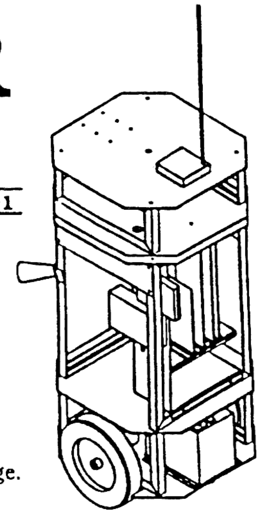
ROBOT BUILDER

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



UPCOMING EVENTS CALENDAR **DEC 1991**

14 Dec. 9 a.m. - 4 p.m. General Membership Meeting, at Orange Coast College
17 Dec. 7 p.m. - 9 p.m. Board Meeting
11 Jan. 9 a.m. - 4 p.m. General Membership Meeting, at Orange Coast College
21 Jan. 7 p.m. - 9 p.m. Board Meeting
08 Feb. 9 a.m. - 4 p.m. General Membership Meeting, at Orange Coast College
25 Feb. 7 p.m. - 9 p.m. Board Meeting
14 Mar. 9 a.m. - 4 p.m. General Membership Meeting, at Orange Coast College
31 Mar. 7 p.m. - 9 p.m. Board Meeting

Monthly meetings are held on the second Saturday of each month at Orange Coast College. The Board Meeting is held on the second Tuesday before the Monthly Meeting at Jerry Burton's Shop and the ROBOT FAIRE committee meetings are held on Friday nights at Joe McCords Shop when planned.

President's Message

The Library commitee will be be meeting at 9am Saturday Dec 12th. The hardware lab will run from 10 am - noon. This month we will be concentrating getting RSSCy running again. Seems he has a few problems in his motherboard.

During the main meeting from 12:30 - 2 pm, Roland will be demonstrating his 68HC11 based motor controller. We will also have some interesting video on the all Japan mouse contests. Joe McCord and his commitee will be giving us an update on the status of the Robot Fair.

From 2:15 - 4 pm Don Golding will continue his development of the Forth based Robot Control Language.

January will be our annual elections for the board of directors. If any of you would like to run for office please contact me at the Dec 12th meeting and I'll make sure you are placed on the ballot. The more people that become active the better. It has been our policy in the past to practically make-up board positions so that everyone that wishes to participate can do so.

Hope you all have a happy holiday season.
Let's make 1992 the year of the robot.

Mouse-bot mk-1

Part 1
by James R. Benson

INTRODUCTION:

I am interested in the programming aspects of robot control. Rather than deal only with theory, I wanted a test platform for some of my ideas. I have already worked on controlling stepper motors. I now wanted to look into controlling devices with a software feedback loop.

When programming a stepper motor, one gives a command like "move in this direction x steps", then you rely on the motor to carry out the command correctly. If instead you have some type of sensor that can give you constant position information, then you can program something like "move in this direction UNTIL you reach x". The advantage of this approach in robotics is that the position sensor can be independent from the motion.

I'm cheap, so I decided to build my device from inexpensive parts that I had noticed at local computer swaps. I started with a (~$15) mouse as my position sensor and salvaged parts from (2x~$5) dead floppy drives to provide stepper motors and wheels.

To drive the motors, I used a (~$30) parallel interface based on the UCN4202 chip. This interface was developed by a friend of mine, Jim Brozek, who has given his permission to release the design to Public Domain.

Since position is being sensed by the mouse, stepper motors could be replaced by many other forms of propulsion. However, the redundancy implied by this method will give me more control of the motion of the device and thus make it easier to verify that my sensing and feedback software is working properly.

Put together, I've got a motor driven mouse that can roll around on my table. It is not of much use for anything else but it does incorporate most of the basic features and concepts of larger robots.

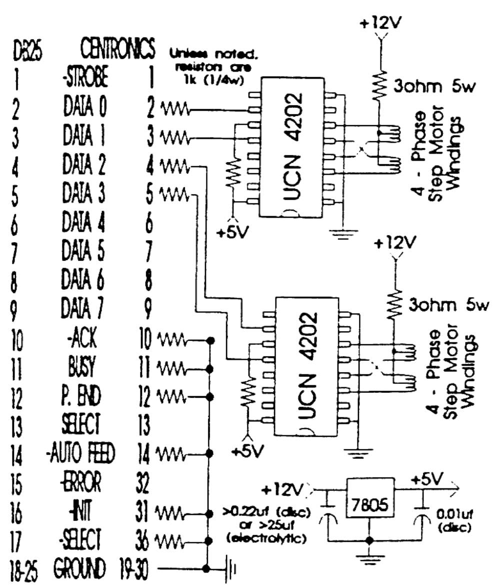
CONSTRUCTION:

*** DISCLAIMER *** The liability for any damage as a result of following these instructions, even if there is an error in these instructions, is your own.

The circuit diagram provided is of the basic parallel interface. The board that I am using was given to me in completed form by Jim Brozek. The circuit diagram was derived from this model by Tim Lewis. I suggest that you take great care in building your own board since I was told that several computer I/O boards were "smoked" while testing early versions. Be aware that building and testing this on your own may cause permanent and substantial damage.

When choosing floppy drives for salvage, I recommend the original full-height 360k floppy drive made by Tandon and used in the IBM PC. The stepper motor from the head positioning mechanism is adequate for propulsion. The flywheel used to spin the diskette can be used as the wheel for the robot. (More recent floppy drives use a direct drive rather than a belt system to spin the diskette -- if these are all you can find then you will have to supply and mount your own wheels.) You will need two drives, preferably the same make and model.

I joined the two stepper motors end-to-end with duct tape and wire. I mounted the wheels by building up the motor shafts with duct tape, firmly shoving the wheels in place, then gluing them down with silicone. I used the mounting screws on the steppers to attach metal brackets to hold the mouse (the same metal brackets that are usually discarded when one puts a new I/O board in an IBM type computer). The mouse is not rigidly attached to the motors but "floats" between these brackets. For more fun, I de-soldered the buttons from the mouse and mounted them at the front to use as "bumpers".



Robot Dawn BBS

Open 24 hours
1200/2400 baud 8N1
(714)538-0614 (modem)

The following are messages that have been posted on the BBS. I thought you might find them of interest.

RSSC Conference:

Date: 10/08/91 (10:01) Number: 5 of 6
From: FRANK CHANEY Refer#: None
To: JERRY BURTON Rcvd: 10/11/91 (11:55)
Subj: NEWSLETTER Security: Public

Hope to meet some of the members, through the BBS. Am completing work on a prog to test some of the HPC functions. Will upload when complete.
Thanks,
f.

General Conference:

Date: 10/19/91 (18:31) Number: 14 of 18
From: ROBERT NANSEL Refer#: None
To: ALL Rcvd: No
Subj: NEW USER Security: Public

Howdy, I just thought I'd introduce myself. I'm a member of the Seattle Robotics Society and I edit the newsletter for the club, the Encoder. Some of you may have seen copies of it. We periodically see copies of your newsletter, Robot Builder. I noticed you used a piece I wrote on servos in your newsletter. If you would like, I can arrange to upload text files that are of interest to robotics people so that you can have material without waiting for our newsletter to arrive; perhaps you can do the same for us. The best way to reach me is to leave a message on the SRS BBS: 206-362-5267 1200 8N1, 24 hr.

Another BBS of interest to you might be the Hobby Robotics BBS, Robots R4U located in Stone Mountain, Georgia. This board hosts the Atlanta Hobby Robotics Association. 404-978-7300 1200/2400 8N1, 24 Hr.

Bob :-))

Date: 10/29/91 (16:30) Number: 17 of 18
From: STEVEN MORRIS Refer#: None
To: ALL Rcvd: No
Subj: NEW USER INTRO Security: Public

Just a quick note to introduce myself. I am relatively new to robotics but have always been interested since I was a kid. I am currently learning about stepper motors, voice recognition and synthesis the hard way...by teaching myself. My goal is to build a robot that can walk under it's own control (as human as possible). I have been told this cannot be done...which just makes me want to try that much more. I work as a systems programmer and am fluent in MVS 370 Assembler, PL/1 and COBOL. I also have a fairly complete metal working shop and am currently putting an electronics workbench together. Hope to "see" you around! Steve Morris (904) 789-8197 home/voice give me a call if you would like to talk.

Robotics Conference:

Date: 10/27/91 (04:05) Number: 4 of 9 (Echo)
From: JOHN GUTMANN Refer#: None
To: ALL Rcvd: No
Subj: HERO ARM Security: Public

Well, I went and did it! Yep I bought one of those Hero Robot arm and bases from Mendelson electronics for $399.00. I have Michael Lynch and Walter/Bev Bryant to thank for passing on the information about it. I first read about it in the BBS message base, then I finally saw the adv flyer. The message base got me aware of it, but the flyer finally sold the deal. I was not sure if the "robot arm kit" alone included the motors at the shoulders. Well it does. I assembled the arm and liked it so much, I called back and ordered 2 more. I ordered just 2 of the arm kits, not the arm and base. The base comes assembled and has a good manual and schematics with it. The Arm kit for $179.00 has assembly diagrams, but no electonic schematics. Anyway I am just really happy with the kits. I am currently finishing up on the cableing and will start running the check out and adjustment routines soon. If you want to do something in the hobby area and want to do it with manipulation, this is THE best buy for the money. Now it is not industrial grade, but is it the best for the hobbiest. All of the major mechanical and structural work is done for you. It will still take you some time to interface it to a computer. John W. Gutmann - SYSOP Robots R4U

Date: 10/27/91 (04:06) Number: 5 of 9 (Echo)
From: JOHN GUTMANN Refer#: None
To: ALL Rcvd: No
Subj: HERO ARM CONT Security: Public

More on the Hero Arm kit--
Well I ran out of space, so here I go to continue. The Hero arm kits sell for $179.00. I called on 3/14/91 ordered 2 kits and they said they ha sold out of the 2000 "B" kits and sll all the" Arm and base kits" They had 84 Arms kits left. My guess is that these will be gone in a week. You probably have 2 weeks at the most. They wont last long. If you consider that Mendelson is nationwide, and with 51 states, that means there is less than 2 per state left.
The motors are 12v dc an are driven by a H bridge. The motors all have opto encoder wheels to attach to the shaft and quadrature detection circuit boards which provide A and B 90 degree Phased output signals. This gives you a closed loop servo for each joint. There are also mechanical limit, to detect end of travel. This is really a great deal for the money. I called HERO and they no longer sell the Hero robots. I called there 800 number and no luck there either. If you want one you need to call mendelson at 1-800-422-3525.
John W. Gutmann - Sysop Robots R4U BBS - 404-978-7300

Date: 10/27/91 (04:08) Number: 6 of 9 (Echo)
From: JOHN GUTMANN Refer#: None
To: SYSOP Rcvd: No
Subj: BBS Security: Public

HI, My name is John W. Gutmann and I am the SYSOP for Robots R4U BBS. I am interested in linking up callers from all over the USA who are interested in Robots. I am willing to post a bulletin on my BBS about your BBS, so that callers who discover my BBS will also find out about your BBS.
Robots R4U is online 24 hours a day, 7 days a week. There is one line operating at 300, 1200, 2400 baud 8N1, ph# 404-978-7300 If you will prepare a file before you call that is 70 characters per line and a maximum of 19 lines, you can save money on phone calls. When you enter a message you can send the file using ASCII into the message base.
Or if you have a bulletin or file you can immediately upload into the file section. On your first call, after registering you have 30 min plus to look around, upload, download, enter messages, and answer surveys.
I will upload to you a file named R4U.BBS. It is a sample call to my BBS, showing the bulletins, message topics, file listings, surveys and conferences. I will record this call and post it on R4U BBS. Please post my file, I will do the same for you, R4U SYSOP

Date: 10/27/91 (04:09) Number: 7 of 9 (Echo)
From: JOHN GUTMANN Refer#: None
To: ALL Rcvd: No
Subj: VIDEO ON ROBOTS Security: Public

Hey Mike,
I received your letter, thanks for replying. I am still in the copies of the Video tapes of the ROBO-SOG. Have MONEY Will SEND. What I need to know is how much and what do I get.
Also I am interested in copies of some of the Photographs slides or prints, either will be ok. Willing to send $20.00 for slides or prints. Willing to pay $5.00 for ship & handleing. Pleeeeeees...... send info. Willing also for $20.00 for video, tape, $5.00 ship and handleing. $50.00 comeing your way, if you can do it. Starved for info about ROBO-SOG. FEED ME.......
John W. Gutmann
Sysop Robots R4U BBS
404-978-7300

Micro gyroscope brings motion sensing to low-cost systems

Tom Williams, Senior Editor

A series of technical breakthroughs in gyroscope technology will soon open the doors for the use of gyroscopes as motion sensing devices in a wide range of computer-based systems including navigation and dead-reckoning systems, robotics and machine control, surveying systems, optical instrument stabilization, hand-held computers and more. The enabling technology is embodied in the GyroEngine by Gyration (Saratoga, CA). The GyroEngine is, quite simply, a low-power, low-cost, very accurate gyroscope about the size of a walnut that can be easily integrated into digital systems. Conventional gyroscopes are typically expensive ($1,000 to $200,000), bulky, heavy, and must be manufactured with precision-machined metal parts. The GyroEngine is manufactured using injection molded polycarbonate plastic, measures 1.25 • 1.75 in. and consumes 0.1 W of power at -3 V.

Gyroscopes operate on the principle of the momentum of a spinning flywheel. Once in motion, the spinning mass resists changes to its angular attitude. In typical gyroscopes, the wheel is mounted on a pair of gimbals that lets the housing—and the plane or ship that contains it—rotate freely around it. Motion sensors in the gimbals relay changes in angular attitude that can then be sent to a gyrocompass or other control system. Typically, these motion sensors are magnetic- or potentiometer-based and require digital-to-analog conversion to yield the digital data needed by a computer. Balancing parts requires precise machining and measurement.

Optical motion sensor

One of the major breakthroughs in the GyroEngine was the development of an optical motion sensor. The optical sensor requires only one sensor for two degrees of motion and it gives a direct digital readout without analog-to-digital conversion. An LED shines light through a ring perpendicular to the spin axis of the wheel. On the ring are lines for optical sensing. In a hole at the gimbal bearing perpendicular to that axis is another grid with radial lines which the light also passes. The interference or moire pattern created by the two grids changes characteristically when the housing is rotated along either axis. A quadrature photosensor picks up the changing pattern which is interpreted by a microcontroller on a small external circuit board.

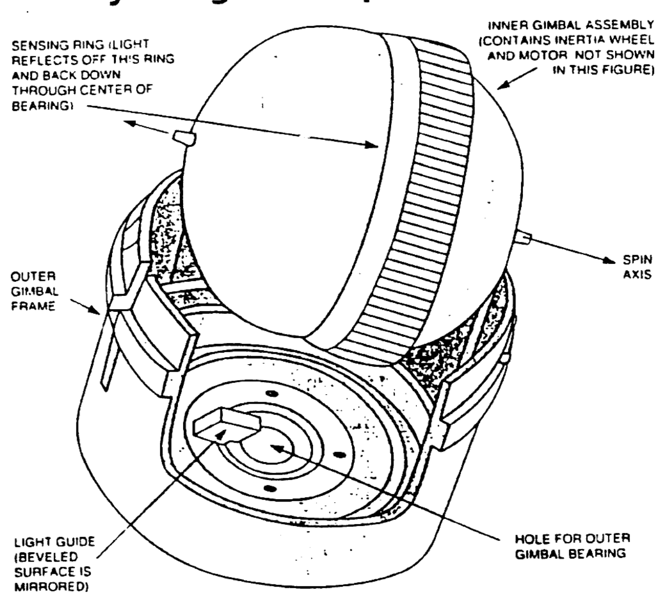
The grid resolution is 2,300 lines/in. and the angular resolution is currently 10 bits/degree. Gyration can produce GyroEngines with greater or less accuracy, with corresponding differences in price, depending on customer needs, says president and CEO Tom Quinn. The raw output of the GyroEngine is parallel, but is also convertible to RS-232 or RS-422 for use in a cursor-pointing device, for example.

Plastic replaces metal

Another breakthrough is in manufacturing. Quinn notes, "Plastic has an almost guaranteed volume weight." Thus, injection molded plastic yields parts of uniform weight and shape so that the only precise balancing required is in the flywheel and that's a matter of shaving just a little metal, Quinn says. The gyroscope and motor are mounted on jewel bearings and the motor control electronics are contained on a surface-mount chip within the motor itself. "This gyroscope has been designed so that we can make two gyros per minute," says Quinn.

Gyration is incorporating the GyroEngine in a product, indeed a pointing device, for use with laptop

GyroEngine - exploded view



The GyroEngine's flywheel and motor are encapsulated in a fluid-filled shell and a system of gimbals that sense two axes. Light shines through a grid of lateral marks on one axis and through a radial grid in a hole on the other axis. The interference pattern of light passing through the two grid systems allows direct digital data sensing of angular changes on two axes.

"The common lunar lander is exactly the kind of thinking we need to get the exploration initiative started and get some early missions going back to the moon," Griffin told *Space News* November 4.

The next step in developing the lunar lander proposal is to get congressional funding for further engineering studies of the concept, Griffin said. "All I can say now is that we're working on that. We think we see a way to do important things early on," he said.

Tethered microrobots could be deployed from the lander to sample rocks and conduct other research on the lunar surface, according to a paper presented at the workshop by Paul Spudis, a research scientist at the Lunar and Planetary Institute in Houston.

Other workshop participants said a variety of engineering experiments could be carried to the lunar surface, using the same basic lander, to help validate lunar outpost building techniques, or to demonstrate mining equipment to process hydrogen, nitrogen and helium from the moon's soil.

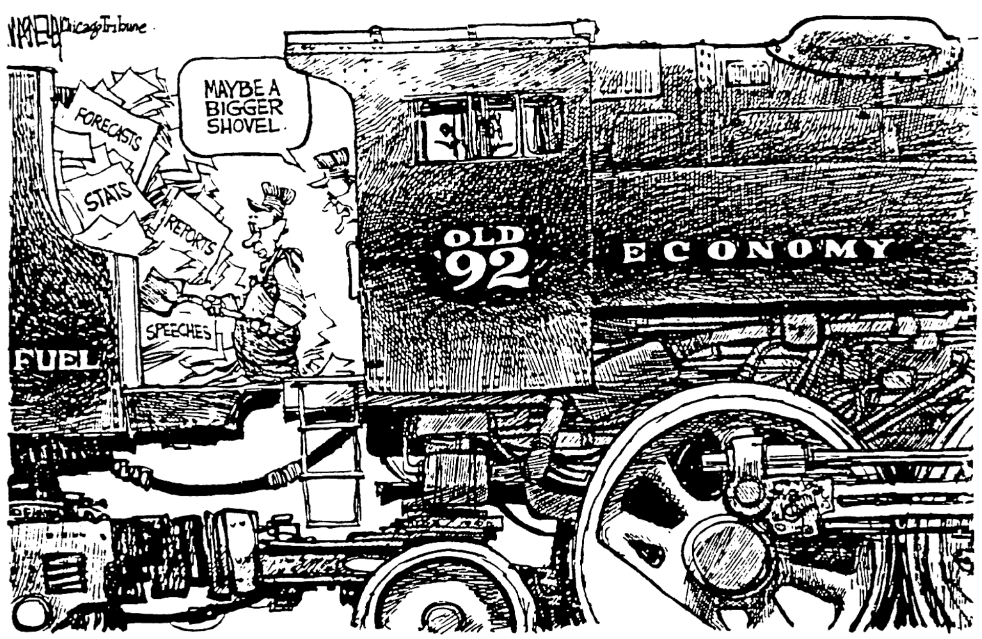
Artemis payloads also could include a one-meter (3.3-foot) diameter lunar telescope that would yield images 10 times sharper than a similar telescope could achieve on Earth, said Jack Burns, head of the astronomy department at New Mexico State University in Las Cruces. The Earth's atmosphere distorts light coming into a terrestrial telescope; the moon has no atmosphere and so lunar telescopes can achieve sharper images for a given size of instrument.

"There are a number of exciting astronomical experiments that the lunar lander could carry before the end of the decade. The secret is to keep it small and cheap, and do good science," Burns said.

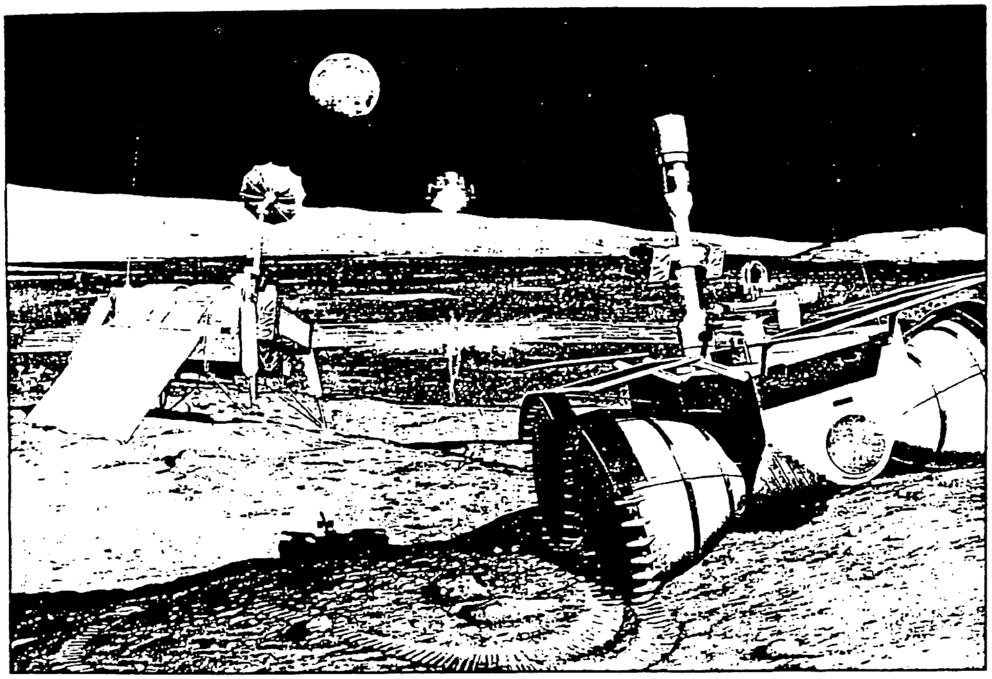
Although no formal nod has been given to implement the Artemis project, Artemis engineers and scientists in the new initiatives office have focused on readying a lunar lander for a 1996 launch date. They are reviewing the possible use of Atlas 2, Titan 2 and Delta 2 launch vehicles as potential boosters for the lunar lander. "As for costs, it is just too premature to detail what the cost of the program would be. We're not a program yet," said Bailey.

Bailey noted that some lunar science experiments being carried out on Earth are very expensive, and speculated that a low-cost common lunar lander might make it less expensive to send experimental apparatus to the moon itself rather than try to simulate the lunar environment in terrestrial laboratories.

To maintain low program costs and achieve a fast-paced schedule, Bailey said Artemis would draw upon the knowledge gained from the Apollo lunar landing program, the automated Surveyor lunar lander series of the 1960s, and the Viking Mars landers of the 1970s.



SPACE NEWS November 11-18, 1991



NASA JSC ARTIST'S CONCEPTION BY PAT RAWLINGS SAIC

Robotic lunar landers are busy at work

gathering samples and studying the moon in a lunar facility of the future. In the distance at center, a manned lander is descending to the moon's surface. On the left is the Artemis lander, which carries the site survey rover, at right. The Artemis lander extends inflatable ramps to let the survey rover out to roam the lunar surface. NASA scientists are studying how robots can help gather information needed in establishing a permanent lunar base in the future. *See story, page 13.*

NASA Works Toward Low-cost Robotic Lunar Lander

WASHINGTON — NASA is studying the possible use of robotic lunar landers in the late 1990s to gather data needed to establish a permanent lunar outpost, to find sites for astronomical telescopes, and to test equipment that could convert lunar resources into oxygen, fuel and construction materials, according to space agency officials.

The concept has been tagged Artemis, named after the Greek goddess of the moon who was the twin sister of Apollo. It could become an early technological component of the Space Exploration Initiative (SEI), U.S. President George Bush's plan to send astronauts back to the moon and onward to Mars, according to Michael Griffin, associate administrator for exploration in NASA's Office of Exploration. Griffin is directing the space agency's SEI effort.

The radar-guided robotic vehicles, each capable of landing with approximately 440 pounds of hardware on selected areas of lunar terrain, would be built principally from off-the-shelf hardware, Stephen Bailey, study team manager for the new initiatives office at NASA's Johnson Space Center in Houston, said in a November 5 interview. By developing a common lunar lander, packages of experiments geared for different purposes could be targeted to various lunar locales.

Bailey said the landers themselves would be platforms employing radar guidance systems to locate their landing sites, rockets to decelerate onto the lunar surface and legs to absorb the shock of landing. The various payloads for exploring the lunar surface would ride to the surface atop the landers. No mockups of the lander have yet been built.

Bailey led a group of about 20 people at the new initiatives office who conducted an informal three-month study of the common lunar lander idea, and the approach subsequently has been embraced by Griffin.

The new initiatives office conducted a two-day workshop on the Artemis project in July at Johnson to determine what sort of experiments researchers could conduct if 440-pound payloads were delivered to desired locations on the lunar surface.

Contrary to the laws of physics and common courtesy, it is possible to be in two places at once.

to workstation computers—GyroPoint. GyroPoint incorporates two GyroEngines to sense motion in three degrees of freedom. A single gyroscope can sense at most two degrees of freedom. A button on the device lets the user select whether the device is sensing three degrees of translational (i.e., lateral) or rotational motion. A system using two GyroEngines, therefore, can sense all six degrees of freedom in a 3-D coordinate system.

Gyration will be supplying GyroPoint as a development kit including the pointer device, drivers and software. "If you could mount the GyroPoint firmly in a car, you could combine it with some software in a laptop, bring in data from the speedometer and with some software build an automobile navigation system," says Quinn. Mapping software from companies such as Etac (Menlo Park, CA), which make automobile navigations systems currently depends on sensor data from a vehicle's wheels. Wheel sensors give forward and backward motion data and by measuring the differential between wheel rotation, also give angular turning data.

The problem with wheel sensors is that they are expensive to install and computing the turning angle from differential data requires processing that's not needed with a gyroscope, which gives direct angular data. According to Quinn, newer cars with digital instruments will soon have digital speedometer data available at the dashboard; integrating a gyroscope-based navigation system should become a lot easier and less expensive.

The small size will also make it easier to put gyroscopes in devices such as robot arms, portable surveying equipment and hand-held systems that work with the global positioning system (GPS), the satellite navigational system that let "Stormin' Norman" execute his huge flanking maneuver in Operation Desert Storm.

"GPS gives you position, but it doesn't give you a heading," says Quinn. Also, GPS updates only about every three to four minutes. While it can be used with a magnetic compass for easy navigation, use with a gyrocompass will allow automated navigation for aircraft, missiles, ships, and robot vehicles of all kinds, and a sensor as small and low-powered as the GyroEngine is expected to let automatic navigation penetrate into ever smaller systems. ■

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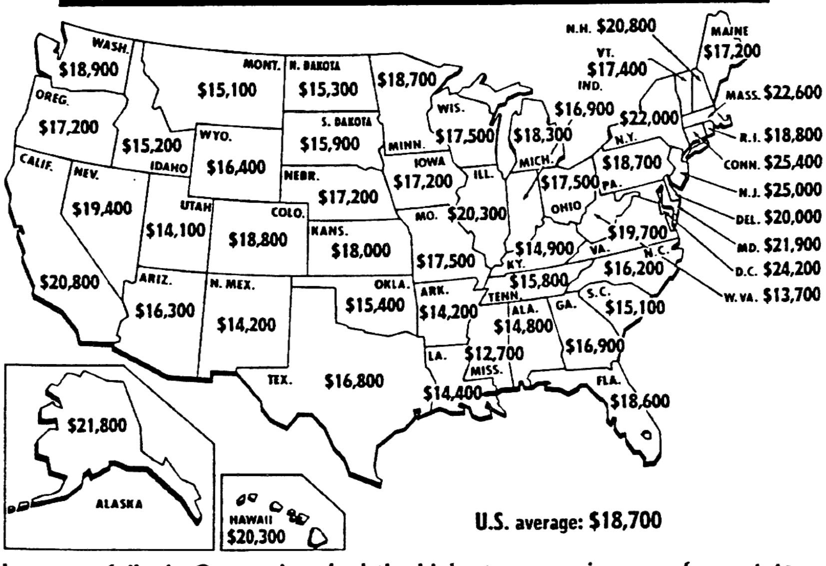
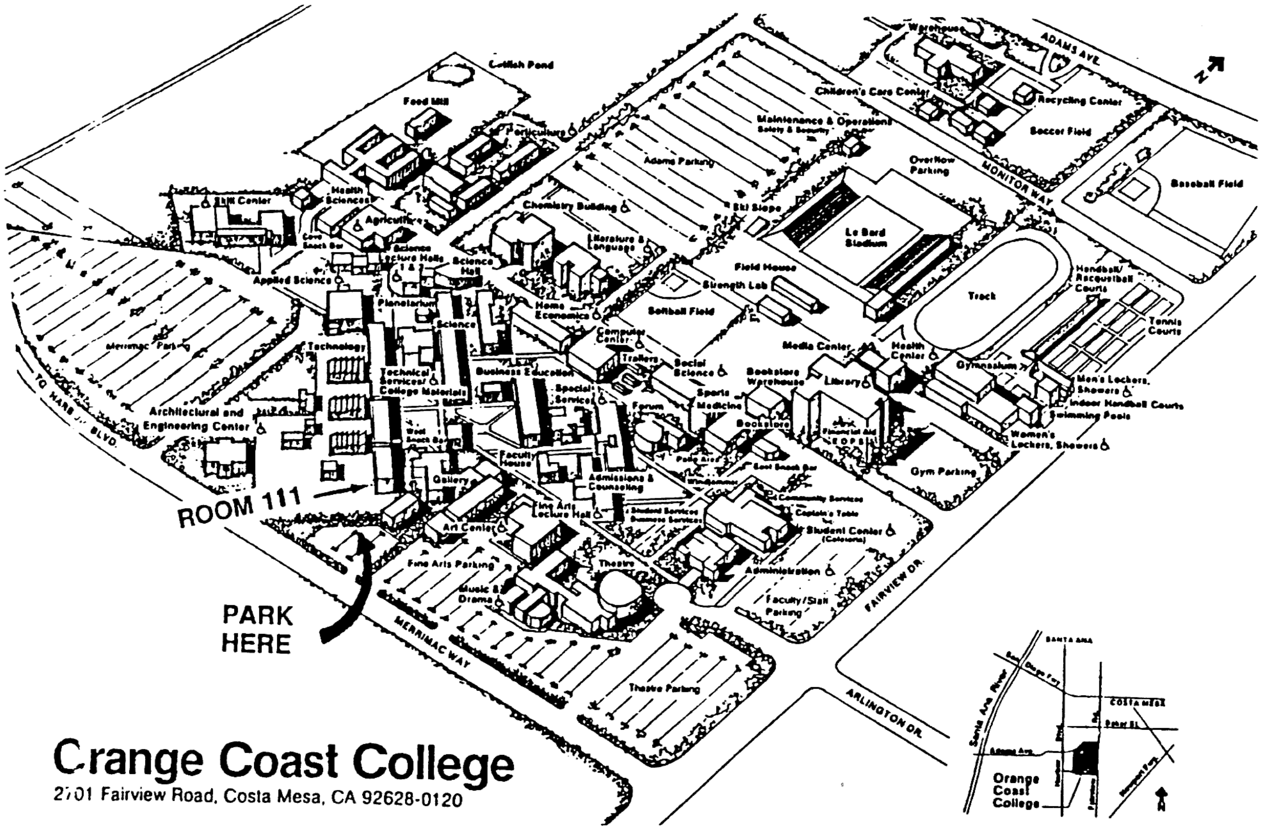
Etac
(415) 328-3825
Gyration
(408) 255-3016

Average incomes, state by state



Last year folks in Connecticut had the highest average income of any state — $25,400 per person, compared to the U.S. average of $18,700, reports the Commerce Department. This map shows the average income per person in each of the 50 states and Washington, D.C. New Jersey residents boast the second-highest earnings — an average income of $25,000 per person. Mississippi's citizens registered the lowest average income — $12,700.



Robotics Society of Southern California
104[illegible]1 South Brookhurst,
Anaheim, Ca. 92804

Two IC Tachometer

A standard shaft encoder's A and B ports generate square waves with the same frequenmcy as the shaft turns. The phase of A will lead or lag that of B by 90°, depending on the direction of rotation. To obtain maximum resolution, the tachometer circuit must count every change of state for the A and B signals. Each such change causes a change of state at IC_{1A}'s output, followed by a 1-μsec negative pulse at the output of IC_{1C}. These clock pulses' positive (trailing) edges cause the counter to count up or down according to the direction of shaft rotation.

You should set the R_1C_1 time constant such that it is approximately twice that of the R_2C_2 product, to ensure adequate setup and hold times for the up/down signal with respect to the positive clock edges. IC_{1C} supports this timing requirement by producing clock pulses of similar duration for either positive or negative transitions from IC_{1A}.

The exclusive NOR logic of IC_{1B} generates the correct polarity of the up/down signal when necessary, at the positive clock edges, by combining the A value with the B value just prior to a transition of either A or B. C_1 provides memory by storing the B value voltage for about 2 μsec. To understand this single gate encoding, note that because the phase relationship of B and A is ±90°, adding -90° to B makes the phase difference 0° or -180°, depending on the direction of rotation. Therefore, an exclusive NOR operation on A and a phase shifted B produces a logic 1 when the inputs are in phase, or a logic 0 when they are 180° out of phase.

If necessary, you can invert the up/down signal's polarity by swapping the A and B inputs or by using a fourth X-NOR gate as a selectable inverter butffer. To invert the clock signal, substitute identical pinout, X-OR gates for the X-NOR gates. And, if necessary to guarantee standard CMOS rise and fall times, you should buffer the A and B signals with Schmitt trigger gates. The maximum frequency for A or B is approximately $(4R_1C_1)^{-1}$.