these components readily and cheaply available through many internet sites.

kIn summary, robotics is an integrated and developing discipline. Even at the most basic level, it immediately utilizes mechanical engineering for the movement aspect of the robot. The sensors and power management of the robot involve electrical engineering. Programming of the robot incorporates computer science skills. The appeal of moving robots will hopefully attract students from each of these disciplines and beyond what will be mentioned to the area of robotics.

At the minimum, the funding of this proposal will impact:

1) *Existing formal courses*. ECE 481A2 – Introduction to Robot Programming and Simulation (enrollment Spring 2015: 40 students) and ECE 555 – Robot Motion Planning (enrollment Fall 2014: 25 students), which regularly include students from both ECE and ME.

2) *Multiple senior design courses throughout the college*. This year, for example, CSU is fielding four teams, approximately 20 students, for the Colorado Space Grant Consortium's NASA Robot Challenge. The equipment will provide future students with introductory equipment where they can learn about mobile robot platforms prior to the development of their challenge robots.

3) *Research platform for college graduate students*. Currently, one PhD student is involved in interactive robotic swarms. This equipment could be used for initial testing of ideas developed in computer simulations.

4) *K-12 Outreach*. The need for outreach to increase interest in the STEM areas is obvious. It has been discussed at the local level but also at the national level. Experiments by Adams State University in Alamosa, Colorado hinted at the potential success of using robots for outreach. Their 3-hour workshops for middle and high school students and college/university students attracted groups from Colorado, New Mexico, and Utah. With the equipment provided from this grant, the ECE department will provide a minimum of three workshops for K-12 students. Each workshop is anticipated to involve 24 students for 3-4 hours.

5) *Cross-campus workshops*. Additionally, periodic workshops will be provided to CSU students across the campus.