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December 30, 2003

TO: Dr. Ken Derucher, Dean, College of ECT

cc: Dr. Orlando Madrigal, Chair, Computer Science
Dr. Ron Roth, Chair, Mechanical and Mechatronic Engineering
Mr. Bruce Racheter, Administrative Analyst, CSUC OSP

FROM: Dr. Benjoe Juliano, Associate Professor, Computer Science

SUBJECT: NSF Progress Report, Fall 2003

I am pleased to share with you a copy of my NSF Progress Report for MRI/RUI Project #0321385, *Acquisition of robotics equipment for an Intelligent Systems Laboratory*. As you will see, although the first four months of the project have been hectic, we have also accomplished so much in such a short time.

On behalf of my co-PIs, Drs. Renee Renner and Ramesh Varahamurti, I would also like to take this opportunity to thank you for all your encouragement and support of our NSF Project. In particular, Dr. Renner and I truly appreciate your support for our research and professional development endeavors that have led to this successful grant proposal. Your support is exemplified by both (1) our trip to MIT to participate in Dr. Rodney Brooks' summer program on *Embodied Intelligence* last Summer 1999, and (2) our trip to Washington, D.C. with Dr. Melody Stapleton as our faculty mentor last Spring 2001 in an attempt to gather grant criteria and make contacts with NSF, ONR, and others. Further, your willingness to match NSF funds with faculty release time shows your solid support and faith in our potential – all these are vital to the continued success of our project.

I look forward to a fruitful and successful Spring 2004 semester as we wrap up the first year of our three-year project.

NSF Progress Report
Fall 2003

Acquisition of robotics equipment for an Intelligent Systems Laboratory
(MRI/RUI 0321385)

December 31, 2003

NSF Program:	EIA – MRI/RUI
NSF Award Number:	03-21385
Report period coverage:	August 15, 2003 – December 15, 2003
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1 OVERVIEW

This project aims to acquire robotics equipment for an *Intelligent Systems Laboratory* (ISL) that will facilitate the development of cross-disciplinary courses and provide exciting collaborative research possibilities. The ISL enables both students and faculty to investigate, design, and implement control algorithms using non-traditional techniques derived from various subdisciplines of Artificial Intelligence, such as fuzzy logic, neural networks, genetic algorithms, hybrid approaches, etc. The ISL also furnishes opportunities to work with people from other disciplines. Such collaborative work gives students the experience of working with non-majors on a joint project, an experience they will all need to be successful in their careers. The robotics equipment acquired for the ISL will be used to support instruction of both undergraduate and graduate students through new and recently modified courses in the areas of *Machine Intelligence*, *Intelligent Systems Design and Applications*, *Intelligent Control*, *Autonomous Robots*, and others. Robotics kits at the basic, intermediate, and advanced levels are to be acquired to facilitate research, research training, and integrated research/education activities at various academic levels. The PIs strive to increase the number of students graduating with intelligent systems background. This goal is motivated by an anticipated increase in the demand for (either solitary or cooperating) autonomous mobile robots for a variety of tasks such as gathering data from potentially hazardous environments, facilitating search and rescue missions, and others. The ISL will be used to facilitate work with undergraduate students (who are either working on their senior project or are involved with the Honors program) and graduate students on both new and ongoing robotics projects. Collaboration with industry partners interested in investigating the applicability of intelligent systems in their companies will also be encouraged.

This report covers part the first year of the project. During the first year, the PIs planned to purchase and set up the basic and intermediate robotics equipment for the ISL and visit robotics labs at universities in the local service area. The PIs also planned to develop the curriculum for a course in *Robotics and Machine Intelligence* in preparation for offering the course in the Spring 2004. Guest lectures by researchers from robotics labs the PIs visited will be scheduled. The PIs also targeted preparation of paperwork regarding the formation of the *Institute for Research on Intelligent Systems* (IRIS). The primary function of IRIS is to manage the use of the ISL and to foster collaborative work between university constituents and other institutions when opportunities arise to use the ISL as a resource for instruction or research. Additionally, the PIs will finalize agreements for recruiting participants in *Girls' SRC*, a *Summer Robotics Camp* for junior high school girls. This summer camp is part of the PIs' aggressive effort to recruit and retain underrepresented groups into the fields of computer science and engineering.

2 ORGANIZATION

When the PIs submitted the proposal for this project to NSF last January 2003, they anticipated starting the project July 1, 2004 if the proposal was accepted. NSF informed the PIs last August 6, 2003 that their proposal was accepted with $346,188 in federal funding and the project was to begin August 15, 2003.

Moving the start date of the project practically a year earlier than the PIs had planned resulted in schedule changes and adjustments. The original plan was to have part of Summer 2004 to prepare for work in Fall 2004; the new start date required starting immediately in the Fall 2003 semester. The most major effect this had was on scheduling course preparation and course offering for CSCI 224, *Robotics and Machine Intelligence* [15], which will be offered in Spring 2004 (originally planned for Spring 2005). The PIs had planned on offering this course in the Intelligent Systems Lab (ISL) that they were supposed to setup and organize over Summer and Fall 2004, but now only had Fall 2003 to do so. As of the writing of this report, the ISL will be housed in O'Connell Technology Center (OCNL) Room 431.

Additionally, the PIs had to make changes to the robotics equipment they were purchasing to outfit the ISL. Most of these adjustments are based on the fact that the PIs had been working on their NSF grant proposal since Spring 2000 and some of the requested robotics kits have become outdated and/or discontinued (*e.g.* see Table 1 for changes to the basic kits). Other kits with additional features and capabilities have also become available.

Table 1: Adjustments made to the set of basic robotics kits.

Original kit(s)	Replacement kit(s)	Notes
30 *LEGO Mindstorms Robotics Invention System (RIS) Deluxe Kits* (#K3800) - *LEGO Mindstorms RIS 2.0* (#3804) - *LEGO Mindstorms Ultimate Builder's Set* (#3800) - *LEGO Mindstorms Vision Command Kit* (#9731)	**30** *LEGO Mindstorms Robotics Invention System (RIS) Kits* (#K9916) [23] - *LEGO Mindstorms RIS 2.0* (#3804) - *Remote Control* (#9738) - *9-volt Motor* (#4176779) - *Capacitor* (#9916) - *Large Wheels and Axles* (#10049) - *Beams* (#10072) - *Cross Axles* (#10074) - *Gear Wheels* (#10076)	LEGO discontinued #3800 *Ultimate Builder's Set* and #9731 *Vision Command Kit*, and so #K3800 *RIS Deluxe Kit* was no longer available at the time the project started. LEGO also discontinued #3801 *Ultimate Accessories Kit*. This replacement reduces the number of LEGO pieces in each basic robotics kit from 1224 (1179 from #K3800 and 45 from #3801) pieces to 906 pieces.
30 *LEGO Mindstorms Ultimate Accessories Kits* (#3801)		

Figure 1. The LEGO *Mindstorms Robotics Invention System Kit* [23].

Some of the biggest changes were the adjustments made to the intermediate robotics kits (see Table 2). Additional studies on the original kits requested indicated that the platforms were either more limited than anticipated or simply outdated. The replacement robotics kits from TAB Electronics [36,37] and Lynxmotion [26] also accommodate a wide variety of sensors for various mobile robotics experiments. The changes also increase the number of intermediate robotics platforms from three to five (actually, the Sony *AIBO*s [32] and the K-Team *Kheperas* [21] could be considered advanced robotics platforms).

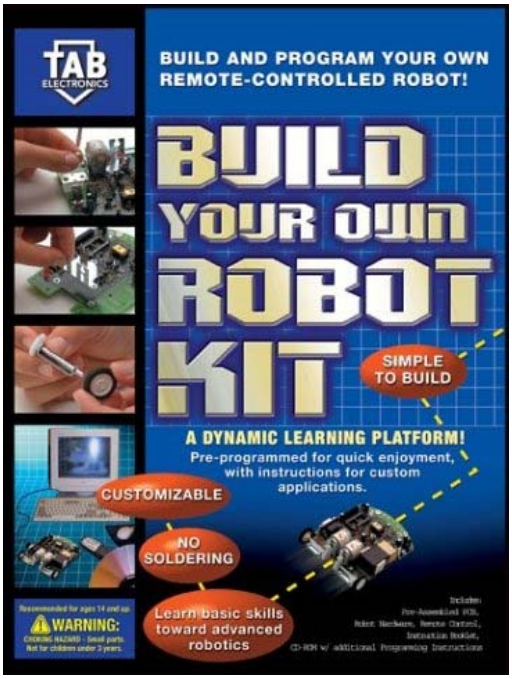


Figure 2. The TAB Electronics *Build Your Own Robot Kit* [36].

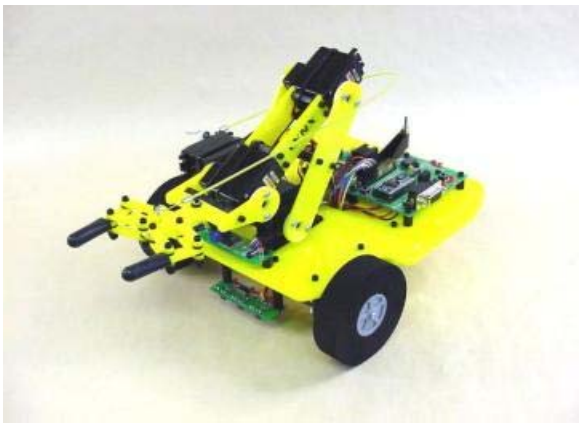


Figure 3. The Lynxmotion *Carpet Rover / Lynx 5 Combo Kit* [26].

Figure 4. The Lynxmotion *Hexapod 1 (OOPic-R) Kit* [26].

Figure 5. The SONY AIBO *ERS-220A* (left) and *ERS-7* (right) robots [32].

Figure 6. The K-Team *Khepera II* minirobot kit [21].

Table 2: Adjustments made to the set of intermediate robotics kits.

Original kit(s)	Replacement kit(s)	Notes
30 *OWI Robotics WAO-G Programmable Fuzzy Robot Kits* (#3-127) [27]	**30** *TAB Electronics Build Your Own Robot Kits* (#3-904) - each powered by a *BasicX-24* BASIC programmable microcontroller [14]	OWI Robotics' *WAO-G* is much more limited than originally anticipated, and could be best used as a good example rather than a robot platform for the ISL. The *Descartes* and the *Rug Warrior Pro* platforms have become outdated.
30 *Living Machines Descartes Robot Kits* (#02-00-000) [25]	**8** *Lynxmotion Carpet Rover / Lynx 5 Combo Kits* (#CRL5-KT) [26]	TAB Electronics offers the *Build Your Own Robot Kit* (BYORK) and the *SUMO BOT*, both distributed by McGraw-Hill and available through Barnes and Noble, Amazon.com, etc. These platforms take a number of sensors and actuators available from companies like Parallax, Jameco, etc. The Sony AIBO platform facilitates the formation of Robo-Soccer student teams for potential competitions. The K-Team Khepera II desktop robotics platform is one of the most popular and highly recommended research robots available.
30 *AK Peters Rug Warrior Pro Robotics Complete Kits* (#AK-RugWP: Complete) [31]	**8** *Lynxmotion Hexapod 1 for OOPic-R Combo Kits* (#H1CC-KT) [26]	
	3 *Sony AIBO ERS-220A Programming Packages* (#ERS220APRGKIT) [32]	
	3 *Sony AIBO ERS-7 Robots* (#ERS-7/W) [32]	
	6 *K-Team Khepera II Minirobots* (#ERS-7/W) [21]	

The PIs also recognized other items they overlooked that were not included in calculating the original requested budget from NSF. These included such things as robot-building electronics tools for the ISL, organizers and/or toolboxes for storing the LEGO Mindstorms kits and partially-completed student projects, documentation equipment (digital camera and video camera) for ISL-related activities and student competitions, and others. Adjustments to the budget to handle this oversight will be detailed in the next section.

For the Fall 2003 semester, the following students were hired for ISL student research assistant positions:

- Matt Bauer, Mechanical and Mechatronic Engineering, undergraduate
- Felipe Jauregui, Computer Science, graduate
- Elena Kroumova, Computer Science, undergraduate
- Alexis Winston, Computer Science, graduate

The three ISL PIs and the four ISL student research assistants collectively make up the ISL research group. This research group was also broken up into three teams. Each PI was made team leader to facilitate project management. The research group teams are:

- Research Projects and Website Team – Juliano, Kroumova, Winston
- Institute (IRIS) and Summer Camp Team – Renner, Jauregui
- Hardware and Lab Planning Team – Varahamurti, Bauer

Additionally, with a number of student and faculty volunteers expressing interest in helping out with this project, regular meetings were scheduled every Friday, 10:30am to 12 noon, in OCNL 247. Organizational meetings (involving the research group) and general meetings (research group plus any interested volunteers) were alternated each Friday. The ISL currently has 24 volunteers in its mailing list (five are faculty of the College of ECT); five of these volunteers, in particular, have been very active in helping out.

Most of the Fall 2003 semester was dedicated to the following tasks:

- purchasing the basic and intermediate robotics platforms (see next section);
- working with administration and other faculty in setting up and organizing details for housing the ISL in OCNL 431;
- inventorying the basic (LEGO *Mindstorms* [23]) robotics platforms; and
- assembling and inventorying some of the intermediate (TAB Electronics *BYORK*s [36] and a Lynxmotion *Hexapod* [26]) robotics platforms.

During the Fall 2003 semester, the College of Engineering, Computer Science, and Technology (ECT) was in the process of combining and moving (computer) labs around O'Connell Technology Center (OCNL). To facilitate this process, Dr. Mike Ward, Associate

Dean of the College of ECT, organized a task force for the transition and planning for OCNL 431. This group consisted of the following people:

- Elbert Chan, Computer Systems Technician, ECT Computing Services
- Benjoe Juliano, Associate Professor, Computer Science
- Dave Memmer, Electrical / Electronic Systems Technician, College of ECT
- Renee Renner, Assistant Professor, Computer Science
- Nick Repanich, Adjunct Instructor, Mechatronic Engineering
- Ron Roth, Professor and Chair, Mechanical Engineering, Mechatronic Engineering, and Manufacturing Technology
- Jimmy Tan-atichat (Lab Transition Task Force Coordinator), Professor, Mechanical and Mechatronic Engineering
- Ramesh Varahamurti, Professor, Mechanical and Mechatronic Engineering
- Mike Ward, Associate Dean, College of ECT
- Larry Wear, Professor and Chair, Electrical and Computer Engineering
- Dale Word, Assistant Professor, Electrical and Computer Engineering

The above group met regularly to discuss OCNL 431 issues such as the various possibilities of organizing equipment in the lab, software needs, scheduling of courses in the lab, hardware needs, and various others. As of the writing of this report, the ISL will be housed in OCNL 431, which the task force has named the Intelligent Systems/Mechatronics Lab. To clearly indentify progress and development in the ISL, Elena Kroumova, ISL undergraduate student research assistant, worked with Dr. Juliano and spent most of her Fall 2003 semester setting up and maintaining the ISL website [19] to detail ISL facilities, projects, contacts, etc.

The LEGO *Mindstorms* [23] kits were inventoried in detail in anticipation of ISL users eventually misplacing some of the 800+ pieces per kit. Each LEGO *Mindstorms Robotics Invention System Kit* (#K9916) actually consists of eight subkits (see Table 1), and the factory packaging of the pieces do not necessarily make general sense. So, referring to various online LEGO parts databases [22,24,30], a comprehensive parts list was developed to inventory each of the LEGO *Mindstorms RIS Kits* that make up the basic robotics platform. (A copy of the inventory sheet, developed by ISL undergraduate student research assistant Elena Kroumova with PI Dr. Juliano, is included in the Appendix.)

Figure 7. Contents of a *LEGO Mindstorms RIS Kit* [23] laid out in OCNL 214 for inventorying.

Faculty, students, and volunteers participated in these inventorying sessions in OCNL 214, the Department of Computer Science Conference Room. OCNL 214 also provided temporary space for use as an ISL meeting room. Additionally, OCNL 214 was used as an "inventory central" area since OCNL 431, where ISL was to be eventually housed, would not be available until the Spring 2004 Intercession period.

Alexis Winston, ISL graduate student research assistant, is working on automating the inventorying system by developing a PHP-based interface to an Oracle database (see Figure 8). Portions of this web interface will only be available through the intranet (administration, assignment of ISL equipment to reservation requests, processing of orders for missing parts, etc.). Some limited information on availability of ISL equipment will be accessible through the Web. Eventually, a proposal-based policy on requesting permission to use ISL equipment will be developed and adopted.

Overall, the inventorying of ISL's 30 *LEGO Mindstorms RIS Kits* [23] took more than 7 weeks to accomplish. Within this time frame, approximately 70 hours of student research assistant work and over 200 volunteer student hours were alloted to get the task done.

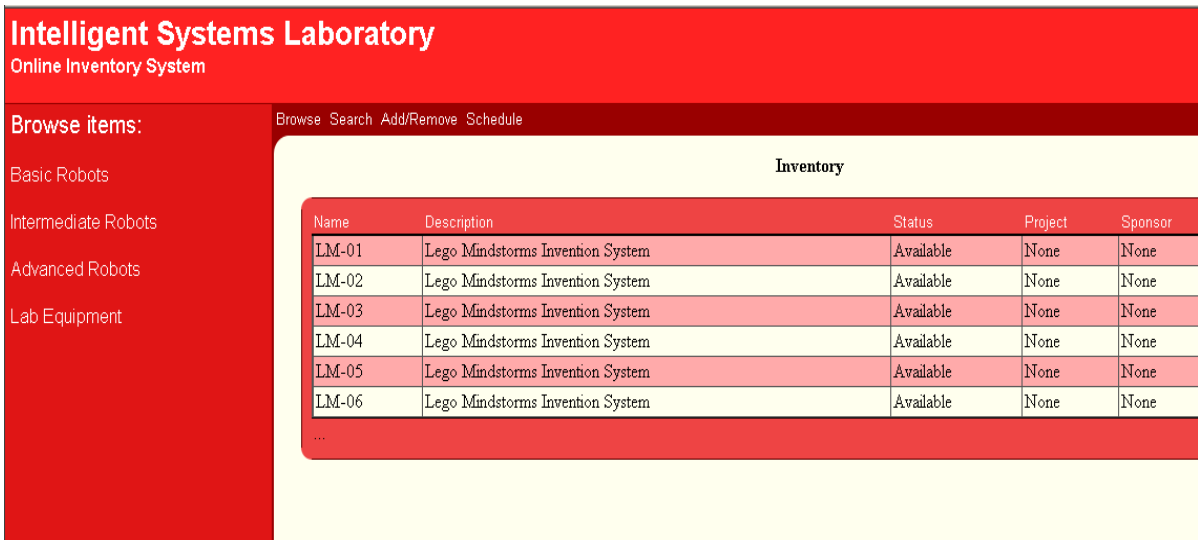


Figure 8. Screen shot of a portion of a prototype ISL online inventory system.

Figure 9. Students organizing *LEGO Mindstorms RIS Kit* [23] pieces in OCNL 214 using Ziploc bags and an inventory sheet.

Figure 10. Volunteer students helping out in the *LEGO Mindstorms RIS Kit* [23] inventorying effort in OCNL 214.

Another task completed this Fall 2003 semester is the assembling and inventorying of some of the intermediate robotics platforms. This task involved 30 TAB Electronics *BYORK*s [36] and a Lynxmotion *Hexapod 1* [26]. Of the 30 *BYORK*s assembled, twelve

Figure 11. Students assembling *TAB Electronics BYORK*s [36] in OCNL 214.

Figure 12. Students debugging faulty *TAB Electronics BYORK*s [36] in OCNL 214.

were "faulty," with problems ranging from wheels only turning one direction to missing parts like transistors or infrared sensors. Ben Wirz, co-developer of the *BYORK*s, was contacted regarding these problems. Replacement parts that can be used to fix these problems were immediately sent by TAB Electronics. There were only some minor problems getting the Lynxmotion Hexapod started; ISL undergraduate student research assistant Matt Bauer took the lead in debugging and and testing this robot platform.

Dr. Renner, ISL Co-PI, is spear-heading the work on the charter for the Institute for Research on Intelligent Systems (IRIS). As of the writing of this report, it seems that the charter will be ready for evaluation by the faculty of the College of ECT in Spring 2004, for submission to and approval by the CSUC Academic Senate in the same semester. Elena Kroumova, ISL undergraduate student research assistant, has set up an IRIS website [17] that details the role of IRIS relative to the ISL, the College of ECT, and the CSUC campus. A copy of the draft version of the IRIS chapter is included in the Appendix.

3 FINANCIAL REPORT

This project was appropriated $346,188 in federal funding for a three-year period beginning August 15, 2003. The original funding requested in the proposal, reduced July 2003 from $437,535 to $346,254 as requested by NSF, is broken down as follows:

Table 3: Original requested funding from NSF.

	YEAR 1 07/01/04 – 06/30/05	YEAR 2 07/01/05 – 06/30/06	YEAR 3 07/01/06 – 06/30/07	TOTAL
REQUESTED FUNDING FROM NSF				
Equipment and Operating Expenses				
Robotics Kits – Basic	$10,495	$0	$0	$10,495
Robotics Kits – Intermediate	$16,801	$0	$0	$16,801
Robotics Kits – Advanced	$0	$199,684	$0	$199,684
Total Equipment	**$27,296**	**$199,684**	**$0**	**$226,979**
Technical Support Personnel				
2 Grad Students; base salary 03-04: $12/hour				
Regular semester - 20 hrs/wk for 32 wks	$15,360	$15,821	$16,295	$47,476
Summer - 40 hrs/wk for 12 wks	$11,520	$11,866	$12,222	$35,607
2 Undergrads; base salary 03-04: $8/hour				
Regular semester - 20 hrs/wk for 32 wks	$5,120	$5,274	$5,432	$15,825
Summer - 40 hrs/wk for 12 wks	$3,840	$3,955	$4,074	$11,869
Total Technical Support	**$35,840**	**$36,915**	**$38,023**	**$110,778**
Fringe Benefits (if charged as direct costs)				
Grads AY @ 7.67%	$2,062	$2,124	$2,187	$6,372
Undergrads AY @ 7.67%	$687	$708	$729	$2,124
Total Benefits	**$2,749**	**$2,831**	**$2,916**	**$8,497**
TOTAL REQUESTED FROM NSF	**$65,884**	**$239,430**	**$40,939**	**$346,254**

As indicated in the previous section, the PIs realized that they had overlooked some items in calculating the original requested budget from NSF. In order to acquire these items, Dr. Juliano submitted a CSUC Office of Sponsored Programs faculty development grant [5] last October 2003. This request for almost $5,000 in operating expenses was formally approved last December 8, 2003 for $4,468. The PI also decided to modify the number of requested advanced robotics platforms in order to accommodate an internally-defined budget line item for $8K+ in supplies. The allotment adjustments to the original requested funding from NSF, as of this semester, is summarized in Table 4. Note that the overall total is not equal to the actual award in order to cover any other unanticipated expenses for the duration of the project.

Table 4: Allotment adjustments to the original requested funding from NSF.

	YEAR 1 08/15/03 – 08/14/04	YEAR 2 08/15/04 – 08/14/05	YEAR 3 08/15/05 – 08/14/06	TOTAL
REQUESTED FUNDING FROM NSF				
Equipment and Operating Expenses				
Robotics Kits – Basic	$8,038	$0	$0	$8,038
Robotics Kits – Intermediate	$63,892	$0	$0	$63,892
Robotics Kits – Advanced	$0	$143,495	$0	$143,495
Total Equipment	**$71,930**	**$143,495**	**$0**	**$215,425**
Adjustments				
Supplies	$8,114	$0	$0	$8,114
Total Supplies	**$8,114**	**$0**	**$0**	**$8,114**
Technical Support Personnel				
2 Grad Students; base salary 03-04: $12/hour				
Regular semester - 20 hrs/wk for 32 wks	$15,360	$15,821	$16,295	$47,476
Summer - 40 hrs/wk for 12 wks	$11,520	$11,866	$12,222	$35,607
2 Undergrads; base salary 03-04: $8/hour				
Regular semester - 20 hrs/wk for 32 wks	$5,120	$5,274	$5,432	$15,825
Summer - 40 hrs/wk for 12 wks	$3,840	$3,955	$4,074	$11,869
Total Technical Support	**$35,840**	**$36,915**	**$38,023**	**$110,778**
Fringe Benefits (if charged as direct costs)				
Grads AY @ 7.67%	$2,062	$2,124	$2,187	$6,372
Undergrads AY @ 7.67%	$687	$708	$729	$2,124
Total Benefits	**$2,749**	**$2,831**	**$2,916**	**$8,497**
TOTAL REQUESTED FROM NSF	**$110,519**	**$183,241**	**$40,939**	**$334,700**

A list of robotics equipment purchased during the Fall 2003 semester is summarized in Table 5. As of the writing of this report, the ISL has a total of 85 robots in 6 platforms. These platforms, also identified in Tables 1 and 2, include LEGO *Mindstorms RIS* Kits [23], TAB Electronics *BYORK*s [36], Lynxmotion *OOPic-R Hexapod 1*s [26], Lynxmotion *Carpet Rover 2 / Lynx 5 Combo* Kits [26], Sony *AIBO ERS-220A*s [32], and K-Team *Khepera II* minirobots [21]. Based on Table 5, the total expenditure for the Fall 2003 semester is about $50,000. Please note the subtotals and totals given in Table 5 do not include shipping costs, indirect costs and incidentals.

Table 5: List of robotics equipment purchased during the Fall 2003 semester
(Note: Shipping costs and incidentals not factored into calculations below).

Robotics Equipment Budget - Adjusted

Phase 1: Basic Robotics Kit(s)

Item	Unit Cost	Qty	Subtotal
LEGO MINDSTORMS Robotics Invention System Kit (#K9916)	$229.00	30	$6,870.00
	Total for Phase 1:		**$6,870.00**

Phase 2: Intermediate Robotics Kit(s)

Item	Unit Cost	Qty	Subtotal
TAB Electronics Build Your Own Robot Kit (ISBN: 0-07-138787-0)	$53.96	30	$1,618.80
NetMedia BasicX-24 BASIC Stamp (BX-24)	$49.95	30	$1,498.50
NetMedia BasicX Software CD	$19.95	1	$19.95
Parallax IR Buddy Pair (#28016)	$47.20	15	$708.00
Parallax Serial Cable for BS2 Programming (800-00003)	$8.00	10	$80.00
Parallax Compass AppMod (29113)	$71.10	10	$711.00
Parallax Audio Amplifier AppMod (29143)	$24.65	10	$246.50
Parallax SSIR Detector (#28019)	$14.95	10	$149.50
K-Team Khepera II robot kit (KheBaseII)	$1,709.21	6	$10,255.25
K-Team Khepera General I/O Turret (KheGenIO)	$259.60	2	$519.20
K-Team K2D B&W camera video turret (KheK2D-B)	$2,510.18	2	$5,020.35
K-Team Radio Turret (KheRadio)	$1,180.00	6	$7,079.99
K-Team Radio Base (KheRadioB)	$1,573.33	1	$1,573.33
K-Team Khepera II Rotating Contact (Kh2Rot)	$303.94	6	$1,823.63
SONY AIBO ERS-220APRGKIT Programming Package	$1,390.00	3	$4,170.00
SONY AIBO Master Studio 1.1	$349.00	1	$349.00
SONY AIBO ERS-210ABPGKIT Programming Package	$1,448.00	3	$4,344.00
Lynxmotion Hexapod 1 (OOPic-R) Robot Combo Kit (H1CC-KT)	$251.82	8	$2,014.56
Lynxmotion Carpet Rover 2 / Lynx 5 Combo Kit (CRL5-KT)	$452.52	8	$3,620.16
Lynxmotion Ultrasonic Range Sensor (URS-01)	$35.95	8	$287.60
Lynxmotion Single Ultrasonic Sensor Housing (URSH-03)	$4.95	8	$39.60
	Total for Phase 2:		**$41,784.92**
GRAND TOTAL (Phases 1 and 2)			**$48,654.92**

4 RESEARCH ACTIVITIES AND RESULTS

Although most of the Fall 2003 semester was spent on purchasing robotics equipment, setup, assembling, and inventorying, there are still a number of research activities that have started as a result of ISL and its current robotics equipment being available in the College of ECT. As of the writing of this report, the following research activities are ongoing or pending approval:

1. Precision farming [1]. Precision farming is the use of unmanned, autonomous vehicles in farming. The purpose of this project is to focus on capacity building research that would facilitate the development of an intelligent ground vehicle capable of autonomously navigating in a field for a variety of tasks (e.g. pesticide application, plowing, irrigation, harvesting, etc.). A CSU Agricultural Research Initiative (ARI) grant proposal will be submitted in January 2004; ISL robotics equipment will be used as proof of concept for various control algorithms under consideration. This project also relates to potential student participation in the Intelligent Ground Vehicle Competition (IGVC) [18].

2. Robotics and visualization [2,3]. Robotics and visualization are very closely related to one another. Intelligent robotics systems need intelligent vision systems in order to be considered intelligent. In particular, autonomous mobile robots for search and rescue missions need highly coordinated and sophisticated vision systems. The focus of this project is to secure and incorporate visualization equipment in the ISL. This research area has a lot of potential applications in grid computing, like Sun Grid Computing Solutions [35].

3. Multi-agent area coverage algorithms [8]. The main objective of this project is to provide an academic framework for research into algorithms and hardware appropriate for multi-agent robotic systems used in area-coverage applications. The framework will address adaptability despite inherent fuzziness/ambiguity in the environment, and cooperative robotic behaviors. Practical applications of this technology to fields such as search and rescue, environmental exploration operations, and environment mapping, will be taken into consideration.

4. Hybrid soft computing agents. Soft computing is any approach that combines intelligent systems techniques such as fuzzy logic, neural networks, genetic algorithms, and others, to solve highly complex problems. Dr. Renner has been working on applications for ensembles of neural networks and hybrid systems with Dr. Roman Neruda of the Institute of Computer Science of the Academy of Sciences of the Czech Republic. During a recent research visit to CSUC, Dr. Neruda informed the PI that he had been trying to secure a grant to purchase some K-Team *Khepera II* minirobots for use in hybrid soft computing agents research.

When he found out that the ISL had recently acquired 6 Kheperas, Dr. Neruda expressed interest in collaborative research on intelligent agents including work in telerobotics (distributed control of robots through the Internet). Hybrid soft computing agents have a lot of potential applications in grid computing, like Sun Grid Computing Solutions [35].

The PIs anticipate good progress and positive results from the above research activities by the time the next Progress Report is written.

5 EDUCATIONAL IMPACT

The PIs are still developing the curriculum for CSCI 224, *Robotics and Machine Intelligence* [15]. This course is currently scheduled to be offered in the Spring 2004 semester, Tuesdays and Thursdays, 11:00 am to 12:15 pm in OCNL 431. The course will be co-taught by the three PIs. One of the main objectives the PIs have for this course is to provide students with a multidisciplinary experience working on more than one robotics platform in solving problems that relate to search and rescue.

At the start of the semester, the PIs had somewhat agreed to expose students in CSCI 224 to the following robotics platforms:

- LEGO *Mindstorms RIS Kit* (see Figure 1) [23];
- TAB Electronics *BYORK*s (see Figure 2) [36]; and
- TAB Electronics *SUMO BOT* (see Figure 13) [37].

The first two robots listed above will be available in the ISL for students to use during the class sessions. The students were going to be required to purchase the $99 *SUMO BOT* [37] at the start of the semester. The philosophy behind this decision was to provide the students with a reasonably-priced robot for use in the class as well as to take home to experiment with. Further, at the end of the semester, students will still have this robot platform to continue experimenting with.

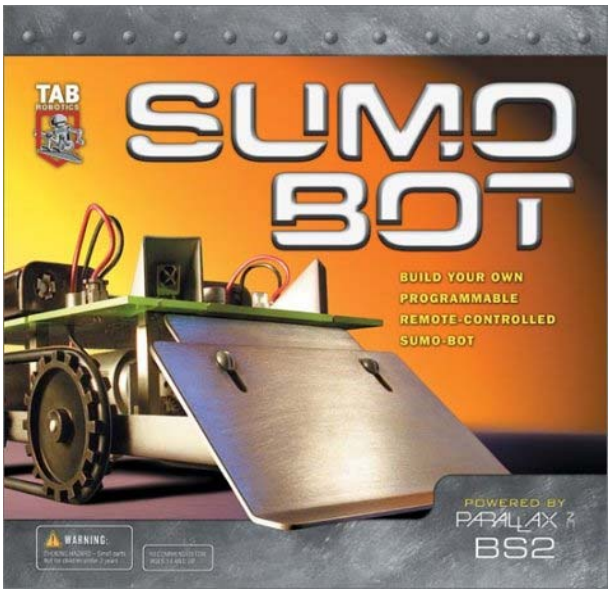


Figure 13. The TAB Electronics *SUMO BOT* Kit [37].

The ISL research group was invited by Parallax, Inc. to visit their headquarters in Rocklin, CA (details of the visit given in next section). As a result of this visit, the PIs are considering the use of some of the Parallax robots and robotics curriculum materials to replace the TAB robots – particularly since the TAB robots do not have an accompanying curriculum. The robots in consideration are:

- Parallax *Boe-Bot Full Kit* (#28132; see Figure 14) [28]; and
- Parallax *SumoBot* (#27400; see Figure 15) [29].

In particular, the Boe-Bot Full Kit includes two textbooks published by Parallax [12,13] that could be used to supplement the CSCI 224 curriculum. Perhaps the biggest concern is that the educational price for the Parallax *Boe-Bot* is almost twice the price of a TAB *BYORK*, and the PIs desire a platform that is affordable for the students. Discussions with Parallax regarding additional educational discounts and/or bulk pricing are ongoing as of this writing.

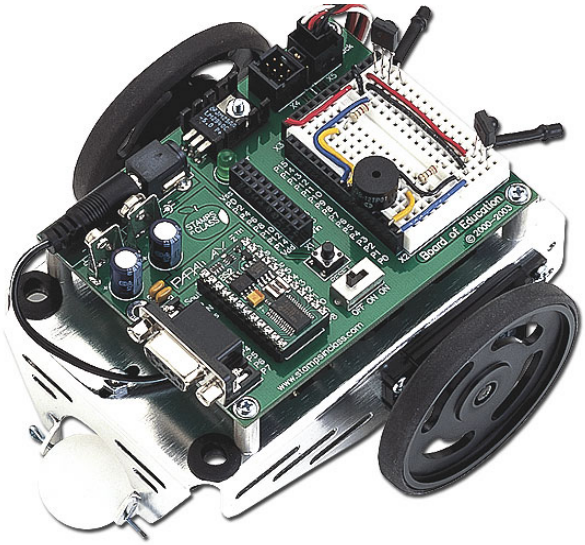


Figure 14. The Parallax *Boe-Bot* Full Kit [28].

The current status and content of the CSCI 224 curriculum is available online [15].

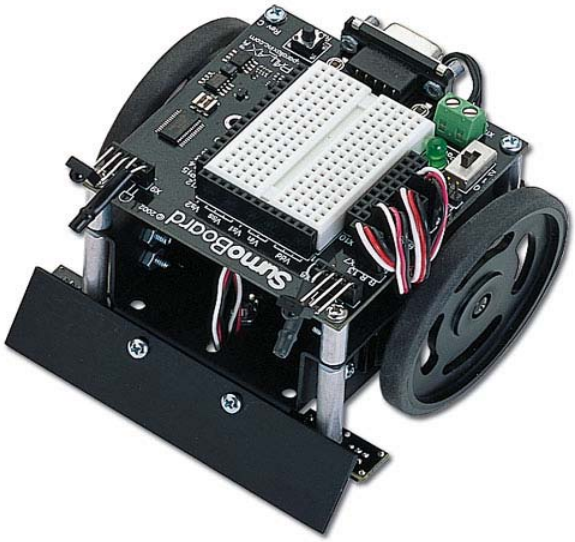


Figure 15. The Parallax *SumoBot* Kit [29].

Additionally, invited lectures/presentations have been given related to the ISL. Last October 15, 2003, Dr. Juliano delivered a presentation for the Upsilon Pi Epsilon Computer Science Lecture Series [4]. The talk focused on the development of the ISL, where the lab will be housed, and expectations in the coming years. Felipe Jauregui, ISL graduate student research assistant, also delivered ISL-related invited lectures to on-going classes in Programming Languages [10] and Introduction to Artificial Intelligence [11]. The ISL research group anticipates future involvement in giving invited lectures, and possibly mini-tutorials on robotics, as the ISL becomes more visible to the university and surrounding community.

6 OUTREACH AND DISSEMINATION OF RESULTS

Under the direction of Dr. Renner, co-PI of this project, Felipe Jauregui, ISL graduate student research assistant is working on various details of the Summer Robotics Camp that is scheduled to be offered in Summer 2004. In particular, Felipe Jauregui and Elena Kroumova worked with the CSUC Mathematics Engineering Science Achievement (MESA) office to put together a tentative plan, and to get ideas and assistance in sponsoring a summer camp for junior high school girls. Felipe and Elena worked with the following people:

- Paul Villegas, MESA Engineering Program (MEP) and MESA Schools Program (MSP) Director;
- Teresita Curiel, MSP Program Director;
- Stephen Thomas, MSP Academic Coordinator; and
- Lupe Jimenez, CSUC MEP & MSP Associate Director

Tentative ideas and logistics plans were discussed with Drs. Juliano and Renner. The CSUC MESA office has agreed to provide the ISL some support for the Summer Camp by providing suggestions in camp management and logistics, funding for some snacks for the kids during the camp, contact information for potential target junior high schools, and other invaluable information.

As mentioned in the previous section, the ISL research group was invited by Parallax, Inc. to visit their headquarters in Rocklin, CA. The ISL research group met with

- Erik Wood, Marketing;
- John Barrowman, Engineering; and
- Kris Magri, Curriculum

The ISL research group spent more than three hours with the group on what would normally be a two-day session. The Parallax robots currently in consideration by the PIs, for use in teaching CSCI 224 in Spring 2003, is discussed in the previous section. The PIs are negotiating with Parallax to bring the educational discount price of the Boe-Bot Full Kit as close to $150 as possible. Additional potential collaborations with Parallax are still being discussed as of the writing of this report. One of these include the development of a *Robotics and Machine Intelligence* textbook based on a Parallax robotics platform.

The ISL PIs were also invited to visit Sun Microsystems in Santa Clara last December 12, 2003. This trip was the idea of Dr. Ken Derucher, Dean, College of ECT, and Grace Caulfield, Global Education and Research. Ms. Caulfield wanted to discuss ways in which Sun Microsystems could get involved with the ISL and ISL-related computing activities. The people who flew to Sun are:

- Rick Bosetti, Team Solutions (Sun distributor)
- Benjoe Juliano, Computer Science
- Renee Renner, Computer Science
- Jerry Ringel, CSUC Library Systems, Student Computing, and User Support Services
- Melody Stapleton, Computer Science

Jerry Ringel was there to represent Bill Post, CSUC Information Resources, in order to determine any possibilties for working with Sun on either campus computing infrastructure or a campus portal project. Drs. Juliano and Renner were particularly interested in potential reconfiguration of the College of ECT Sun Ray [33] ultra-thin clients and Sun servers to use Sun N1 technology [34] to bring together Solaris-, Linux-, and Windows-based application servers hosting thin clients. Such a setup provides students and faculty access to a variety of instructional and research tools available from multiple platforms using a single thin client. Additionally, Drs. Juliano and Renner are also interested in Sun Grid technology [35] for testing/running complex algorithms in intelligent systems, and use in data visualization and intelligent vision [2,3].

Unfortunately, due to the hectic first semester of this project, the ISL research group was not able to schedule any visits to neighboring robotics labs. The successful trips to Parallax and to Sun Microsystems has definitely provided the group with sufficient incentive to pursue plans to visit robotics research labs beginning this Spring 2004 semester.

As of the writing of this report, Dr. Juliano is involved in organizing a special session on Soft Computing Applications in Mobile Robotics [20] for the *International Conference on Computational Science and its Applications*, ICCSA 2004, scheduled for May 14 - May 17, 2004 in S. Maria degli Angeli, Assisi (PG), Italy. The special session focuses on soft computing-related empirical and theoretical studies aimed at solving challenges in mobile robotics, including (but not limited to) the areas of (1) data-acquisition and information-processing mechanisms underlying cognitive abilities like perception, recognition, information storage and information retrieval; (2) learning and acquisition of approximate models of the surrounding environment; (3) cooperative (or collaborative) problem solving; (4) cooperative (or collaborative) target sensing and identification; and/or (5) on-the-fly behavior modification. The PI hopes to establish collaboration with participants of the session and the conference. (A copy of the CFP is provided in the Appendix.)

7 REFERENCES

ISL-Related Research Proposals, Presentations, and Progress Reports

[1] J. Arthur, M. Spiess, and R. Varahamurti, "Autonomous farming using intelligent ground vehicles (precision farming)," CSU Agricultural Research Initiative (ARI) proposal, 2003.

[2] J. Challinger, "Exploring our new robotics lab for research proposal development and classroom use," CSUC Office of Sponsored Programs faculty development grant proposal, 2003.

[3] J. Challinger, "Establishment of a research program on cooperating autonomous mobile robots," CSUC Office of Sponsored Programs research proposal, 2003.

[4] B.A. Juliano, "The Intelligent Systems Laboratory: Connecting the departments of the College of ECT," Upsilon Pi Epsilon Computer Science Lecture Series, October 15, 2003 http://isl.ecst.csuchico.edu/info/slides.swf

[5] B.A. Juliano, "Acquiring additional equipment for the Intelligent Systems Laboratory (ISL)," CSUC Office of Sponsored Programs faculty development grant proposal, 2003.

[6] B.A. Juliano, P. Ratliff, R.S. Renner, and C. Steinback, "Recruitment and retention of under-represented students in the College of ECT," concept paper and proposal, October 1999 http://www.ecst.csuchico.edu/~juliano/Papers/PDF/r&r%20paper.pdf

[7] B.A. Juliano, R.S. Renner, and M. Callan, "Seeking potential grants and collaborative research in the Washington, D.C. area," progress report, March 2001 http://www.ecst.csuchico.edu/~juliano/Papers/PDF/2001dcTripProgressReport.pdf

[8] S. Liese, A. Whaples, J. Stimatze, "ROAMFREE: Research into optimized algorithms for multi-agent fuzzy robotic environment explorations," ISL research pre-proposal, October 2003.

[9] J. Wills, "Grant funds study of robots to attract new students," *Inside Chico State*, Volume 34, Number 4, October 30, 2003 http://www.csuchico.edu/pub/inside/archive/03_10_30/01_robots.html

ISL-Related Research Papers and Technical Documents

[10] F. Jauregui, "Programming in robotics using NQC," CSCI 150 (Programming Languages) invited lecture, December 2003.

[11] F. Jauregui, "Introduction to Robotics: Using the LEGO Mindstorms Robotics Invention System and NQC," CSCI 223 (Introduction to Artificial Intelligence) invited lecture, December 2003.

Other Referenced Documents

[12] Parallax, Inc., *Robotics! Text, version 1.5*, http://www.parallax.com/detail.asp?product_id=28125.

[13] Parallax, Inc., *What's a Microcontroller? Text, version 2.1*, http://www.parallax.com/detail.asp?product_id=28125.

Miscellaneous URLs

[14] BasicX-24 microcontroller website http://basicx.com

[15] CSCI 224: *Robotics and Machine Intelligence* website http://www.ecst.csuchico.edu/~juliano/csci224/

[16] Embodied Intelligence course website http://www.ai.mit.edu/courses/6.836/

[17] The Institute for Research on Intelligent Systems (IRIS) website http://iris.ecst.csuchico.edu

[18] Intelligent Ground Vehicle Competition (IGVC) website http://igvc.org

[19] The Intelligent Systems Lab (ISL) website http://isl.ecst.csuchico.edu

[20] International Conference on Computational Science Applications, ICCSA 2004, Special invited session on "Soft computing applications in mobile robotics" http://www.ecst.csuchico.edu/~juliano/ICCSA

[21] K-Team website http://k-team.com

[22] LDraw.org LEGO-style 3D modeling website http://www.ldraw.org

[23] The LEGO Mindstorms website http://mindstorms.lego.com/eng/

[24] LEGO Users Group Network (LUGNET) website http://www.lugnet.com

[25] Living Machines website http://robotalive.com

[26] Lynxmotion website http://lynxmotion.com

[27] Mondotronics website http://robotstore.com

[28] Parallax Boe-Bot Full Kit – EDU Discount http://www.parallax.com/detail.asp?product_id=EDU-28132

[29] Parallax SumoBot http://www.parallax.com/detail.asp?product_id=27400

[30] Peeron.com LEGO parts online database http://peeron.com

[31] Rug Warrior Pro Robotics Kit http://www.hobbytron.net/warrior.html

[32] Sony AIBO website http://www.us.aibo.com

[33] Sun Ray Ultra-Thin Clients http://www.sun.com/sunray/

[34] Sun Software Solutions – N1 next generation IT architecture http://www.sun.com/software/solutions/n1/

[35] Sun Grid Computing Solutions http://www.sun.com/grid/

[36] TAB Electronics Build Your Own Robot Kit http://www.tabrobotkit.com or http://books.mcgraw-hill.com/cgi-bin/pbg/0071387870

[37] TAB Electronics SUMO BOT Kit http://www.tabrobotkit.com or http://books.mcgraw-hill.com/cgi-bin/pbg/0071411933

Acquisition of robotics equipment for an Intelligent Systems Laboratory

Summarized Timeline

Y E A R 1

RESEARCH ACTIVITIES	*EDUCATION ACTIVITIES*
•Visit U.C. Berkeley's Robotics and Intelligent Machines Lab (http://robotics.eecs.berkeley.edu/), Stanford's Robotics Lab (http://robotics.stanford.edu/), and USC's Institute for Robotics and Intelligent Systems (http://iris.usc.edu/iris.html) •Submit paperwork regarding the formation of an *Institute for Research on Intelligent Systems* (IRIS) to CSUC Academic Senate. •Attend domestic/international conferences/workshops.	•*Summer 2004:* Procurement, setup, and familiarization with robotics equipment. •*Fall 2004:* Develop curriculum for CSCI 224, *Robotics and Machine Intelligence*; recruit people and setup curriculum for *Summer Robotics Camp*; finalize agreements with local junior high schools to determine the process of student selection for the *Summer Robotics Camp*. •*Spring 2005:* Administer CSCI 224, *Robotics and Machine Intelligence*; attend area robotics society events and begin recruiting students for future robotics competitions; set up guest lectures by robotics researchers from visited robotics labs.

Y E A R 2

RESEARCH ACTIVITIES	*EDUCATION ACTIVITIES*
•Visit Planetary Robotics Lab (PRL) at NASA's Jet Propulsion Lab (JPL), Cal Tech •Organize student participation in robotics competitions in the area •Investigative studies in building teams of cooperating, intelligent agents (simulated agents and mobile robots) •Attend/present at domestic/international conferences and/or workshops.	•*Summer 2005:* Administer *Summer Robotics Camp*; prepare any revisions to CSCI 224 based on experience administering the course last Fall. •*Fall 2005:* Advise/Engage students in robotics projects through CSCI 190 (*Directed Individual Programming*), ME/MECA 289 (*Directed Engineering Experience*), ECE 290/291 (*Senior Project*), or CE/CSCI/ECE/ME/ MECA 299H (*Honors Project*) – ongoing until completion of project. •*Spring 2006:* Administer CSCI 397, *Seminar in Advanced Topics*, cross-listed with ME 397, *Advanced Topics in Mechanical Engineering*, and CSCI 397, *Seminar in Advanced Topics.*

Y E A R 3

RESEARCH ACTIVITIES	*EDUCATION ACTIVITIES*
•Continue studies in building teams of cooperating, intelligent agents (simulated agents and mobile robots) •Prepare and finalize grant/project report. •Present at domestic/international conferences and/or workshops.	•*Summer 2006:* Administer *Summer Robotics Camp*. •*Fall 2006:* Administer CSCI 224; organize student participation in area robotics society events/competitions. •*Spring 2007:* Administer CSCI 298, *Advanced Topics in Computer Science*, cross-listed with MECA 298, *Advanced Topics in Mechatronics*.

Acquisition of robotics equipment for an Intelligent Systems Laboratory

Timeline of Research and Education Activities

YEAR #1: August 2003 – July 2004	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Notes
Education Activities															
BASIC/INTERMEDIATE robotics equipment															30 LEGO MINDSTORMS Robotics Invention System Kit
Procurement			■	■											18 OWI Robotics WAO-G Programmable "Fuzzy" Robot Kit
Setup and familiarization				■	■	■	■	■	■	■	■	■	■	■	20 BoE-Bot Board of Education Robot Kit
															12 AK Peter's Rug Warrior Pro Robot Kit
CSCI 224 (Robotics and Machine Intelligence)															
Curriculum development					■	■	■						■	■	
Administration								■	■	■	■	■			
Evaluation												■	■		
Summer Robotics Camp															
Process of student selection (with MESA?)					■	■									
Finalize plans/logistics						■	■	■							
Finalize agreements with local junior high schools									■	■	■	■			
Administration													■	■	Involve NeWT, UPE, IEEE, MESA?
Research Activities															
Visits to university robotics labs in the area															
U.C. Berkeley's Robotics and Intelligent Machines Lab				■	■										
Stanford's Robotics Lab					■	■									
USC's Institute for Robotics and Intelligent Systems											■	■			
IRIS – Instiute for Research on Intelligent Systems															
Begin paperwork for formation of IRIS							■	■	■						
Submit paperwork to Academic Senate										■	■				
Develop electronic library of relevant papers			■	■	■	■	■	■	■	■	■	■	■	■	
Eventually integrated into ISL website															
Robotics competitions								■	■	■	■	■	■	■	
Determine venues and deadlines															
Attend robotics conferences and/or workshops								■	■	■	■	■	■	■	
Ongoing beyond completion of project															

Acquisition of robotics equipment for an Intelligent Systems Laboratory

Timeline of Research and Education Activities

YEAR #2: August 2004 – July 2005	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Notes
Education Activities															
ADVANCED robotics equipment															8 iRobot Magellan Pro
Procurement															3 iRobot ATRV-Mini
Setup and familiarization															
Robotics projects with students															CSCI 190
Ongoing beyond completion of project															ME/MECA 289
															ECE 290/291
CSCI 397 / ME 397 (Advanced Topics)															CE/CSCI/ECE/ME/MECA 299H
Curriculum development															
Administration															
Evaluation															
Summer Robotics Camp															
Administration															Involve NeWT, UPE, IEEE, MESA?
Evaluation															
Research Activities															
Visits to university robotics labs in the area															
Planetary Robotics Lab at NASA's JPL, Cal Tech															
CMU Robotics Institute															
Robotics competitions															Robotics Society of America – Exploratorium, SF
Determine venues and deadlines															
Recruit students															
Planning and coordination															
Attendance and participation															
Develop electronic library of relevant papers															
Eventually integrated into ISL website															
Research cooperating intelligent agents															
Simulated agents and mobile robots															
Attend/Participate in robotics conferences and/or workshops															
Ongoing beyond completion of project															

APPENDIX: Modified Timeline

Acquisition of robotics equipment for an Intelligent Systems Laboratory

Timeline of Research and Education Activities

YEAR #2: August 2005 – July 2006	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Notes
Education Activities															
Robotics projects with students															CSCI 190
Ongoing beyond completion of project			■	■	■	■	■	■	■	■	■	■	■	■	ME/MECA 289
															ECE 290/291
CSCI 224 (Robotics and Machine Intelligence)															CE/CSCI/ECE/ME/MECA 299H
Curriculum development	■	■						■	■						
Administration			■	■	■	■	■								
Evaluation							■	■							
CSCI 298 / MECA 298 (Advanced Topics)															CE/CSCI/ECE/ME/MECA 299H
Curriculum development					■	■	■						■	■	
Administration								■	■	■	■	■			
Evaluation												■	■		
Summer Robotics Camp															
Administration	■	■													Involve NeWT, UPE, IEEE, MESA?
Evaluation		■	■	■	■	■									
Research Activities															
Robotics competitions															
Determine venues and deadlines	■	■	■												
Recruit students			■	■	■										
Planning and coordination				■	■	■	■								
Attendance and participation								■	■	■	■	■	■	■	
Develop electronic library of relevant papers	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Eventually integrated into ISL website															
Research cooperating intelligent agents	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Simulated agents and mobile robots															
Attend/Participate in robotics conferences and/or workshops	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Ongoing beyond completion of project															
Work on grant/project final report	■	■	■	■	■	■	■	■	■	■	■	■	■	■	

APPENDIX: Modified Timeline

Robotics Invention System Kit (#K9916)

	PartNum	Color	Description	#3804	#9738	#4176779	#9916	#10049	#10072	#10074	#10076	TOTAL
Axles, Joiners, Pins (BAG 1) 273	x33	Black	Technic 1 x 3 with 2 Axle Holes and Pin						2			**2**
	32062	Black	Technic Axle 2 Notched	10						4		**14**
	4519	Black	Technic Axle 3	3								**3**
	4519	Gray	Technic Axle 3							4		**4**
	6587	DkGray	Technic Axle 3 with Stud	2						2		**4**
	3705	Black	Technic Axle 4	7						4		**11**
	32073	Black	Technic Axle 5	2								**2**
	32073	Gray	Technic Axle 5							4		**4**
	552	Black	Technic Axle 5.5 With Stop							2		**2**
	3706	Black	Technic Axle 6	8						4		**12**
	300	Gray	Technic Axle 7							4		**4**
	3707	Black	Technic Axle 8	7						2		**9**
	3737	Black	Technic Axle 10	4						2		**6**
	3708	Black	Technic Axle 12	2						2		**4**
	6538b	Black	Technic Axle Joiner Offset							2		**2**
	6538b	Gray	Technic Axle Joiner Offset	4								**4**
	6536	Black	Technic Axle Joiner Perpendicular							2		**2**
	6536	Gray	Technic Axle Joiner Perpendicular	6								**6**
	32068	Gray	Technic Axle Joiner Perpendicular 3 Long	2								**2**
	32184	Black	Technic Axle Joiner Perpendicular 3L						2			**2**
	32291	Black	Technic Axle Joiner Perpendicular Double							2		**2**
	41678	Black	Technic Axle Joiner Perpendicular Double Split							2		**2**
	3749	Gray	Technic Axle Pin	16								**16**
	3713	Gray	Technic Bush	40								**40**
	4265c	Gray	Technic Bush 1/2 Smooth	18								**18**
	3673	Gray	Technic Pin	24								**24**
	4274	Gray	Technic Pin 1/2	8								**8**
	32002	DkGray	Technic Pin 3/4	16								**16**
	32136	Yellow	Technic Pin 3L Double	2								**2**
	32557	Black	Technic Pin Joiner Dual Perpendicular							2		**2**
	75535	Black	Technic Pin Joiner Round						2			**2**
	6558	Black	Technic Pin Long with Friction	8								**8**
	32054	Blue	Technic Pin Long with Stop Bush	4								**4**
	4459	Black	Technic Pin with Friction	24								**24**
	6553	Black	Technic Pole Reverser Handle							2		**2**
	6553	Gray	Technic Pole Reverser Handle	2								**2**
	9244	Gray	Technic Universal Joint							2		**2**
BAG 1 TOTAL				**219**	**0**	**0**	**0**	**0**	**6**	**48**	**0**	**273**

	PartNum	Color	Description	#3804	#9738	#4176779	#9916	#10049	#10072	#10074	#10076	TOTAL

APPENDIX: LEGO Mindstorms Inventory Sheet

Robot Kit: ISL LM-_____

Beams (Liftarms)	6575	Black	Technic Cam						2			**2**
(BAG 2)	6575	Gray	Technic Cam	2								**2**
84	x68	Black	Technic Liftarm 1 x 2						2			**2**
	43857	Black	Technic Liftarm 1 x 2 Straight						2			**2**
	6632	Black	Technic Liftarm 1 x 3						2			**2**
	6632	Gray	Technic Liftarm 1 x 3	4								**4**
	32523	Black	Technic Liftarm 1 x 3 Straight						2			**2**
	2825	Black	Technic Liftarm 1 x 4						2			**2**
	2825	Gray	Technic Liftarm 1 x 4	2								**2**
	x200	Black	Technic Liftarm 1 x 4 Thin						2			**2**
	32017	Black	Technic Liftarm 1 x 5						2			**2**
	32017	Gray	Technic Liftarm 1 x 5	4								**4**
	32316	Black	Technic Liftarm 1 x 5 Straight						2			**2**
	41666	Gray	Technic Liftarm 1 x 5 with Double Bevel Gear and with 1 12 Tooth Bevel								2	**2**
	32063	Black	Technic Liftarm 1 x 6						2			**2**
	32065	Black	Technic Liftarm 1 x 7	4					2			**6**
	32348	Black	Technic Liftarm 1 x 7 Bent						2			**2**
	x150	Black	Technic Liftarm 1 x 7 Straight						2			**2**
	152	Black	Technic Liftarm 1 x 9 Bent						2			**2**
	6629	Black	Technic Liftarm 1 x 9 Bent	4					2			**6**
	120	Black	Technic Liftarm 1 x 9 Straight						2			**2**
	32525	Black	Technic Liftarm 1 x 11 Straight						2			**2**
	32009	Black	Technic Liftarm 1 x 11.5 Double Bent						2			**2**
	32009	Yellow	Technic Liftarm 1 x 11.5 Double Bent	4								**4**
	32278	Black	Technic Liftarm 1 x 15 Straight						2			**2**
	32140	Black	Technic Liftarm 2 x 4 L Shape	2					2			**4**
	41667	Gray	Technic Liftarm 2 x 5 x 3 with Double Bevel Gear, 75' Gearing Axlehole,								2	**2**
	32056	Black	Technic Liftarm 3 x 3 L Shape						2			**2**
	32056	Gray	Technic Liftarm 3 x 3 L Shape	4								**4**
	32249	Black	Technic Liftarm 3 x 3 L Shape with Quarter Circle						2			**2**
	32526	Black	Technic Liftarm 3 x 5 L Shape						2			**2**
	32250	Black	Technic Liftarm 3 x 5 L Shape with Quarter Oval						2			**2**
	2905	Black	Technic Triangle						2			**2**
BAG 2 TOTAL				**30**	**0**	**0**	**0**	**0**	**50**	**0**	**4**	**84**

	PartNum	Color	Description	#3804	#9738	#4176779	#9916	#10049	#10072	#10074	#10076	TOTAL
Bricks, Large	3701	Black	Technic Brick 1 x 4 with Holes	10								**10**
(BAG 3)	3701	Green	Technic Brick 1 x 4 with Holes	2								**2**
48	3894	Black	Technic Brick 1 x 6 with Holes	8								**8**
	3702	Black	Technic Brick 1 x 8 with Holes	8								**8**
	2730	Black	Technic Brick 1 x 10 with Holes	8								**8**
	3895	Black	Technic Brick 1 x 12 with Holes	6								**6**
	3703	Black	Technic Brick 1 x 16 with Holes	6								**6**
BAG 3 TOTAL				**48**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**48**

APPENDIX: LEGO Mindstorms Inventory Sheet

Robot Kit: ISL LM-_____

	PartNum	Color	Description	#3804	#9738	#4176779	#9916	#10049	#10072	#10074	#10076	TOTAL
Bricks, Small	3004	Black	Brick 1 x 2	20								**20**
(BAG 4)	3004	Yellow	Brick 1 x 2	4								**4**
113	3003	Black	Brick 2 x 2	20								**20**
	3941	Black	Brick 2 x 2 Round	8								**8**
	3001	Black	Brick 2 x 4	5								**5**
	6249	DkGray	Brick 2 x 4 with Pins					4				**4**
	4589	White	Cone 1 x 1	2								**2**
	4589	Yellow	Cone 1 x 1	2								**2**
	3747	Black	Slope Brick 33 3 x 2 Inverted	4								**4**
	3040	Black	Slope Brick 45 2 x 1	12								**12**
	3040	Yellow	Slope Brick 45 2 x 1	4								**4**
	3665	Black	Slope Brick 45 2 x 1 Inverted	4								**4**
	3665	Yellow	Slope Brick 45 2 x 1 Inverted	4								**4**
	32064	Green	Technic Brick 1 x 2 with Axlehole	4								**4**
	3700	Black	Technic Brick 1 x 2 with Hole	12								**12**
	3700	Yellow	Technic Brick 1 x 2 with Hole	4								**4**
BAG 4 TOTAL				**109**	**0**	**0**	**0**	**4**	**0**	**0**	**0**	**113**

	PartNum	Color	Description	#3804	#9738	#4176779	#9916	#10049	#10072	#10074	#10076	TOTAL
Connectors	32013	Black	Technic Angle Connector #1							2		**2**
(BAG 5)	32013	Blue	Technic Angle Connector #1	4								**4**
32	32034	Black	Technic Angle Connector #2							2		**2**
	32034	Blue	Technic Angle Connector #2	2								**2**
	32016	Black	Technic Angle Connector #3							2		**2**
	924	Black	Technic Angle Connector #4							2		**2**
	32015	Black	Technic Angle Connector #5							2		**2**
	32015	Gray	Technic Angle Connector #5	4								**4**
	32014	Black	Technic Angle Connector #6							2		**2**
	32137	TrBlue	Technic Connector Block 3 x 2 x 2	4								**4**
	44	Gray	Technic Connector Toggle Joint Smooth							2		**2**
	32039	Black	Technic Connector with Axlehole							2		**2**
	32039	Gray	Technic Connector with Axlehole	2								**2**
BAG 5 TOTAL				**16**	**0**	**0**	**0**	**0**	**0**	**16**	**0**	**32**

	PartNum	Color	Description	#3804	#9738	#4176779	#9916	#10049	#10072	#10074	#10076	TOTAL
Gears	2983	Gray	Electric Technic Micromotor Pulley	2								**2**
(BAG 6)	6573	DkGray	Technic Differential New	1							1	**2**
73	2854	Gray	Technic Engine Crankshaft Centre	2								**2**
	3647	Gray	Technic Gear 8 Tooth	6							3	**9**
	6589	Gray	Technic Gear 12 Tooth Bevel	5							5	**10**
	32270	Gray	Technic Gear 12 Tooth Double Bevel								2	**2**
	4019	Gray	Technic Gear 16 Tooth	4							2	**6**
	6542	DkGray	Technic Gear 16 Tooth with Clutch								2	**2**
	32198	Gray	Technic Gear 20 Tooth Bevel								2	**2**

APPENDIX: LEGO Mindstorms Inventory Sheet

Robot Kit: ISL LM-_____

	32269	Gray	Technic Gear 20 Tooth Double Bevel								2	**2**
	3648	Gray	Technic Gear 24 Tooth	4							2	**6**
	60c01	White	Technic Gear 24 Tooth Clutch	1								**1**
	3650	Gray	Technic Gear 24 Tooth Crown Type III (x pattern)	4							2	**6**
	x403	Gray	Technic Gear 36 Tooth Double Bevel								2	**2**
	3649	Gray	Technic Gear 40 Tooth	4							2	**6**
	3743	Gray	Technic Gear Rack 1 x 4	4								**4**
	3736	Gray	Technic Pulley Large	2							2	**4**
	2856	Black	Technic Turntable Base, connected to 2855								1	**1**
	2855	Clear	Technic Turntable Top, connected to 2856									
	4716	Black	Technic Worm Screw	2							2	**4**
BAG 6 TOTAL				**41**	**0**	**0**	**0**	**0**	**0**	**0**	**32**	**73**

	PartNum	Color	Description	#3804	#9738	#4176779	#9916	#10049	#10072	#10074	#10076	TOTAL
Motors, Sensors + Cables	5306b	Black	Electric Brick 2 x 2 x 2/3 Pair with Wire, 13 cm	4								**4**
(BAG 7)	5306b	Black	Electric Brick 2 x 2 x 2/3 Pair with Wire, 120 cm	2								**2**
12	2982c01	Blue	Electric Light Sensor	1								**1**
	71427c01	Gray	Electric Technic Mini-Motor 9v	2		1						**3**
	879	Gray	Electric Touch Sensor Brick 3 x 2	2								**2**
BAG 7 TOTAL				**11**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**12**

	PartNum	Color	Description	#3804	#9738	#4176779	#9916	#10049	#10072	#10074	#10076	TOTAL
Plates, Large	3710	Gray	Plate 1 x 4	10								**10**
(BAG 8)	3666	Gray	Plate 1 x 6	10								**10**
71	3460	Gray	Plate 1 x 8	8								**8**
	4477	Gray	Plate 1 x 10	6								**6**
	3020	Yellow	Plate 2 x 4	6								**6**
	30157	DkGray	Plate 2 x 4 with Pins					2				**2**
	3034	Green	Plate 2 x 8	4								**4**
	3832	Gray	Plate 2 x 10	6								**6**
	2419	Green	Plate 3 x 6 without Corners	2								**2**
	3033	Gray	Plate 6 x 10	1								**1**
	3709b	Gray	Technic Plate 2 x 4 with Holes	4								**4**
	32001	Gray	Technic Plate 2 x 6 with Holes	4								**4**
	3738	Gray	Technic Plate 2 x 8 with Holes	8								**8**
BAG 8 TOTAL				**69**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**71**
Plates, Small	2654	Black	Boat 2 x 2 Stud	2								**2**
(BAG 9)	3956	Gray	Bracket 2 x 2 - 2 x 2	2								**2**
88	4275	Black	Hinge Plate 1 x 2 with 3 Fingers	2								**2**
	4531	Black	Hinge Tile 1 x 2 with 2 Fingers	2								**2**
	3024	Gray	Plate 1 x 1	8								**8**
	4073	Black	Plate 1 x 1 round	2								**2**
	4073	Blue	Plate 1 x 1 round	2								**2**

APPENDIX: LEGO Mindstorms Inventory Sheet

Robot Kit: ISL LM-_____

	4073	White	Plate 1 x 1 round	2								2
	6019	Black	Plate 1 x 1 with Clip Horizontal	2								2
	4085c	Black	Plate 1 x 1 with Clip Vertical - Type 3	2								2
	3023	Gray	Plate 1 x 2	20								20
	32028	Gray	Plate 1 x 2 with Door Rail	8								8
	3623	Yellow	Plate 1 x 3	2								2
	3022	Blue	Plate 2 x 2	4								4
	3022	Gray	Plate 2 x 2	8								8
	3022	Green	Plate 2 x 2	2								2
	2420	Gray	Plate 2 x 2 corner	8								8
	4032	Blue	Plate 2 x 2 Round	2								2
	4032	White	Plate 2 x 2 Round	2								2
	2817	Gray	Plate 2 x 2 with Holes	4								4
	3680c01	Blue	Turntable 2 x 2 Plate	2								2
BAG 9 TOTAL				88	0	0	0	0	0	0	0	88
	PartNum	Color	Description	#3804	#9738	#4176779	#9916	#10049	#10072	#10074	#10076	TOTAL
Rubber Bands, Hoses, etc.	x400	Clear	Electric Technic Fiber Optics Cable Wide, 25L	1								1
(BAG 10)	x88	Black	Rubber Band Square	4								4
28	x90	Yellow	Rubber Belt Extra Large	3								3
	x89	Blue	Rubber Belt Large	3								3
	x71	White	Rubber Belt Small	3								3
	75	Yellow	Technic Flex System Hose	2								2
	78	Black	Technic Ribbed Hose, 9 L	4								4
	78	Teal	Technic Ribbed Hose, 9 L	4								4
	78	Purple	Technic Ribbed Hose, 12 L	4								4
BAG 10 TOTAL				28	0	0	0	0	0	0	0	28
	PartNum	Color	Description	#3804	#9738	#4176779	#9916	#10049	#10072	#10074	#10076	TOTAL
Wheels	32072	DkGray	Technic Knob Wheel								2	2
(BAG 11)	32007	White	Technic Tread Sprocket Wheel	4								4
39	4185	Gray	Technic Wedge Belt Wheel	4							2	6
	x265	Gray	Wheel 11 x 8 with Center Groove					5				5
	30285	White	Wheel 30.4 x 14					8				8
	2994	White	Wheel 30.4 x 14 VR	2								2
	6595	White	Wheel 49.6 x 28 VR	2								2
	2903	White	Wheel 81.6 x 15 Motorcycle	4								4
	3482	Yellow	Wheel Centre Large	6								6
BAG 11 TOTAL				22	0	0	0	13	0	0	4	39
	PartNum	Color	Description	#3804	#9738	#4176779	#9916	#10049	#10072	#10074	#10076	TOTAL
Tyres	680c01	Black	Technic Tread	2								2

APPENDIX: LEGO Mindstorms Inventory Sheet

Robot Kit: ISL LM-_____

(BAG 12)	70162	Black	Technic Wedge Belt Wheel Tyre	2							2
32	3634	Black	Tyre 17 x 43	2							2
	x266	Black	Tyre 17.5 x 6 with Shallow Straggered Treads					4			4
	x436	Black	Tyre 24 x 14 with Small Shallow Straggered Treads					4			4
	x142	Black	Tyre 30.4 x 14					4			4
	6578	Black	Tyre 30.4 x 14 VR Balloon Very Small	2							2
	6594	Black	Tyre 49.6 x 28 VR	2							2
	2902	Black	Tyre 81.6 x 15 Motorcycle	4							4
	2346	Black	Tyre Medium	4							4
	3483	Black	Tyre Small	2							2
BAG 12 TOTAL				20	0	0	0	12	0	0	0	32

	PartNum	Color	Description	#3804	#9738	#4176779	#9916	#10049	#10072	#10074	#10076	TOTAL
Miscellaneous	6133	TrOrange	Animal Dragon Wing	2								2
(BAG 13)	6007	DkGray	Brick Separator	1								1
33	4176779	Green	Capacitor				1					1
	3960	White	Space Radar Dish 4 x 4	2								2
	4221	Black	Grab Jaw, attached to 4220 and 6048	4								4
	4220	Yellow	Grab Jaw Holder, attached to 4221 and 6048	2								2
	6048	Black	Arm Piece with Pin and 2 Fingers, attached to 4220 and 4221	2								2
BAG 13 TOTAL				13	0	0	1	0	0	0	0	14

	PartNum	Color	Description	#3804	#9738	#4176779	#9916	#10049	#10072	#10074	#10076	TOTAL
Other	884	Yellow	Electric Mindstorms RCX, 2.0	1								1
	x124	Black	Electric Remote Control for RCX		1							1
	x431c01	DkGray	Electric Transmitter Tower IR USB with Black Front	1								1
			Contructopedia™	1								1
			CD-ROM Software	1								1
Other TOTAL				4	1	0	0	0	0	0	0	5

718	1	1	1	31	56	64	40		912

#K9916 LEGO Mindstorms Robotics Invention System Kit

- **#3804 LEGO Mindstorms Robotics Invention System 2.0**
- **#9738 LEGO Remote Control**
- **#4176779 LEGO 9-volt Motor**
- **#9916 LEGO Capacitor**
- **#10049 LEGO Large Wheels and Axles**
- **#10072 LEGO Technic Beams**
- **#10074 LEGO Technic Cross Axles**
- **#10076 LEGO Technic Gears Wheels**

APPENDIX: LEGO Mindstorms Inventory Sheet

Robot Kit: ISL LM-_____

APPENDIX: ISL Website

CALIFORNIA STATE UNIVERSITY, CHICO

College of Engineering, Computer Science, and Technology

INSTITUTE FOR RESEARCH ON INTELLIGENT SYSTEMS

Intelligent Systems Laboratory

O'Connell Technology Center, OCNL 431

APPENDIX: IRIS Website

CALIFORNIA STATE UNIVERSITY, CHICO

College of Engineering, Computer Science, and Technology

INSTITUTE FOR RESEARCH ON INTELLIGENT SYSTEMS

Questions or problems regarding this web site should be directed to the Webmaster.

DRAFT
12/19/2003

C H A R T E R

1. Entity's Name:

Institute for Research on Intelligent Systems (IRIS)

2. Description:

The *Institute for Research on Intelligent Systems*, or *IRIS*, oversees the College of Engineering, Computer Science, and Technology's *Intelligent Systems Lab* (or *ISL*). In particular, IRIS handles policies and management issues pertaining to the ISL. IRIS shall also serve as an advocate for curriculum, research, outreach, and projects related to the ISL.

MISSION / VISION

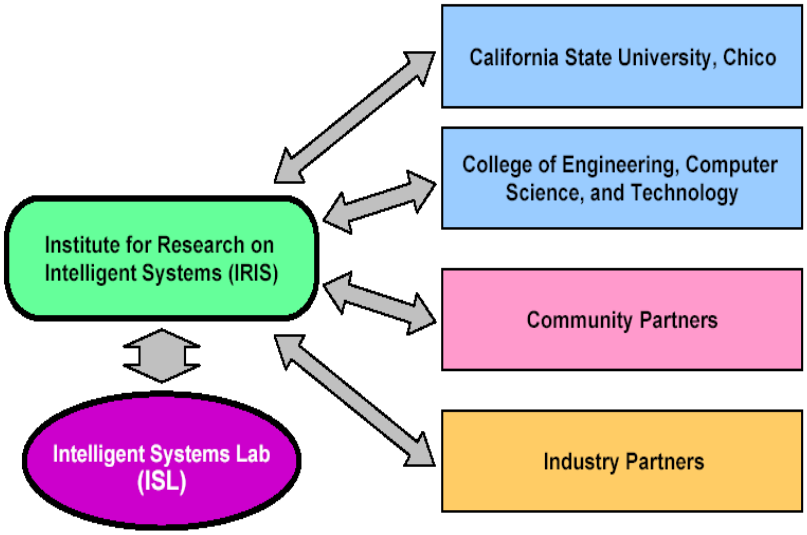
- *Mission:* Leading – within the CSU System – in the discovery, development, analysis, and integration of accesible intelligent systems research and technologies (*e.g.* autonomous robotics applications) for use in the community and the industry.

- *Vision:* To provide high-quality regional, national, and international research and instructional services in intelligent systems design, analysis, and implementation.

OBJECTIVES

- manage the use of the ISL and all equipment under the jurisdiction of the ISL (*i.e.* all instrumentation and equipment secured through ISL-related contracts and grants);
- foster collaborative work within the College of ECT;
- assist in forming partnerships for funded projects with regional industries, federal, state, and local agencies;
- serve as a liaison to constituents when opportunities arise to use the ISL as a resource for instruction or research;
- outreach and recruitment for the ISL and related curriculum/majors;
- oversight of camps, seminars, workshops, and curriculum decisions related to ISL and its mission;
- provide a venue for mentoring and guiding student projects for competitions;
- provide a venue for assisting in funding and travel opportunities for competitions and conferences;
- dissemination of ISL, IRIS, and curriculum-related news and activities.

ORGANIZATIONAL STRUCTURE



IRIS will have a Board of Directors that will consist of the three (3) PIs (see list of Contacts below), one (1) full-time faculty representative from a Department of the College of ECT, and one (1) full-time faculty representative from a Department outside of the College of ECT. The three (3) PIs are permanent lifetime members, replaced only if they resign their position or leave the College of ECT. The other two faculty members on the Board are positions nominated and voted annually by faculty of the College of ECT. Each of these two positions has a staggered two-year term, with the non-ECT position starting initially as a one-year term. The Board shall always consist of a majority of faculty from the College of ECT.

The Director of IRIS will be a member of the Board who is a full-time, tenured faculty from a Department of the College of ECT. The Director is nominated and elected by the Board for a five-year term. The first Director is one of the PIs and is decided by the three (3) PIs.

3. Contact(s):

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4. University Relationship:

IRIS will enhance the infrastructure for research within the College of ECT by facilitating collaboration with other institutes and centers within the College like (1) the Center for Manufacturing Excellence, (2) the IBM Corporation Networks Laboratory, and (3) the McLeod Institute of Simulation Sciences. Likewise, IRIS will facilitate collaboration with other institutes and centers within and around the CSUC campus.

IRIS will coordinate dissemination of results and progress with ISL-related projects and research through appropriate conference *Proceedings* and other peer-reviewed publications, as well as through the IRIS and ISL websites[1]. These websites will facilitate online access to electronic versions of these publications/reports and presentations, including a list of projects, contacts, details of the summer robotics camp (including a link to the summer camp's WebCT website), and other related information. An *IRIS Annual Report* will be submitted to the Dean of the College of ECT for distribution to university constituents, the community, and industry partners. Student involvement in robotics competitions and the summer camp will also be publicized with media coverage whenever possible.

1 The ISL website is at `http://isl.ecst.csuchico.edu/` and the IRIS website is at `http://iris.ecst.csuchico.edu`.

APPENDIX: ICCSA 2004 CFP

CALL FOR PAPERS
(See extended deadlines below)

SOFT COMPUTING APPLICATIONS IN MOBILE ROBOTICS

A Special Session of the

2004 International Conference on Computational Science and its Applications
(ICCSA 2004)

S. Maria degli Angeli
Assisi, Italy
May 14 - May 17, 2004

Session Chair:
Benjoe Juliano
Juliano@csuChico.edu

This session focuses on various applications of soft computing in the area of mobile robotics. Ongoing work combining fuzzy logic, neural networks, genetic algorithms, etc. to solve problems in cooperation, search and rescue, and others will be highlighted. Of particular interest will be applications to groups of coordinated, cooperating mobile robots subjected to unknown, dynamic environments.

If you or someone you know are engaged in soft computing-related empirical and theoretical studies aimed at solving challenges in mobile robotics, including (but not limited to) the areas of

- data-acquisition and information-processing mechanisms underlying cognitive abilities like perception, recognition, information storage and information retrieval
- learning and acquisition of approximate models of the surrounding environment
- cooperative (or collaborative) problem solving
- cooperative (or collaborative) target sensing and identification
- on-the-fly behavior modification

with possible applications (including, but not limited) to multi-agent

- decision analysis
- dynamic systems modeling & diagnosis
- intelligent control
- machine vision
- signal processing
- system identification
- search-and-rescue (or similar area-coverage applications)

you are encouraged to submit a paper title and a short (a few sentences) abstract by December 20, 2003 to express interest

APPENDIX: ICCSA 2004 CFP

in participating.

Send submissions/proposals/inquiries to

Dr. Benjoe Juliano
Juliano@csuChico.edu
Department of Computer Science
California State University - Chico
Chico, CA 95929-0410
U.S.A.

Please take note of the following important dates:

December 20, 2003 - Title and short abstract submission deadline.
January 15, 2004 - Full paper submission deadline.
February 10, 2004 - Notification of acceptance.
February 25, 2004 - Camera-ready papers and pre-registration due.
May 14-17, 2004 - ICCSA 2004 in S. Maria degli Angeli, Assisi, Italy.

Full papers must be submitted by January 15, 2004 in order to be considered for publication in the Lecture Notes in Computer Science series (LNCS), Springer-Verlag. Submitted papers must be formatted according to the rules of LNCS (see `http://www.springer.de/comp/lncs/authors.html`). Every paper will be refereed by at least two independent reviewers.

Text version

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