ROBOT BUILDER

The official publication of the ROBOTICS SOCIETY of SOUTHERN CALIFORNIA
10471 South Brookhurst, Anaheim, Ca 92804

SECOND ANNIVERSARY EDITION

UPCOMING EVENTS CALENDAR AUG 1991

AUG 8	RSSC Meeting at Orange Coast College: 7-9 PM Topic: SHAN and 2nd Anniversary of RSSC
AUG 10	RSSC Robot Project Workshop, at Orange Coast College
AUG 27	RSSC Board Meeting, At Jerry Burton's Lab.
Sep 12	RSSC Meeting at Orange Coast College: 7-9 PM Topic: RF Wireless Data Link
Sep 14	RSSC Robot Project Workshop,
Sep 24	RSSC Board meeting, at Jerry Burton's Lb.
Oct 10	RSSC Meeting: 7-9 PM Topic: Odetics Mechanical Hand
Nov 14	RSSC Meeting: 7-9 PM Topic: Network Architecture/Lan
Dec 12	RSSC Meeting: 7-9 PM Topic: 68HC11 Controller Demonstration

PRESIDENT'S MESSAGE

This meeting marks our second year of operation, my how time flies when your having fun. We will be having a mini-robot fair to celibrate, complete with demonstrations and refreshments.

We will be showing videos, and all members are encouraged to bring their robots and/or projects to share with the members and guests.

Please submit your responses to the questionaire that was in last months ROBOT BUILDER so we can plan for next years meeting formats and scope of Society activities. This is an opportunity for the membership to indicate the direction you wish the Society to take. The board will review your input and give a summary of what the membership wants for the 1992 meetings, in the Sep issue of the ROBOT BUILDER. It is important to submit your desires, as this is the only means we really have to gage the direction you wish to go.

Last month was our first month at ORANGE COAST COLLEGE and we had a good turn-out. Hopefully this move will allow RSSC to continue its growth and development. Tom Hersh indicates we may have some parking problems after the first of the year due to the start of the new semester. It has been suggested that we move our meetings to Saturdays. It was discussed at the last board meeting and we came up with the following tenative schedule, subject to membership approval.

Meetings on the 1st Saturday of each month with a Software/Systems Lab meeting from 10am-noon, the General Meeting from noon-2pm, and a Hardware (mechanical/electrical)
Lab meeting from 2-4 pm. This way each member could attend just the sessions they were interested in and you only have one meeting a month to attend.

Don Golding will be putting together a FORTH Training Workshop to teach FORTH to those interested. Tenatively it is scheduled for an all day Saturday session.

Jess Jackson is writing an outline for a course entitled "Introduction to Robotics", to be given on a Saturday (9am to 4pm) and be offered at least four times a year. This course would be useful for getting new members up to speed. If any of you having teaching experience or would like to contribute a lecture to this series, please contact me ASAP, Jerry Burton (714) 535-8161.

Hope to see you all at the August celebration. ORANGE COAST COLLEGE- AUG 8- 7PM.....JB

ACTION ITEMS

These are the current items that are needed for the completion or expansion of the club ROBOT development. There was discussion at the RSSC meetings and some have been assigned a task leader.

1. The "DOCKING STATION" has been assigned to Tim Lewis. This station will be used for charging and will have an automatic interconnect. Tim reports that there are four or five potential designs. Final decision of what functions the docking station will incorporate has to be determined. Tim solicits help in making the final design decisions before undertaking construction.

2. An "RF LAN" or computer to computer interconnection. This requirement was needed to assist in the debugging and monitoring of the operation of the mobile ROBOT's computer program. Roger R. has finished the wireless phone project and will demonstrate the link at the September meeting. He had it operational at the ACP swap meet and was driving his ARMATRON remotely.

3. SONAR BEAM FOCUSING. The present Polaroid tranducers have a rather wide (30 degrees) beam spread. To better locate an obstacle, the beam width needs to be focused and reduced to a narrow beam. There is a sonar tape measure that uses what looks like three sonar transducers to generate a very narrow sound beam. Please bring what information you may already have or what you can obtain about this acoustical technique.

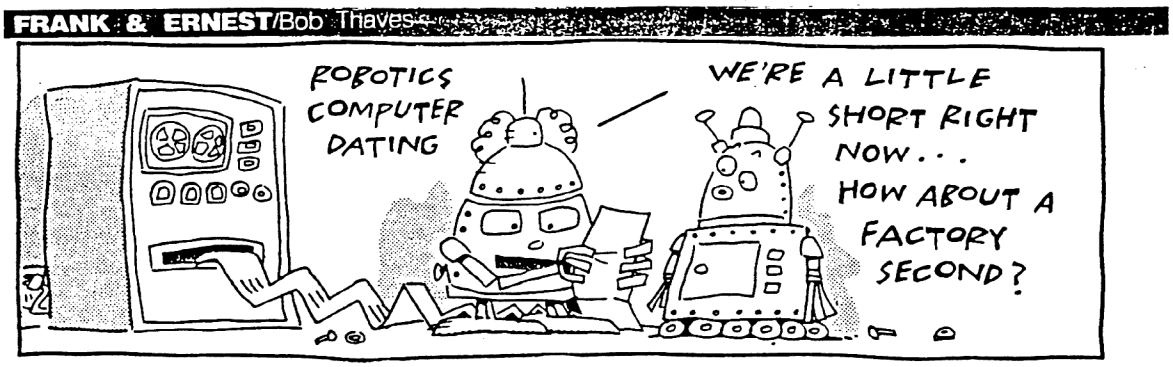
4. SONAR RETURN SIGNAL AMPLITUDE. Jerry B proposed this action item. He wants amplitude information from the sonor return to allow more exact determination of the pointing angle to the reflector or obstacle. A sonar board from Jerry B's Hero Jr. has been installed in the ROBOT, interfacing through a parallel port. This will allow the electrical group the generate an A/D design to read the amplitude of the sonar return signal into the onboard computer. No report yet as to their progress.

5. INTERFACE ARCHITECTURE. There was no consensus with in the membership as to the selection of a standard CPU or Single Board Computer. Further discussions about the selection of a club standard CPU for the various distributed functions on the ROBOT seemed to indicate that a selection of a common interface was the more appropriate requirement. This approach would allow each member to use his or her favorite CPU and if the interface is common, then all can communicate between the elements.

6. TI VOICE BOARD REPLACEMENT There are a number of members that own COVOX units and are evaluating the concept. The COVOX board is now installed and operational in the ROBOT after overcoming interrupt problems.

7. HEADING SENSOR. Heading sensor is still required as part of the design of our autonomous ROBOT system. Some thought has been given to RDF, Gyrocompass, or Flux Gate as a possible solution. This is a long term requirement and action remains open at the present time.

These are the action items for August. If you have ideas and\or potential solutions to any of these problems, call Jerry B or myself, set up a SIG or bring the idea to the general meeting.....JJ



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RSSC Board Meeting 25 June 91

The Society monthly board meeting was held 25 June. 91 at Jerry Burton's Laboratory. The meetings will now be held regularly on the fourth Tuesday of the month at 7 P.M. at Jerry's lab. All board members except Joe McCord were in attendance at the meeting.

The August monthly board meeting will move to the last Tuesday of the month 27 Aug 91. The August general meeting will also meet on the second Thursday of the month as the first day of August is also a Thursday.

Joe McCord has arranged the new Society general meeting location. The August general meeting will be held on Thursday 8 August 91 at 7:00 PM. in Room 123 of the Technical Building of Orange Coast College. 2701 Fairview Road, Coasta Mesa, Ca., 92626.

August is the Societies second anniversary and we want to have a few award presentations at the general meeting. There are some people, we think, who need to stand up and take a bow. Joe McCord also wants to bring THE ROBOT COMPANY's latest creation to the meeting for show and tell. Joe is pioneering some facets in robotics and you do not want to miss the August meeting. Don Golding will have RSSCy present and Jerry Burton will have his "NEWTON" Dumbbot present. Roger Ruszkowski will have the wireless link present. We would like everyone else to bring their "pets" to the meeting.

Our society address and meeting location has changed. The secretary will have the writeup in "COAST COMPUTE" corrected to reflect the changes.

The society bulletin board is up. Hours are 6 P.M. to 12 P.M. The number is (714) 535-5432. Protocol is 2400 baud, 8 bit, no parity, 1 stop bit. The board is currently only supported by one phone line. Its a start and our thanks to Jerry Burton for getting it this far along. Roger is slated to present the wireless link at the September general meeting.

CLUB BULLETIN BOARD

The RSSC Bulletin Board is now operational. There is a good resource for every one to use. It is to be used to discuss problems and to ask for help, etc. The phone is Jerry's and should be used after 6 o'clock. Phone 714-535-5432, 300/1200/2400 Baud using ProCom software with a protocol of N-8-1. See you there soon.....JJ

HELP WANTED

Your Editor is asking for help in the production of the ROBOT BUILDER. The news letter takes a lot of time and effort to research, edit, write, produce, and mail it on time. Time and tide wait for no man when you are facing a deadline each month. The previous editor, Scott MacGillivray had schooling (Masters Degree) that began to take his time and he asked to be relieved of the News Letter duties. Roland Koluvek put one issue out in December at which time your current editor looked the situation over and said "I Volunteer".

After I had volunteered, I asked Scott how much time it took him and he said about 20 hours. I was aghast and swallowed hard and thought to myself, "What aml getting myself into".

Well he was right! It does take a lot of time. I now find that additional business pressures and other outside activities force me to make the decision to step down as your News Letter editor. I want to pursue other activities like building my own ROBOT. I'll keep my sensor column and also write other reviews from time to time. I enjoy the research and the writing but the total production job has become too much for my schedule and I will be passing the Editorship after the AUG Second Anniversary Issue. Roger Ruszkowski has graciously said he would take it for a few issues and Scott M. stated he would be through with his degree work by early 1992 and could help out then.

The news letter of any organization is a direct reflection of the membership and it represents the organization to the outside world. It helps attract new members and in general shows how the organization is functioning.

I want to thank you,for it has been my pleasure to serve as your editor.....Jess

EDITORS THANKS TO THE MEMBERSHIP

I want to thank all of you that submitted articles, letters, news clips to make this a full issue. I couldn't have done it without you. Thanks again. .....Jess

PS. I want you to help Roger keep future issues of the ROBOT BUILDER full of "stuff" thats of interest to all of us. In this way we can all learn and keep up with whats happening in the world of robots.

1991 ROBOT OLYMPICS

I sure was interested in the coverage of the Glasgow Olympics. It had a good representation of the robotic efforts of universities and enthusiasts. I have read other reports about this event and I chose to reproduce this article for your information. Most robots traversed the obstacle course much like our RSSCy would perform. Go a while, then stop to think a while then go on etc. I was impressed with the winner for his machine could traverse the course with out stopping.

It article states that Japan wants to host the next Olympics. However, back on this side of the pond, I have become aware of a competition being held in Ontario Canada, tentatively in October. Thanks to the ENCODER, the newsletter of the Seattle Robotics Society. It is being sponsored by the IEEE of Canada and the University of Waterloo.

The following events are scheduled: A SOLAROLLER, a self starting robot dragster, A PHOTOVOR, where robots face off with each other, A HIGH JUMP, where robot creatures leap and land on their feet, ROPE CLIMBING, first up and first down wins, LEGGED RACE, walking creatures run for the gold, ROBOT SUMO, push the opponent out of the ring, NANO MOUSE, just a smaller and simpler form of the mircro mouse, MICRO MOUSE, metal mice run for the gold.

I am going to send for the rules and guidelines. It should be fun. Potential competitors fill out a "behavior sheet" ahead of time and competitions will be determined based on the number of competitors. Those in a class by themselves will be given honorable mention and everybody will be included in the OLYMPIC PORTFOLIO.....JJ

Mechanical athletes totter towards Olympic glory

Helen Gavaghan

A ROBOT called Yamabico took the prize for the best overall performer at last week's Robot Olympics in Glasgow. Colin Lindsay, from the Turing Institute of Strathclyde University which hosted the games, said that Yamabico, from Tsukuba University in Japan, took the laurels because it was able to negotiate a path strewn with obstacles without having to stop. Most robots need to scan each obstacle and process that information every time it encounters something in its path. Peter Mowforth, one of the judges from the Turing Institute, said: "Every component in the system was beautifully engineered." Japan now wants to stage the next games for the mechanical athletes.

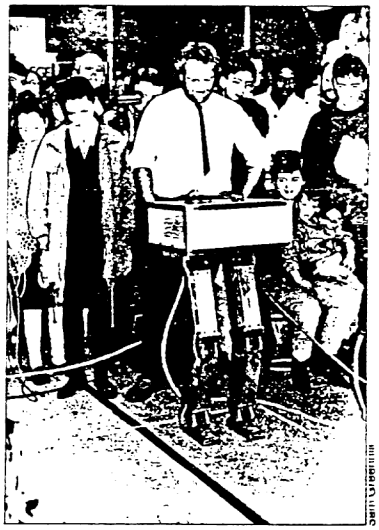
The games, held in the sports hall of the university, got off to a shaky start. Trollevman, the robot designated to light the Olympic flame, suffered an electrical fault. Instead of carrying the flame from The Parthenon Greek restaurant to the games, the robot's creators had to take the robot to the games in a Land-Rover.

The competitors, from schools, universities and amateur groups, seemed dogged by technical hitches. One six-legged robot from the Massachusetts Institute of Technology refused to start its race. Photographers' flashguns blinded the sensors on some robots, disrupting their movements. The electronics in another failed and its designers could not buy the replacement parts they needed.

Nevertheless, experts attending the show thought that the effort was worthwhile, both for encouraging school children to take an interest in the sciences behind robotics and for the exchange of information between competitors.

Ruzena Bajcsy, a professor of computer science at the University of Pennsylvania, said: "What we have here represents the efforts of universities and enthusiasts. We don't have robots from the automobile industry or the military. At least in the US, they are the big sponsors."

Bajcsy said that the biggest problem that robotics faces is perception. The aim that she and other experts are pursuing, is to produce a robot that will learn to rocognise objects, without having to refer to vast banks of rules they store in their electronic memories. Rule-based systems are rigid and have many shortcomings.



On your marks: the biped from Cardiff

Russell Beale and Tom Jackson from the University of York gave an example of the problem. To recognise a tree according to rules, the robot's memory would contain a description of a tree as an object with a trunk, branches and leaves. If a robot then encountered a palm tree, it would not recognise a tree. It is necessary to train robots so that they would decide that there was a strong possibility that a palm tree was a tree.

Such an approach often relies on neural networks, computer systems that mimic the way a human brain works. Neural networks can be trained to perform certain types of tasks better than normal computers. A robot with such a vision system would view a variety of objects and when it identifies them correctly, the researcher reinforces the connections in the networks which gave the correct answer.

Beale and Jackson are developing neural networks to interpret visual information. They find that putting their equipment on a robot is a good way to test the visual system since it would then encounter a variety of conditions.

Many of the other robots at the games were simply platforms for investigating particular problems in robotics, rather than prototype designs for specific tasks. One such problem is that of developing an energy efficient and smooth locomotion for robots, such as walking. But walking involves balancing an inverted pendulum—like balancing a broomstick on one hand. The walking action involves coordinating two connected inverted pendulums.

Paul Channon, a postgraduate student at the University of Wales, Cardiff, entered a biped walking robot. Channon started with computer simulations of walking and for each simulated step measured parameters such as position, speed and acceleration and computed the energy of the whole step. Channon repeated this for a thousand steps which differed slightly from one another.

With this information, he built a physical model to verify his simulation. "The computer simulation only studies motion in a plane, not rocking from side to side, so we need the physical model," said Channon. His robot carries pressure and acceleration sensors and is connected to a computer which monitors the sensors and decides how the biped should move next.

The work on display in Glasgow showed how young the discipline of robotics is, compared with the way that it is portrayed popularly in films, television and books. Mowforth, who dreamt up the idea for the Olympics, said that the images that surround us, such as Daleks and Cybermen, suggest that they are easy to build. "They are not," he said. □

Training course for ROBOTICS-RSSC

Basic Electricity
Basic Digital information

Safety in design
- Hardware
- Software

Locomotation
- Wheeled
- Tracked
- legged

Propulsion
- DC motors
- AC motors
- Stepper motors

Arms
- End effectors

Heads pan and tilt

Sensors
- Switched feelers
- Acoustal
- Infared
- Laser
  - Time of Flight
  - Angular calculation
- Battery charge level
- Smoke detector
- Temperature
- Visual
- Voice Recognition

Power
- Batteries
  - Gel Cells
  - NiCad
  - Lead Acid
- A P U

Type of Control
- Teleoperated
  - RF link
  - Laser link
  - IR link
  - Wire link
- Assisted Atonomous
- Atonomous

On Board intelligence
- DC operated PC computer
- Distributed Processors
- Network I/O

TRAINING CLASSES

In my spare time (ha ha) after getting the ROBOT BUILDER produced every month, I have been thinking what a training course would include to help the membership of the Society. I some time don't have a proper perspective for the task because I've been working with all aspects of robotics for 30 years or so as a control systems engineer.

I have spoken to many of you about what information you need and I have not gotten a consensus from any one. The needs are wide ranging because the interests in robotics are equally as broad.

I have put together a "FAM" or familiarization course to be taught in a six hour time slot some Saturday for the benefit of the membership.

I want comments back from the membership as to what you want and need in the first teaching seminar to be held shortly.

The Society has just received a copy of the learning program "INTELLIGENT MACHINES" put out by the Heathkit Educational Systems. It has a lot of good information in it, however the experiments are developed around the Heathkit ET-19 Robot trainer. Any member is welcome to borrow this book for their own study if you want. Just ask.

I have a mechnical arm from this Robot and as soon as it's assembled I'll start working up some driver electronics to interface it to a PC parailel port. Then the fun begins developing software to control the movement of the arm.

It will all be included in the basic class work for all to know and learn. .....JJ

PARKING - ORANGE COAST COLLEGE

I included another copy of the OCC map on the back again. I am concerned that some of you that came to MCI haven't made it down to Orange Coast yet. Come one, come all. Its a great place. They do charge 50¢ for parking. Its their way of controlling the cars in their parking lot. The parking lot has both metered and unmetered spaces. You need a pass to park in the unmetered spaces. I found the easy way to get the pass. Follow the arrows on the map and its self explanatory or intuitively obvious. Enter the campus on ARLINGTON DR. and keep to your right. On the map you'll see a little black dot in the street. This is the location of a little red box thats just waiting to devour your two quarters and give you a valid pass for the night. Proceed to your left and turn right on MERRIMAC WAY and proceed down the street and turn right into the parking lot. See you in room 123 of the Technical Building .....JJ

LETTERS TO THE EDITOR

RSSC VOLUNTEER ACTIVITIES

by Roger Ruszkowski.

The society is approaching its second anniversary with the August meeting. At the general meetings new people have been asking why the meetings are organized as they are. Others are asking why the society is ignoring whole aspects of their imagined universes. There are times that even I want to peer into my opaque crystal ball and divine the future of this society.

A long two years ago some people got together and started to transform reality. Tom Carrol was at the initial meeting held at MTI college and got him self elected as the first president of the Robotic Society of Southern California. The people present at that first meeting turned out to be the societies active members. Those people (and most are still with us) formed an organization to meet their current ideas and goals. Tom and the members of the society transformed their wishes and wants into reality.

All the devils advocates seem to say do this, do that, and what if, and what about that. In reality there are just no quantum leaps of spontaneous creation. In the real world there is no "fade to a commercial" and come back with a "fait accompli". It takes real time and real work to produce real results. Consider also that everyone in the society is a volunteer. If a member produces anything tangible its only because they chose to find the time in there own personal schedual to do it.

I was not at the initial meetings when the general meeting format was established. It is currently this way because the people who showed up and took an active part came to a general consensus that it should be this way.

Business meetings and the Saturday work shops also are organized or disorganized to the degree that the people who are in attendance want them to be. Time has always been a premium at the meetings. I feel that two hours a month at the general meeting is just not enough time to cover all points of interest. To help with this problem Joe Mc Cord sought out a new meeting location where the members can extend the informal chitchat after the conclusion of the meeting.

The general meeting agenda is a fairly standard format. The president even calls the room to order 10 minutes late. New people are welcomed as proscribed by Miss Manners. The presentation at the meetings get an hour of our attention and hopefully the presentation is an educational experience. After the presentation we have a secession of random and open access. This is a kind of a newsy or short story session. Coming attractions are presented and current activities are covered. The meeting adjourns and those with additional time begin to network.

For those of you that are present at the general meetings will notice that very little of this meeting is reported in the news letter. You also have noticed that presentations are centered around the societies robot. Open access time is dominated with information on the societies meeting schedule and the societies robot and current projects. If you want more of the general meeting reported in the news letter get your keyboard hot and compose it. Jess works hard to edit, compose, and put the news letter together, get it printed, folded and mailed. Rowland works equally hard to keep the current membership list and address labels up to date for the society. These guys are volunteers like you and I. Jess and Rowland said I volunteer to do this task and they do it every month. You have a news letter only because Jess gets it produced and Rowland gets a set of mail labels generated. You want to see something more in the news letter then compose it and give it to Jess. Please submit real things in writing.

The verbal air time is limited to open access at the general meetings. Do not come to the meeting and ask some one else to do any thing for you. We active volunteers have our own agendas and ideas. We are utilizing our hobby time to transform our own ideas into reality. You want your ideas transformed into reality then you must do it for your self. If you can share it with someone else through the society then I feel your being very productive. I enjoy what I am doing with my hobby time and am happy that I can share some of it with others through the society.

If you want to present a topic at the general meeting please tell Jerry Burton about it. Remember you may have to do the arrangements your self.

I don't suggest you stand up in open access and say "Jerry the society should do this or that". If you can get someone to respond to your asking some one else will arrange the event and that volunteer is probabily going to arrange it to their liking. You want something you arrange it! Every thing that has ever been presented has been because some one volunteered to do it. And every one did it their way. Remember your working in the real world. Getting someone to show up and speak for an hour is not real easy. Your also going to be asking some one to volunteer their resources and

time. But please do get involved in recruiting speakers. Jerry is trying to stay three months ahead of the calender at the monthly business meetings. Talk to Jerry about your ideas and the elected leaders will follow up to help you help the society on these things.

The current active members do dwell on our society robot. We do ignore many other aspects of robotics. Jess is not over whelmed with news letter articles from the membership on other aspects of robots. The active group has their own interest and are serving themselves. This is not wrong! If other people want different facets of robotics explored then these people must pull their own wagon. No one has volunteered to entertain you or to do research for you. Jerry has been asking for special interest groups to get active.

Will you lead a special interest group? Will you attend the business meeting each month to coordinate your interest group activities? Will you write a 200 word column for the monthly news letter? Will you arrange for your group to meet once a month outside of the general meeting and the Saturday hardware workshop? You may meet at Jerry's shop but not at the same time. Would you like to try and arrange to fill the general meeting speakers hour twice a year. I do not want to discourage you but if the society is going to grow and diverge off its current narrow path someone is going to have to lead it. The current group has its own interest and agenda. You see these interests and agendas at every meeting. If you want it expanded you are going to have to do it.

The time that Jess has is taken up with the news letter and he doesn't even have time to start on his own robot. Mark is creating RSSCy one part at a time just as fast as he can. Don is working on software to the exclusion of his finishing the assembly of his own NEWTON robot. Don started that assembly task last November.

My full time occupation is getting in the way of my hobby to the point where I can't even show up as planned at a general meeting. You want this society to be something else you are just going to have to do it your self. No one is going to do a lot, you just do not have the time to do it. But if every one could just do a bit now and then, then the society will continue to move alone and have a future.

Many people come to the meetings and have interests that they need help with. Many of our members are very gifted people. We are not yet inventing new wheels in robotics and many of the newcomers just need some help with their education. The questions that people have are somewhat immediate in that no one wants to do research and wait a month to get an answer. I think we all need to get to know each other better in the areas of our shared hobby. Lets encourage new people to ask for help and try to answerer specific questions for them. We need more meeting time and some one to lead the meetings.

I see the society growing and starting several special interest groups. I think the groups will meet at various locations. The groups will not try to duplicate the format of the general meetings. I think some new leaders will have to pick up these interest and lead them. The current leaders are stretched to cover the current activities and are unable to expand much into new interests. The elected leadership is open to any and all efforts to increased participation from the members. You can come around and say do this or do that. However, we currently are not getting done the things that some one else has already laid on us to do.

Most likely, we will not get to what ever you want. But should you try to implement your ideas by doing things your self, we will support you and follow you. Your invited to the business meetings to get your special interest scheduled. The news editor will publish what ever you submit on a floppy. We will advertise your activities. Most of us probably share your interest and would attend your workshops if the time did not conflict with our livelihood. I have many people asking me to do things for them as the societies secretary. However, I do not have anyone vieing for this volunteer job that I could promptly dump it on. I hear many "want-to bees" buzzing but I see very few "do bees" performing.....RR

MEMBERSHIP APPLICATION

I have included and application on the back page for you to hand out to friends or acquaintances if they are interested. Use it any way you want but use it to advertise the Society.

MORE INFORMATION

I just received on my desk here at JPL, the IEEE ROBOTICS & AUTOMATION Journal for 1991. It is a three volume set of over 2800 pages, containing over 400 papers. I'll place the Table of Contents in the Engineering Notebook and try to locate a set in Orange County for the membership to see.....JJ

The Roboteer
by Jerry Burton

Dumbot has been in Mark's shop getting a new head so I havn't been doing much in Navigation lately. However, as I demonstrated to some of you at a recent Lab there are some inherent problems in the HPC regarding accurately being able to move through a specified path. Roland Koluvek has been working on an alternative using a 68HC11 processor for motor control. I am working on an alternative method of doing sonar processing using the returned amplitude and it becomes obvious that we had better have some sort of standard method of interfacing various subsystems or we are going to have a mess.

This month I would like to propose an archecture that will allow a number of different subsystems to be integrated into a single structure. I've started a design project to use the Signetics 80C552 as a basis for multiple controllers, that when integrated will provide the ability to use a simple building block approach to robot development.

You will be able to start simply and merely add more subsystems as your robot develops. The heart of the concept is to use a standard controller card with a standard connector to a personality card to make a specific subsystem.

Each controller would be identical and by putting in the unique ROM software and an appropriate personality card you can have motor controllers (both direct drive using pulse width modulation, or steppers), sonar subsytems, vision, infra-red, laser range finders, RF link, etc.

Each controller would be linked to the other controllers using a simple LAN structure. The PC would be just another subsystem and be able to ask for data from any other subsystem or give commands to a subsytem as a task requires information. The link could be either a high-speed serial link or the popular 2-wire I^2L interface. Both the 68HC11 and 80C552 have this ability. If a driver for the PC were written to use a serial port for an I^2L protocol, then a network such as shown in figure 1 is possible.

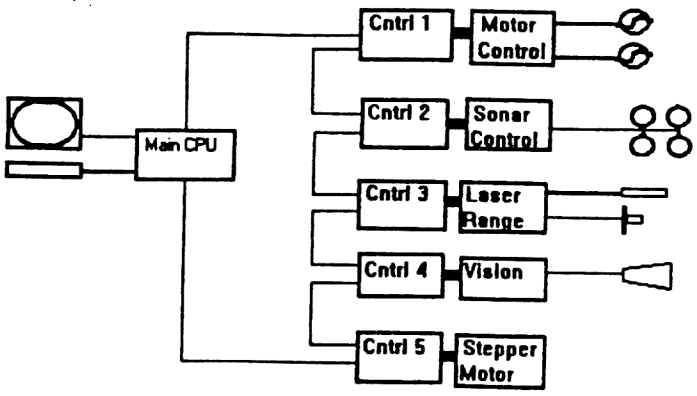


Figure 1 - Overall Architecture

Whereas the HPC used a single controller to integrate motor control, sonar, IR, light control, sound input, etc. The design I'm proposing is to split these functions into many smaller (and simpler) controllers that perform a single function. There are several advantages to this approach.

First, each subsystem dòes a single well-defined function. For example, suppose we have a contoller that provides PWM (pulse width modulated) outputs to two motors and reads the results of a pair of bi-phase encoders. Such a controller could respond to high level commands like 10 degrees left, 3 feet forward, 5 feet back, etc. The controller would translate a command into specific signals to 2 motors and monitor the result for completion - THAT'S ALL IT WOULD DO ! Of course while a subsystem is carrying out it's assigned task it would be monitoring the LAN for commands, (e.g. Cancel, Collision Detected, Abort, etc). If your robot needed 4, 6, 8, ... motors you would merely add more controllers as you add functionality. Each pair would be totally independant from the others, and be able to operate simultaneously.

Second, the subsystem requesting the service does not have to make any assumptions about HOW the motor controller is to execute the commands given to it. All it needs is a command structure and a result. The subsystem doing the movement can be changed at any time and the requestor is none the wiser. This allows new stategies to be tried out WITHOUT HAVING TO CHANGE ANY OF THE OTHER SUBSYSTEMS. This is a crucial point in developing a truly distributed processing environment.

Third, the SW in each controller is simpler since it is limited to performing just a specific function. By changing the ROM and adding the appropriate personality module the same controller can be used to perform a variety of tasks. This allows production costs to be minimized and allows for economy of scale. I estimate such a controller could be built & sold for under $ 100. In this way a very powerful robot could be contructed in an evolutionary fashion and the cost to build it would be spread over a longer time, thus minimizing the impact on the old pocket-book.

Using this approach new subsystems can be created by merely developing an appropriate personality card, e.g. active IR, vision, laser range finding, RF link, etc., writing the appropropriate interface software to interface to the new module and integrating it into the existing LAN. The standard LAN interface SW would be indentical on all controllers and probably would be in the form of a library that each controller would link in. Subsystems with differant processors could easily be interfaced as long as they adhere to the interface standard. This is also true of the main processor that you use to provide overall guidance and commands to the various subsystems. If you wanted to build a robot based upon an Apple architecture as opposed to the IBM PC it should be transparent.

It should be possible to use these simpler controllers in a stand alone mode with commands coming through its serial port. In this way you could study motor control, sonar control, etc. without having to even have a robot platform built, you would merely hook-up your main computer to the controller via a serial port and then send commands either from a program or directly from the keyboard. You could even control one of these controllers using nothing more than an ASCII terminal and typing in commands directly.

I'll keep you posted on the progress of the project and will be working closely with Roland to make sure our subsystems can talk to each other.

If you have any comments or critical input to these ideas feel free to give Jess a write-up for inclusion in the next newsletter.

Robot Hand Would Adapt to Contours

A conceptual device would use hydraulic pressure to activate fingers.

Projections on the opposing fingers of a proposed robot hand would automatically conform to the contours of an object on contact. The hand could therefore be used to grasp objects of various shapes and sizes. The conforming process would be passive; the pressure of the object on one or several pad elements would force the other pad elements to touch it. The hand would not use elaborate mechanisms involving motors, cams, and cables.

The projecting elements on each finger would be pistons connected to a common hydraulic reservoir within the finger (see Figure 1). The reservoir is initially filled and sealed, with the pistons at the midpoint of their travel. The application of a force to one piston would cause a pressure to be exerted equally on all the other pistons. The diameters of the pistons near the middle of the finger would be less than the diameters of pistons near the edge. Therefore, the middle pistons would tend to move farther under an increase in pressure in the reservoir and to exert smaller forces. A gimbaled pad at the tip of each piston would tilt to align with the local surface of an object.

When the finger approached a flat-surfaced object head-on, all pads would contact the object simultaneously (see Figure 2). If the hand approached at an angle, the pistons would push the object into a position in which the pistons would be uniformly displaced, as though the finger had approached head-on.

When the finger approached a small sphere or cylinder, the middle piston would contact the object first. Because of its small diameter, it would tend to travel farther than the other pistons and would thus allow the round surface to sink in farther for a more secure grip. The hydraulic pressure generated by the middle piston would move its neighbors outward to meet the object. As they made contact, their tip pads would tilt to the local slope of the surface of the object. The pistons would interact similarly in contacting irregular objects and concave objects.

The pistons would tend to center a symmetrical object like one with a spherical or flat surface because the piston forces would decrease toward the middle of the finger. An offcenter object would be subjected to higher forces at the side farthest from the center. The tilted pads would then exert sideways forces that would slide the object inward.

The same gradation of forces would inhibit rolling of an object. The object would become cradled securely in the pads without excessive force.

A sensor could monitor the pressure in the reservoir, and the pressure could be limited to prevent the pistons from damaging an object. No other sensing or control would be needed.

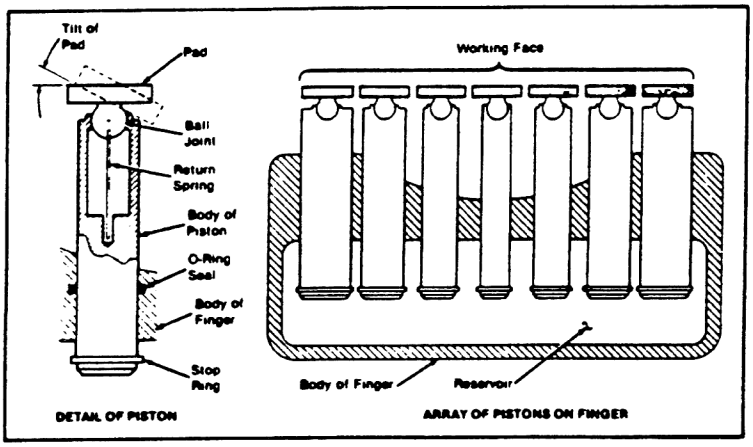


Figure 1. Pistons Connected to a Common Reservoir would provide a gentle, firm grip. The fingers would communicate with each other via the hydraulic pressure, without an elaborate control system.

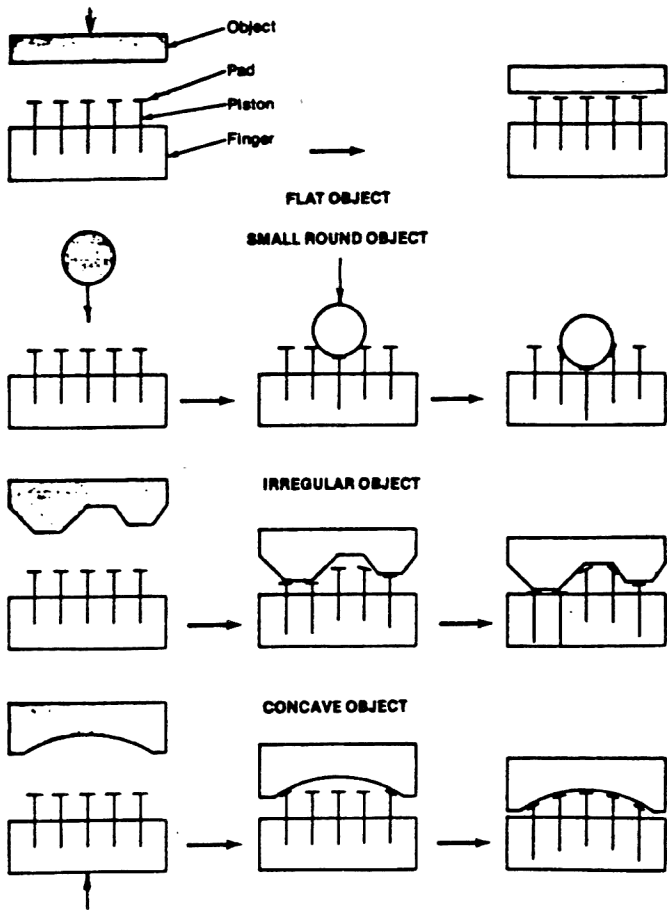


Figure 2. Pistons Would Move In and Out, and their tips would slope to match the contour of an object. Their action would tend to center the object on the finger.

The Forth Corner

by Don Golding

This is the first of a new series. We will talk about the Forth Enviorment, what's new, and hopefully teach some of you this very powerful way of programming and controlling your robots.

Forth was invented by Charles Moore in 1968. He oftens refers to himself as the "Discoverer of Forth". His task was to write the software which controls the Telescope at Kitt Peak. With a computer and engineering background dating back to the 1950's, he thought a new approach for real-time programming was needed. For real-time testing and modification it must be interpretive. For real-time execution it must be fast, and further the new environment must support multitasking. The final requirement would be a very efficient use of system resources (ie: MEMORY). Many of you software types would agree, NO LANGUAGE CAN DO ALL OF THIS! But Moore came up with a solution: FOURTH. The fourth generation language. His computer would only allow five characters for file names, so he called it FORTH.

Most of you think of interpreters (like basic) as being very slow. And they are. Basic actually must compile (convert to machine code) every time it is run. Forth compiles only when a new word is added to the system. Forth is really a collection of *words*. These are collected in a structure called a *dictionary*. When you type a *word*, Forth looks for it and executes it. If you type a number, Forth puts it on the stack. This is the Forth *outer interpreter*. Very simple. A word is executed and numbers are put on the stack. When you compile a new word, which is actually a collection of previously defined words, Forth's compiler looks up the word in the dictionary, finds it *memory address* and compiles this address into the new word. It then gets the next word finds its address and compiles its address until it reaches the end of the *definition*. Later, when the newly defined word is executed, the *inner interpreter* gets the address of each word used in the definition and executes it. Lets look at the more closely. We want a word to move the robot forward so many feet. We want to use it as follows:

10 feet forward

feet would be defined as follows:

```
: feet ( #-of-feet -- )
    12 * ;
```

We create a new word by using a colon. Forth ignores parentheses, they are used for documentation purposes only. Forth sees a number 12 so it is put on the stack. Forth then sees the word * so it is executed. The word * is a Forth word that multiplies two numbers on the stack. So the definition of *feet* simply multiplies the number or argument by twelve. *forward* is defined so it takes the number of inches from the stack and issues the command to the motor controller. The word * is written entirely in assembler for speed as most of Forth's low level words are. The *inner interpreter* in a 16 bit Forth system are two machine instructions: increment memory pointer and jump. So you can see, Forth is very fast, has a minimum of memory requirements, and is intrepretive.

Charles Moore later created the RTX 2000 Forth Microprocessor that was implemented using a 33,000 cell gate array. Due to its parrallelism, it can perform up to four instructions per cycle giving it an average execution speed of ten MIPS with a burst rate up to forty MIPS. It costs about sixty dollars. In comparision, the Intel 386 has a speed of about three MIPS, has been implemented in a custom VLSI chip requiring over 300,000 gates. I admit we are comparing apples and oranges here, but it gives you an idea as to the simplicity of Forth.

Some areas where Forth is used:

IBM programmed a CAD package.

Ball Electronics used a Forth Engine on a Star Tracker for the Space Shuttle.

JPL for deep space probe control systems.

Aston Tate wrote Rapidfile with it.

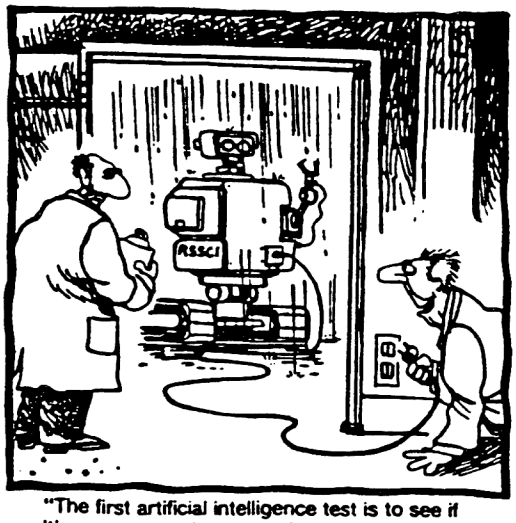
Paperback Software wrote VP Planner with it. It was such a threat to Lotus 123 that Lotus sued them , putting them into bankruptcy.

Lockheed uses Forth Engines for custom controllers.

A high tech airport in Saudia Arabia uses Forth as a network operating system controlling all terminals with full graphics.

Well that's it for this month, *may the Forth be with you...*

SNAFU/by Bruce Beattie

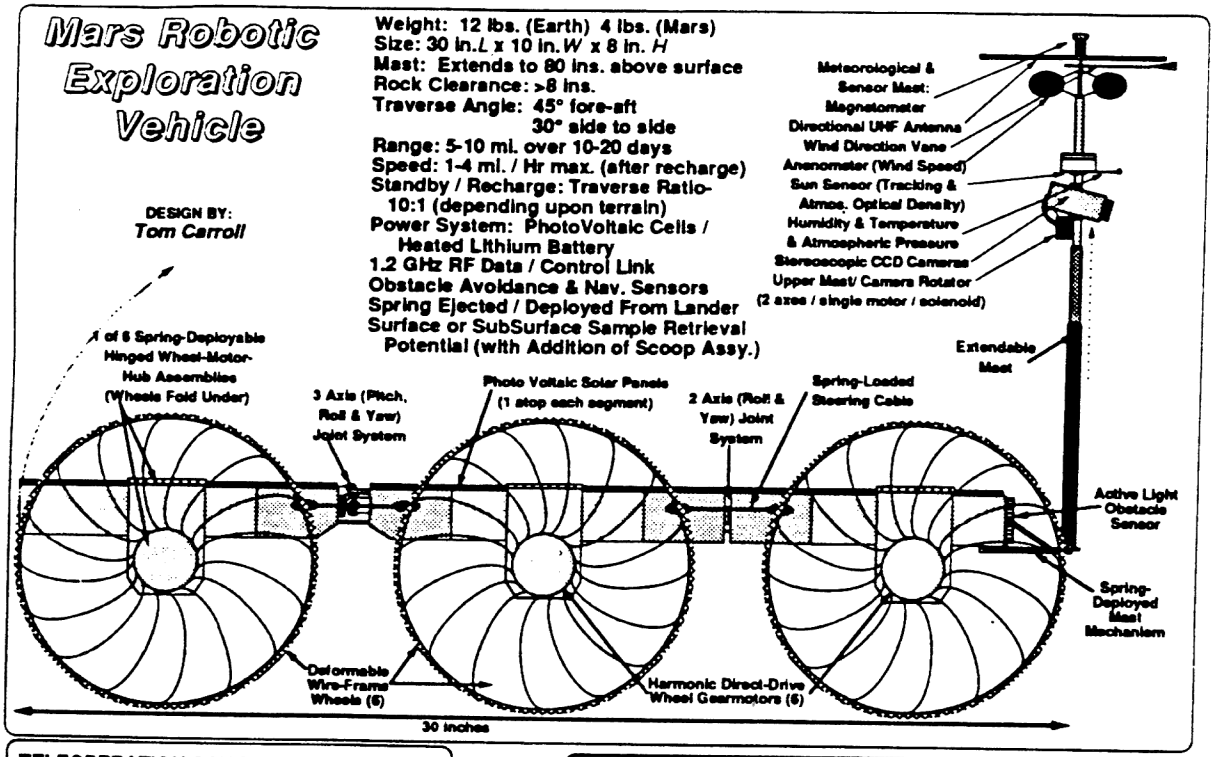


"The first artificial intelligence test is to see if it's smart enough to come in out of the rain."

Mars Robotic Exploration Vehicle

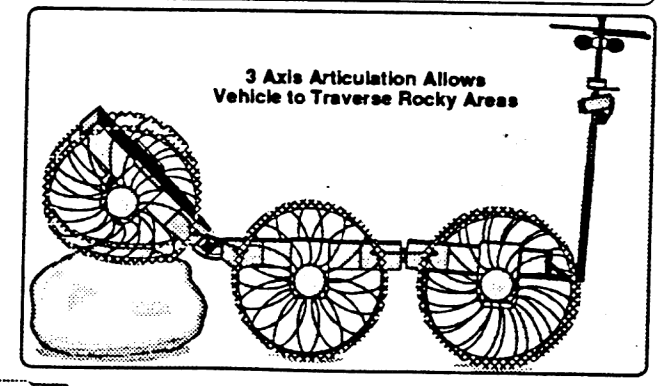
DESIGN BY:
Tom Carroll

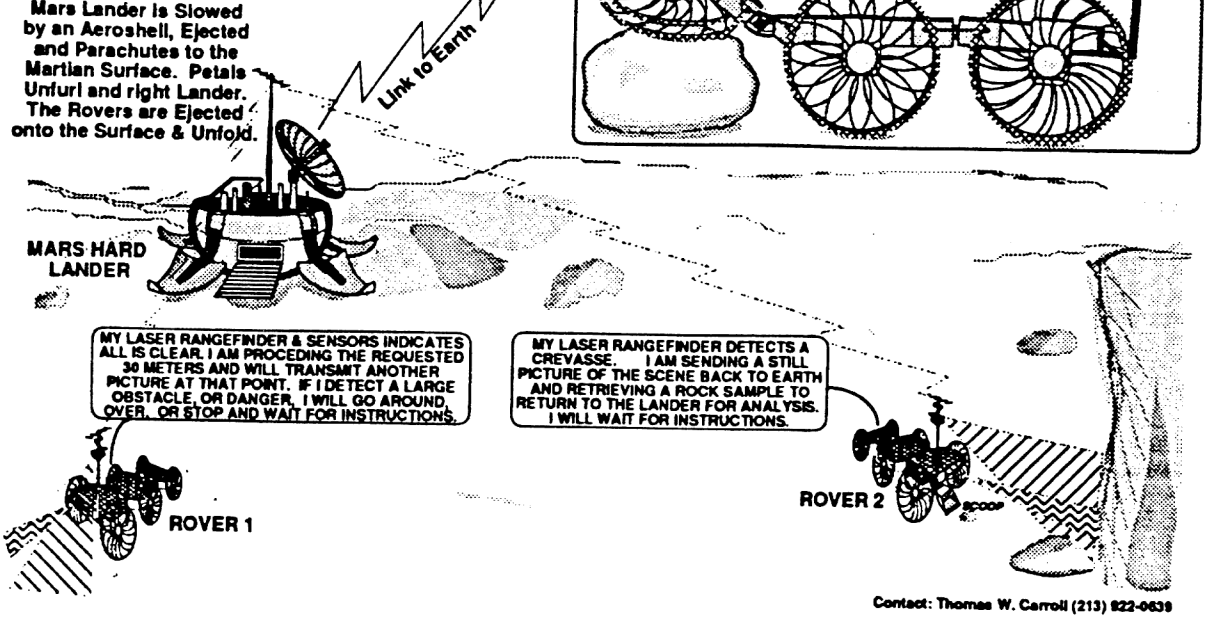
Weight: 12 lbs. (Earth) 4 lbs. (Mars)
Size: 30 in.*L* x 10 in.*W* x 8 in. *H*
Mast: Extends to 80 ins. above surface
Rock Clearance: >8 ins.
Traverse Angle: 45° fore-aft
30° side to side
Range: 5-10 mi. over 10-20 days
Speed: 1-4 mi. / Hr max. (after recharge)
Standby / Recharge: Traverse Ratio-10:1 (depending upon terrain)
Power System: PhotoVoltaic Cells / Heated Lithium Battery
1.2 GHz RF Data / Control Link
Obstacle Avoidance & Nav. Sensors
Spring Ejected / Deployed From Lander
Surface or SubSurface Sample Retrieval Potential (with Addition of Scoop Assy.)



TELEOPERATION CAN BE ACCOMPLISHED FROM PLANETARY DISTANCES WITH "SEMI-AUTONOMOUS" ROVERS, DESPITE THE MANY MINUTES OF 2-WAY COMMUNICATIONS LINK TIME TO EARTH

A System Similar to the Computer Aided Remote Driving (CARD) System Developed by JPL can be used to Operate Many Rovers By Teleoperation,- even at the Multi-Million Mile Distance of Mars.





Contact: Thomas W. Carroll (213) 822-0639

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This Contraption Is No Weird Golf Cart; It's a New Marine

* * *

The Corps Is Testing Robots As Battleground Spies; But They Don't Shoot

By Bob Davis
Staff Reporter of The Wall Street Journal

WASHINGTON – Sure, the Marine Corps could use a few good men. But this $350,000 recruit? He's no John Wayne. In fact, he looks more like a Teenage Mutant Ninja golf cart.

For a body he has an all-terrain vehicle. For head and eyes, a video camera with night-vision electronics. For a rear, an optical-fiber cable. The weird-looking contraption is a robot Marine: Robo-Spy, the Corps' newest recruit.

Robo-Spy doesn't eat, sleep, gripe or goldbrick. He can sneak up behind a hill and watch for the enemy, detect contamination by chemical weapons, move miles ahead of base camps, and target tanks for the artillery. He can "make Marines invincible," says Ray Bowles, a retired Marine colonel who helped build the service's first robots.

Leatherneck Suspects

Still, he's not exactly the pride of the Corps. One thing is, some robots, if not the peaceful Robo-Spy, could threaten to take some of the fun out of the job. "There's something macho about jumping out of a foxhole and gutting a guy with a bayonet," says Powell Johnson, a civilian robot tactician. Armed robots, which work at long range, "take that away," he says.

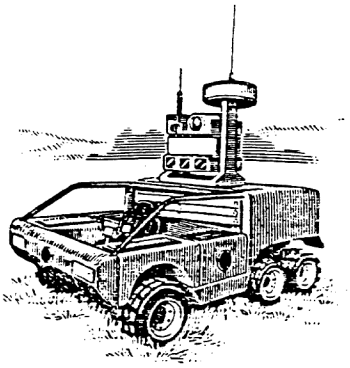
The late Mr. Wayne might have thrown the sands of Iwo Jima into the robots' gears, had robots been around at the time. Something like that may have happened recently at the Marines' Camp Pendleton, in California. Leatherneck Luddites were among the suspects in the hamstringing of a robot: His cable seems to have been slashed.

That's not the only trouble. Robots don't take prisoners. Some liberal-minded Californians think robots could violate the Geneva Convention and become unwitting war criminals. "We'll wind up with a war of machines, with soldiers as bystanders or casualties," says Gary Chapman, director of Computer Professionals for Social Responsibility, a Palo Alto organization.

Then, too, at the very least, fighting robots violate one of the Three Laws of Robotics, promulgated 48 years ago by Isaac Asimov, the science-fiction writer. The First Law: Robots must not injure humans. Mr. Asimov tells an inquiring reporter that he hates the idea of military robots and then, at the mention of Robo-Spy, hangs up his telephone in disgust.

By 1988, fearful of berserk robots on the battlefield, Congress forbade them to carry weapons. While the ban has formally ended, the Pentagon got the message, and has stopped dreaming of making ever meaner machines.

The government already had begun testing the Prowler, which sprayed machine-gun fire all around it; the Robotic



Robo-Spy

Ranger, which roamed Fort Benning, Ga., blasting targets with machine guns and antitank missiles; and the Fire Ant, a robot cannon developed at Sandia National Laboratories, better known for nuclear research, in New Mexico. Fire Ant automatically fired at any tank within view, but it had one drawback, of sorts. A disposable robot, it was designed so that it blew up as it fired its single round.

Most military robots are now envisioned as unarmed spies to be sent out into the cold—or the heat—to lead patrols and serve as forward observers. "When we need a volunteer, we'd say, 'Robbie, you go on ahead,' " says Mr. Johnson, who works at the Army Infantry School at Fort Benning.

The Marines own a few Robo-Spies and have ordered 14 more, for a total of $5 million, from Robotic Systems Technology Inc., a subsidiary of privately held F&M Machine Corp. in Hampstead, Md. The new models—officially called Surrogate Teleoperated Vehicles (STVs)—consist of Polaris Big Boss all-terrain vehicles outfitted with video cameras and infrared and acoustic sensors.

A Robo-Spy is more videogame than Terminator. A human Marine, hidden in a bunker and watching a video image, drives the thing via remote control and tells it exactly what to do.

Scott Myers, who heads the STV project at Robotic Systems, sketches a typical Robo-Spy mission. A Marine drives the STV, as he would an ordinary car, to the outskirts of a suspicious-looking town. He jumps out, hides, and uses his video controller to direct the robot into town. Want to peek in a second-story window? Push a button that lifts the STV's cameras and sensors 10 feet high and look in. If someone clubs the robot, Mr. Myers says, at least the Marines will have learned there are hostile people about.

The robots aren't ready for real-life snooping yet. For one thing, remotely driving a robot isn't much fun; it makes a lot of people nauseous. The Marines have developed a 3-D driving helmet that looks like an ophthalmologist's nightmare, with a tiny video screen for each eye. Move the helmet, and the robot's camera eyes move too. Drivers say the contraption makes them feel like a disembodied part of the robot, but they get sick because they can't feel the road.

"Every time I come to a hairy turn," says Sgt. Mitchell Liburd, the Marines' main robot driver, "I say to myself, 'I'm not in here, I'm not in here. I'm just watching TV.' " Sgt. Liburd is one of the few and the proud who can keep their breakfasts down while steering a robot. Robert Finkelstein, a Potomac, Md., robot consultant, calls driving a robot, "an out-of-body experience."

Robots probably won't be ready for the Persian Gulf. Stephen Roehrig, a Sandia robot manager, says that after the U.S. started sending troops to Saudi Arabia, the Army asked him if he could build 1,000 Fire Ants in three months. He says he couldn't.

The STVs aren't due to become operational until next fall. Marines are using STV-like robots for testing. At Camp Pendleton last year, the robots showed what they could do. A videotape of the test showed three robots locating Jeeps and tank targets, and aiming laser beams at them. Hellfire missiles tracked the beams to destroy the targets. By the end of the tape, the robots had directed the killing of seven enemy vehicles without suffering a loss.

Then again, no one was shooting at the robots, and the tape didn't show everything that happened. One of the 10 Hellfires landed 100 yards from a group of VIPs, igniting a brushfire and terrifying the visitors, say engineers who monitored the test. Another missile severed a fiber-optic cable, blinding one of the robots.

As for the Camp Pendleton robot with a possibly sabotaged cable, one Marine engineer blames a wild bison for stomping on it. Others blame Luddites, or goldbrickers who thought "if they could break the vehicle, they would get the day off," says Mr. Myers.

Race is on to build microscopic robots

U.S., Japan compete to refine technology

By David Thurber
Associated Press

TOKYO – In the minds of researchers, a robot the size of a pill slides down the patient's throat, through his stomach and into the intestine.

It scans the intestinal walls with a miniature camera, searching for possible tumors, and sends the images to a doctor watching a monitor.

Then, under instructions transmitted by the doctor, it extends a tiny arm with a blade and takes a tissue sample for examination.

Someday, the researchers say, such micro robots will be real, able to travel through blood vessels or the digestive system to examine the body, perform simple surgery or repair artificial organs.

The government is starting to pour money into research, but the Japanese are entering the race late.

In 1987, Japanese researchers "were taken by surprise when they saw minute motors made out of silicon displayed at an international conference by American scientists," said Hiroyuki Fujita of the Tokyo University Institute of Industrial Science. "It was very impressive. Now a number of Japanese universities have begun micro-machine research."

Masahiko Kobayashi of the Ministry of International Trade and Industry said, "We want to develop two kinds of robots: ones for medical use that are small enough to enter the bloodstream, and ones for industry that can travel into the intricate parts of equipment like nuclear power plants or jet engines to make repairs."

Medical instrument sales and the costs of equipment maintenance accounted for about 10 percent of Japan's gross national product in 1990, or about $310 billion, said Kimiharu Sato of the Japan Robot Association.

> 'By using semiconductor manufacturing technology, we can make very complicated tiny things very easily'
> – Hiroyuki Fujita, researcher

"It's not clear how much of that could be taken over by micro robots, but it means research into such machines is very attractive," he said.

Producing robots with gears, motors and other parts that measure about 100 microns, a fraction of the diameter of a human hair, is akin to producing a car the size of a postage stamp.

In the 1960s and 1970s, Kobayashi's ministry sponsored research projects that propelled advances in technologies for automobiles and semiconductors, industries in which Japan has enjoyed huge success.

This year, it is launching a 10-year, $180 million project intended to reverse Japan's late start in micro-robot research.

Kobayashi said robots tiny enough to examine the insides of narrow tubes might prevent accidents like one at Japan's Mihama nuclear plant, where metal fatigue caused a cooling tube to burst and release radioactive water.

"If robots can be kept permanently inside such equipment, it will allow inspections and maintenance to be done much more frequently because there won't be any need to shut down and dismantle the equipment each time," he said.

Researchers also envision tiny devices that can be implanted in people to determine and administer regular doses of drugs to particular organs.

Two main paths are being followed by researchers in Japan and in government-financed projects in the United States and Germany.

One focuses on ways to vastly reduce the dimensions of existing machines. The other is trying to develop entirely new methods of designing and making motors and other small parts.

A Japanese researcher is attempting to develop synthetic muscles that will allow robots to move without relying on batteries. Another new process uses the same photographic etching methods employed in fabricating tiny computer semiconductor chips from silicon.

In his laboratory, Fujita pointed to a silicon wafer with rows of tiny motors the size of specks of dust.

"By using semiconductor manufacturing technology, we can make very complicated tiny things very easily," he said.

"For example, eventually we may be able to make the moving parts of a portable stereo system small enough to fit inside your ear, or tiny fluid control valves that can regulate the flow of blood through a mosquito."

Analysts say Japan still trails the United States in fabrication of silicon mechanical parts, but could surge ahead if its giant semiconductor makers devote more research to miniaturizing mechanical parts.

"Japanese corporate research is usually limited to areas where there's a clear vision of an eventual product, even if it's a number of years in the future," Fujita said.

"Because we're still unsure of what will result from micro-machine research, there hasn't been much activity by companies. So the government's project is important in getting them involved."

Specific research topics have not yet been decided for the project, which is open to foreign researchers.

"There's a question of what the project can achieve in 10 years," Kobayashi said. "We would like to be able to make a robot that is small enough to enter the bloodstream, but 20 years is probably not enough to achieve that.

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