Robotics miniFAQ For Beginners

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Contents

What's New ?

This updated miniFAQ:

- Updates some of the product descriptions and adds a few links. All links checked as of the distribution date.
- Adds special subsections on Grippers and Wheel Hubs in the Parts section

Why A miniFAQ ?

Requests for information on robotics from beginners appears from time-to-time on various newsgroups and list servers. The response to these requests is highly variable depending on when and how the request is stated. Sometimes no reply is given at all. The original Robotics FAQ is an out-of-date (by several years), no longer maintained, lengthy document that may be imposing to a beginner and, running at over 400 pages, is burdensome to read on-line or to download and print. Hence the perceived need on my part for a miniFAQ that covers some of the basics while being admittedly limited in scope, making no pretension towards completeness or political correctness. This document is oriented for beginners and also contains material of interest to more advanced users.

Scope

This miniFAQ is intended as a source to find the answers to questions most often posed by beginners – where do I start?, what do I need to know?, where can I find information and supplies?, and where do I go for help? The information given here is from my personal perspective and comprise a list of sources that I have found useful. Enough links are provided so that those interested can find what they are looking for (in the way of robotics). I have endeavored to make the miniFAQ concise and have not included references to material on pick-and-place or remote-controlled machinery.

Where Can I Find Information on Robots and Robot Clubs?

Your public library and the Internet contain a wealth of information on robots, mobile and industrial. Below are a few general links that have extensive references to other robot web sites. Only a few of the larger robot club web pages are cited, in general those that contain a variety of useful information to those outside the club's geographic area. Other clubs wishing links herein are welcome to contact the author.

GENERAL INFORMATION LINKS

1. Robotics Internet Resources Page
   www-robotics.cs.umass.edu/resources.html

2. Robot News, Projects, Articles
   www.robots.net/

3. Robot Competition FAQ
   http://robots.net/rcfaq.html

4. JPL/NASA Robotics Reference Page
   http://robotics.jpl.nasa.gov/

5. Association for Unmanned Vehicle Systems International (AUVSI)
   www.auvsi.org

6. BEAM Robotics – a minimalist, counter-culture approach to robotics
   www.solarbotics.com/

NEWS GROUPS

There are only two robot newsgroups that I'm aware of. There are many related newsgroups in the "sci" and "rec" categories.

1. comp.robotics.misc
2. comp.robotics.research
3. sci.electronics.design
4. sci.electronics.misc

LIST SERVERS

There are a great many of these. To avoid being inundated with individual emails, you

can often subscribe to a digest version which comes once a day. Three lists I recommend for help with microcontrollers (see Section on microcontrollers below) are:

1. Basic Stamp list. Send a message to: majordomo@parallaxinc.com., with the word help in the body of the message. Instructions will be emailed back to you; save them for future reference.

2. BasicX list. Subscribe at http://groups.yahoo.com/group/basicx/

3. PIC list. Send a message to: LISTSERV@mitvma.mit.edu, with the word help in the body of the message. Save the returned instructions for future reference.

ROBOT CLUB LINKS

These pages have a broad list of links, newsletters, and other information on robotics.

1. Austin Robot Group www.robotgroup.org
2. Dallas Personal Robotics Group www.dprg.org
3. Portland Area Robotics Society www.portlandrobotics.org
4. Seattle Robotics Society www.seattlerobotics.org

What Introductory Books and Magazines Are Available ?

Whether beginner or advanced researcher, one needs to keep apprised of robot design and construction techniques, the state-of-the-art, and general activity.

ROBOT BOOKS

A selection of books geared toward mobile robots is presented below. For further information and ordering go to www.robotbooks.com, or www.bn.com. or www.amazon.com.

1. "Mobile Robots: Inspiration To Implementation," 2nd edition, by Jones, Flynn, and Seiger, 1998. ISBN 1-56881-097-0. A very good overview of mobile robots and subsystems. Goes into satisfying detail on many robot subsystems, including behavior-based control architecture. The book gives two detailed examples of mobile robots. My only complaint with this book is that it gives many examples of code and microcontroller hardware specifics for the 68HC11 microcontroller, applicable to an expensive kit sold by the same publisher.

2. "The Robot Builder's Bonanza," 3rd edition, by Gordon McComb and Myke Predko, 2006. ISBN**:** 0071468935. Covers many areas at a beginning level: tools needed, sensors, motors, batteries, materials, etc. This is a vastly enlarged and improved edition of the 1987 classic, about double the length, and has corrected the errors of the first edition. This is a very good book by the master of amateur robotics with a wealth of idea and techniques for robot construction.

3. "Building Robot Drive Trains", by Dennis Clark and Michael Owings, 2003. ISBN 0-07-140850-9. As the title implies, the book concentrates on motors, motor mounting, electronic motor control, wheels, tracks, and multipods. Motors include DC gearhead motors, R/C servos, and stepper motors (advanced stepper techniques are not covered). Many details on mounting, coupling, and modifying parts are covered well. This is a good, entry level book on the subject of drive trains.

4. “Constructing Robot Bases”, by Gordon McComb, 2003. ISBN 0-0-140852-5. A thorough book that covers construction materials, tools, techniques, and hardware, as well as basic robot bases, frames, drive geometries, batteries, and power systems. Lots of useful tables and practical advice. This is a comprehensive book which I strongly recommend for beginners and those without construction experience,

5. “Introduction to Autonomous Mobile Robots”, by Roland Siegwart and Illah Nourbakhsh, 2004. ISBN 0-262-19502-X. This is the best book available for those serious about building autonomous robots that operate in real world environments. It covers basic locomotion types, robot kinematics, perception, localization, and planning and navigation, albeit concisely. The book is mathematically rigorous in places but those parts can be skipped and the major ideas are still comprehensible. The brief 300 pages covers the major competing techniques used with success by university researchers. The book is meant to be an introduction not a cookbook, but I know of no better source for planning, navigation, and localization techniques.

6. “Introduction to AI Robotics”, by Robin R. Murphy, 2000. ISBN 0-262-13383-0. This book is the first of it’s kind on the market that covers the essentials of artificial intelligence as applied to programming robots. There is also a large section on navigation techniques, a small part of which is mathematically intense.

7. “Practical Electronics for Inventors”, by Paul Scherz, 2000. ISBN 0-07-058078-2. This is a very good, introductory book on electronics. It covers the basics at a practical level with some excellent analogies. The author uses mathematical expressions occasionally, including derivatives and integrals, but calculus is definitely not required for understanding the text. The coverage is very good and I would recommend this over The Art of Electronics for its simplicity and straightforward applications. As a first edition, there are a number of errors in the some of the mathematical expressions.

8. “Practical Robotics: Principles and Applications,” by Bill Davies, 1997. ISBN 0-968183-0-X. Written as a text for a course in engineering design, this is a very useful compendium on homebrew mechanical and electronic construction techniques and lots of practical tips.

9. “Sensors for Mobile Robots: Theory and Application,” by H. R. Everett, 1995. ISBN 1-56881-048-2. An excellent book that goes into detail on a great many sensors, from simple to very complex. An excellent reference book. Some parts are highly technical.

10. “Artificial Intelligence and Mobile Robots: Case Studies of Successful Robot Systems,” by Kortenkamp, Bonasso, and Murphy, 1998. ISBN 0-262-61137-6. Case studies of working robots in the areas of mapping and navigation, vision, and mobile robot architectures. Some chapters are easy to read, but mostly this is at an intermediate-reading level.

11. “Navigating Mobile Robots: Systems and Techniques,” by J. Borenstein, H. R. Everett, Liqiang Feng, 1996. ISBN 1-56881-058-X. Surveys sensors, systems, methods, and technologies used in mobile robot navigation, detailing relative and absolute position measures including odometry; inertial navigation; active beacons; artificial and natural landmark

recognition; and model matching. A little advanced in parts.

12. "Robo Sapiens: Evolution of a New Species", by Menzel and D'Aluiso, 2000. ISBN 0-262-13382-2. This book is a collection of a great many photographs and interviews with robot researchers around the world. There is a lot of coverage on anthropomorphic robots but others are covered as well. Some very brief specs are given for the various robots. A good non-technical overview of current research in this area.

13. "Service Robots: Products, Scenarios, Visions", by Schraft and Schmierer, 2000. ISBN 1-56881-109-8. The book defines service robots as those between industrial and personal robots, and surveys current products and research in seventeen service sectors from agriculture to underwater. The coverage seems weighed toward European efforts but covers research from around the world. I would have liked a clearer distinction between products, working models, prototypes, and just ideas.

14. "The CMOS Handbook," by Don Lancaster, revised by Howard Berlin, 1987. ISBN 0 672-22459-3. A classic. Although somewhat dated, an excellent introduction on CMOS chips, logic, timers, counters, shift registers, etc. with very worthwhile tutorial sections on basic digital circuits. I highly recommend this book for beginners to digital electronics. However, you may want to substitute the 74HCXX for the older, but still highly serviceable, CD4000 family of chips.

15. "Easy PIC'n" (ISBN 0-9654162-0-8), "PIC'n up the Pace" (ISBN 0-9654162-1-6), and "PIC'n Techniques" (ISBN 0-9654162-3-2) by David Benson. Introductory and intermediate level books on programming the PIC microcontrollers. Also, "Serial PIC'n" (ISBN 0-9654162-2-4) by Roger Stevens, a comprehensive text for implementing serial communications between a Microchip PIC microcontroller and an external device. I highly recommend these books. Square One Electronics, www.sq-1.com, (707) 279-8881. These are the simplest books on PIC programming referenced here. New titles are added from time to time.

16. "Programming and Customizing the Basic Stamp Microcontroller," by Scott Edwards, 1998. ISBN 0-07-913683-2. Assumes no special prior knowledge, well illustrated and full of example code.

ROBOT MAGAZINES

1. *Robot*, www.botmag.com, a new quarterly robot magazine (four issues published to date). Maplegate Media Group, 650 Danbury Road, Ridgefield, CT 06877. Phone: (203) 431-7787.

2. *Servo*. A monthly magazine devoted purely to amateur robotics. Supporting web page at www.nutsvolts.com. Nuts & Volts Magazine, 430 Princeland Court, Corona, CA 91719 USA . Phone: (909) 371-8497.

3. *Nuts & Volts*. A monthly publication of electronics, including amateur radio, cellular communications, computers, lasers, and more along with build-it-yourself electronics project. Supporting web page at www.nutsvolts.com. Nuts & Volts Magazine, 430 Princeland Court, Corona, CA 91719 USA . Phone: (909) 371-8497.

There are many electronic magazines that indirectly support robotics such as *Circuit Cellar* (www.circellar.com). I suggest browsing these at newsstands to find those that are compatible with your skill level and interests.

Where Can I Find Parts For My Robot ?

There are three general categories: Radio Shack; local electronics, R/C hobby, or ham radio supply stores; and mail order. Mail order carries the largest selection and generally the best price. Radio Shack is good when you need just a couple of some things and don't want to wait, but the unit price can be two or three times the mail order price. Radio Shack is also on-line and stores have stopped producing a catalog. They also have decreased the variety of components carried in the retail stores but sometimes the stores have items in the store room if you ask them to check.

Starting with the miniFAQ August 2006 edition, special subsections following the vendor list will be added for selected parts.

Small businesses specializing in robot building parts: microprocessors, sensors, electronics parts, kits, building materials, etc. These sites are well worth visiting (listed in alphabetical order).

1. Acroname Electronics, www.acroname.com. Acroname (Steve Richards) has developed an excellent line of robot products over the last several years, in particular a wide variety of commonly used sensors, plus a variety of small motors, wheels, special connectors, drivers, controllers, and Acroname's own variety of microcontroller. Very reliable and responsive service.

2. Budget Robotics, www.budgetrobotics.com. Relatively new supplier by well know robotics author Gordon McComb. Expanding line of products specializing in expanded PVC construction material, hackable bases, small wheels, and a variety of specialized parts, and now grippers.

3. Gamatronix, http://www.gamatronix.com/. Very inexpensive, LMD18200 based, dual H-Bridge driver, and a unique motor driver with quad encoder readers and PID built in.

4. HVW Technologies, www.hvwtech.com. A Canadian company with motor controllers, sensors and some miscellaneous parts for robots.

5. Robot Books, www.robotbooks.com. An excellent variety of robot books on several levels, videos, kits, parts for large robots including a combat robot class motor (not cheap), and specialized building materials.

6. Robot Electronics, www.robot-electronics.com/. Located in the UK, formerly known as Devantech (Gerry Coe) makes the best robot sensors and motor drivers available. Some of these are distributed by Acroname.

7. Robot Shop, www.robotshop.ca. A Canadian company with an excellent selection of small motors (and mounting brackets!), sensors, IR beacon, motor drivers, microcontrollers, kits, and other supplies.

8. Robotics Connection, www.roboticsconnection.com/index.html. Lots of wheel encoders, specialized turrets and unique robot platforms, and the cheapest Sharp IR sensors.

Some of my favorite catalog suppliers, in alphabetical order, are:

1. All Electronics, www.allelectronics.com. Excellent prices for electronic odds and ends. (800) 826-5432.

2. Alltronics, www.alltronics.com. Variety of electronic parts. (408) 943-9773.

3. C and H Sales, www.candhsales.biz/cgi-bin/shop991/shop.pl/page=start_shopping.htm On-line catalog a little cumbersome; printed catalog sent with order. Very good selection of DC gearhead motors. Always check here for DC gearhead motors (try both the "motors" and "encoders" categories). (800) 325-9465

4. Digikey, www.digikey.com. Complete catalog of all the standard electronic parts. Also carries Basic Stamp, lots of Microchip parts, and a modest variety of semiconductors. Speedy service, moderate prices. (800) 344-4539.

5. Electronics Goldmine, www.goldmine-elec.com. Small catalog of odds and ends, stock moves quickly. (800) 445-0697.

6. Herbach and Rademan, www.herbach.com. Surplus parts. Good source for small motors and a variety of mechanical parts. (800) 848-8001.

7. Images SI, www.imagesco.com. Has a nice servo operated, two axis gripper, servo motors and brackets, sensors, and some other robot parts.

8. Jameco, www.jameco.com. A great variety of parts, components, kits, semiconductors, etc. Recently expanded line including more robotics parts. Good source at good prices. (800) 831-4242.

9. Marlin P. Jones, www.mpja.com Misc. electronics parts. (800) 652-6733.

10. McMaster-Carr, www.mcmaster.com, the super mechanical parts supplier, from nuts and bolts to forklifts. Very fast delivery. Ask for the printed catalog; because of the large size, it's much easier to browse than the on-line version.

11. Mouser Electronics, www.mouser.com. Large selection of semiconductors and other components. (800) 346-6873.

12. Radio Shack, www.radioshack.com/ Large selection of electronic parts, tools, and kits, and other goodies. RS has started to reduce the inventory of components in their retail stores and no longer have a paper catalog. The on-line catalog has many more items than are carried in the stores. (800) 442-7221.

13. Robot Store, www.robotstore.com, now part of Jameco.

14. Servo City, www.servocity.com. Carries most everything for R/C servos, including repair kits, servo horns/arms/linkages, servo mountings including right angle and x-y axis, transmitters, speed controllers. Also carries some shaft couplers and servo gears, chains, and sprockets

15. Small Parts, www.smallparts.com Rod, bar, sheet, tube, screw, fasteners, and all manner of small mechanical parts in a variety of metal and plastic materials. Informative catalog. Premium prices, comparison shop with other sources. (800) 220-4242.

16. Tower Hobbies, www.towerhobbies.com . General R/C hobby plane, boat, car supplier; also carries small servo motors and a variety of wheels. (800) 637-4989.

Special Parts

Grippers – most suppliers don't carry grippers and the several that are available vary considerably in style and size. Professional grade grippers are machined and expensive. Those referenced here are relatively inexpensive, however, the movements are generally imprecise and only approximately repeatable. In all cases check your order for details; some come with servo(s), some don't. In addition, some grippers also are available with associated robotic arms or wrist movements (and additional servos). There are two griper styles: either a scissor action, in which the gripper jaws pivot from a common point, or the more complicated parallel mechanism, in which the jaws remain parallel while opening and closing. Note that although the gripper size openings vary quite a bit, they can be modified by cutting and bolting on jaw extensions. This works fairly well if the servo has enough torque to supply sufficient force for your needs. Many grippers allow different servos to be fitted, in which case you may want to buy the bare gripper, if available in that configuration. In alphabetical order by supplier:

1. Budget Robotics, www.budgetrobotics.com, offers two scissor style grippers: a Gripper Kit (KIT301) and the Big Gripper (KIT305).

2. Images SI, www.images.com, offers a parallel jaw gripper (GR-01).

3. Lynxmotion, www.lynxmotion.com, offers many different arm assemblies but only one gripper, the parallel jaw Lynx A Gripper Only kit (LAG-KT).

4. Pololu, www.pololu.com, carries a scissor type, the Joinmax Digital gripper kit (0093).

5. Robodyssey, www.robodyssey.com, offers a scissor Gripper Kit (GKWS).

Wheel Hubs – mounting wheels to motors presents special challenges, the most obvious of which is that the motor shaft is probably not the same size as the wheel axle hole. If the hole is smaller it can frequently be drilled out but mounting is problematical. The wheel may be modified so that a set screw clamps it to the motor shaft, although this may be difficult to implement on some wheels.. Better is a hub that is made to fit on a shaft and bolts to the wheel. The hub mounts to the shaft with one or two set screws. Even if the shaft has a flat portion, the screw will eventually back out and the wheel will slip on the shaft. To prevent this use a drop of

removable Loctite. Make sure it is the removable kind or the screw will never come out (Loctite Blue works well). If you absolutely, positively want to ensure no slippage, you can, with difficulty, drill a hole through the shaft so that the set screw enters the shaft and can be bolted on the other side. This may require a special numbered drill bit. If the shaft is hardened steel, a special bit available through machinery supply outlets will be required.

1. Jameco, www.jameco.com, (www.jameco.com/webapp/wcs/stores/servlet/CategoryDisplay?storeId=10001&catalogId=10001&langId=-1&categoryId=754055), or (www.robotstore.com/store/default.asp?catid=1560)
   An excellent variety of clamped and set screw hubs from 1/8 to 3/8 inch bores, and 4 to 6 mm bores.

2. Lynxmotion, www.lynxmotion.com, (www.lynxmotion.com/Category.aspx?CategoryID=42)
   A nice selection of hubs, some of which are also re-sold through Jameco.

3. Servo City, www.servocity.com, (www.servocity.com/html/servo_shaft_adaptors.html),
   Hub adapters for HiTech and Futaba servos that allow the servo to drive shafts of various diameters.

What Sensors Are Used For Mobile Robots ?

A mobile robot needs many types of sensors. Which and how many depends on the robot's task and environment, and the sensor size, complexity and cost. Fortunately there are a variety of reasonably priced sensors that are effective and easy to use. A sensor's effectiveness depends on its placement, synergy with other sensors, output processing, and interpretation. Sensors are used to either help the robot to move around or to accomplish some task besides mobility. Some sensors serve both purposes. We won't attempt to be comprehensive but only refer to the most common sensors used. Refer to the book by H. R. Everett for more details.

1. Proprioceptive sensors measure some internal condition of the robot, for instance battery voltage or temperature. A variety of thermistors, precision resistors, or special chips are available.

2. Dead Reckoning sensors attempt to measure the position, speed, orientation, or distance traveled so that the robot can navigate in the blind, guessing its present position from its last know position. The most common dead reckoning sensor is a motor or wheel encoder. An encoder built into the motor is more accurate and convenient. Wheel encoders are usually ad hoc devices that involve a perforated disk or reflective strips attached to the wheel. These are sensed by a light sensitive detector. A Hall effect sensor may be used to sense magnets attached to the wheel.

3. Proximity sensors measure the closeness of a robot to something without actually measuring the range or distance. These sensors are most often used as a virtual bumper to avoid collisions. A illumination source and detector are frequently used together. This may be a simple incandescent bulb or LED or a modulated IR LED to reduce ambient light effects, and a phototransistor.

Ranging sensors measure distance, usually by triangulation or time of flight. These sensors are most often used for navigation and obstacle avoidance.

- Sonars. Sonar (SOund Navigation And Ranging) sensors measure distance by timing the time it takes a sound wave to make a round trip between the sensor (which both emits and detects the sound) and some reflecting surface.

  The best sonars are the one's made by Devantech (www.robot-electronics.com). Since they are made in England it's easier to order from US suppliers. Two are Acroname (www.acroname.com) and the Mark III Robot Store (www.junun.org/MarkIII/Store.jsp). You can find technical information on the Devantech site. The SRF04 is easier to use and less expensive than the SRF08, which has more capability. The SRF04 range is from 3" to 10 ft; the SRF08 from 1.5" to 17 feet and detects multiple reflections.

  Sonars from Polaroid (now made by SensComp) used to be the standard. They are bulkier, require more power, and are more expensive, but have a longer range, about 35 ft under ideal conditions, which may not be an advantage for most robots. However, they are more problematic and difficult to interpret with ranges beyond 15 to 20 feet.

- Infrared Rangers. A variety of these are made by Sharp and find distance by triangulation. Some of these sensors have a digital output, some analog, some operate continuously, some have fixed ranges. Different versions have ranges of 1.5 to 12 inches, 4 to 30", or 8 to 60". An important characteristic is the time between measurements, which is shortest for the continuous, analog devices. This update or sampling rate determines how fast the robot can move and still be aware of its surroundings.

4. Vision sensors are available as CCD and CMOS cameras. You can use any video camera and a PC with commercial or home brew image processing software but the smart way to go is with CMU Cam, a low cost, very powerful, compact unit developed by the robotics group at Carnegie Mellon University (http://www-2.cs.cmu.edu/~cmucam/). Photos and a users manual can be downloaded from the CMU site. Units can be purchased from Acroname (www.acroname.com) or Seattle Robotics (www.seattlerobotics.com/cmucam.htm), but check out the CMU site first.

5. Environmental sensors measure the presence of sound, electromagnetic energy (gamma and x-ray, ultraviolet, visible light, infrared, radio frequency), magnetic fields, vibration, chemical products, etc. These sensors are usually used to accomplish the robot task, other than moving around. There are too many sensors available to list here.

   - Sound or Acoustic Energy: a small, ceramic microphone will work. You'll need some additional circuitry and a way to filter out background noises, including the robot motor noise. Microphones with a build in preamp are available.
   - Electromagnetic Radiation
     - Gamma and X-Ray: not commonly used by amateurs, since this is a hazardous environment. Velleman makes an inexpensive kit to measure gamma rays and high energy beta rays (electrons).

- Ultraviolet: Hamamatsu makes a professional UV detector (used for fire detection) that works very well in the narrow UV range of 185 to 260 nm, the solar blind region. Available from Acroname and Hamamatsu directly.

- Visible: a very inexpensive light detector is a photoresistor made of cadmium sulfide (CdS). These are small and very inexpensive, and available from many sources including Radio Shack. A photocell will also detect light. A phototransistor should work but are usually rated for the red or near-infrared part of the spectrum.

- Infrared: For the near-infrared there are phototransistors; for the mid-infrared (8 – 14 microns) there are pyroelectric devices. A popular one is made by Eltec and is available from Acroname, HVW Tech, Jameco, and some of the surplus catalogs. You may want a kit that also includes a Fresnel lens to collect and focus the light on the detector. The pyroelectric sensor can be used to detect IR radiation from body heat or to detect the motion of an infrared emitting object (as in home security motion detectors).

- RF: these are not commonly used by amateurs. RF covers a very large frequency range. If a specific frequency is needed, a relatively simple detector circuit can be made. Electronic bug detectors work from about 50 MHz to 3 GHz, but are on the expensive side. There are also field strength meters made for amateur radio use for the 100 kHz to 500 MHz range that are inexpensive.

- Magnetic Fields: a pick-up coil will detect a changing magnetic field but will need some circuitry to amplify and filter the output. An electronic compass will also indicate magnetic fields, although these are usually made for detecting the Earth's relatively weak field and may saturate in strong fields. For strong, local field changes a Hall effect sensor can be used. These are mostly used to detect rotating ferromagnetic parts, or as switches triggered by magnets. Small reed switches are also used for magnetic switches. A compass may also be used for navigation. These come with (expensive) and without (inexpensive) correction for tilt. Caution: a basic physical law states that a sensor cannot differentiate between gravitational and inertial acceleration. That is a sensor cannot, in one measurement, distinguish between tilt and acceleration of a moving or turning robot. Two excellent compasses are the V2Xe from PNI (http://www.pnicorp.com) and the CMPS03 from Devantech (www.robot-electronics.com).

What's An Easy To Use Computer For A Robot Brain ?

This section is my personal introduction to those microprocessors I think are suitable for beginners. The simplest would be one of the Basic Stamp II versions - the other extreme would be an off-board Unix workstation running LISP. There is a lot of philosophical approach that enters here, as well as practicality, and, unfortunately, much computer machismo, as in my-computer-can-beat-up-your-computer. Only microcontrollers are discussed here. Since the miniFAQ is meant for beginners, here is my personal view, based upon ease of use:

1. Basic Stamp. This is the simplest microcontroller to start with. The Basic Stamp is manufactured by Parallax Inc. If you use a Basic Stamp, I suggest the BS2SX-IC. The price is from $ 49 to $ 99, depending on version, and there are good introductory books, lots of application notes and projects, and an active list server. It programs from a PC, and uses a form of the BASIC computer language (called PBasic). The manual and programming software are free from the manufacturer. The downside is that the processor is slow, memory space somewhat limited, depending on the Stamp version, only integer arithmetic, and there are no interrupts or timers available. There are about six versions of the Basic Stamp II, most have 16 I/O pins, and a version that runs Java. Check the Parallax site for a comparison of the different versions. One can't beat the price or the simplicity for a beginning system. Order from Parallax www.parallax.com or many of the electronics catalogs or suppliers listed above.

2. BasicX microcontroller. This microcontroller supports a multi-tasking operating system, floating point math , internal timers, built in A/D, 19 I/O pins, a basic language compiler, and 32 K of memory. The BX-24p, a 24 pin DIP that is pin compatible with the Basic Stamp II (i.e. You can substitute it in the same socket) are $ 49; a development system, including BX-24, is $ 99. A BX-35 has 25 I/O pins but needs other components. The development software and manuals can be downloaded from Netmedia's web site, www.basicx.com. The BasicX is far superior to the Basic Stamp in speed and function; however, if you are an absolute beginner, the documentation and application notes are less developed.

3. PIC microcontroller. There are several different varieties available. Beginners often favor the 16F84, but many, many varieties are available. The programming software and manuals are free from the manufacturer, Microchip. Look for the MPLAB package at www.microchip.com. The individual chips cost about $10. On the downside you need to purchase a programmer (from $60 to $199), and you'll need to put together a small board to carry the micro, its oscillator, and connection pins (printed circuit boards are available from MicroEngineering Labs, www.melabs.com) The advantages to using a PIC are: you have a lot more control over program structure and timing, access to interrupts, and execution speed is much faster. Order from Digikey for the largest variety. Ordinarily PICs are programmed in assembly language (see the books section above), but compilers are available for PBasic and "lite" versions of C.

4. Atmel AVR. This is a popular competitor to the PIC line of microcontrollers, with the usual enthusiasts (I'm told this is a better term than "nuts"), lined up on both sides. You can get started with a minimum set-up, the TinyAVR, from New Micros (www.newmicros.com), or go with the higher end MAVRIC IIB from Gamatronix (www.gamatronix.com). A search under the Vendor tab at www.avrfreaks.com, which can be ordered by distributors, will reveal other suppliers of the AVR single board computers. One reason this micro is popular is the availability of a free, executable, open source software development tool hosted on Windows platforms. It is available at: http://sourceforge.net/projects/winavr/, and includes the GNU GCC compiler for C and C++.

5. PICStic. A series of Stamp-like microcontrollers, but with more capability and faster execution time. The PICStic also allows the use of assembly language programming and access to the PICs timers and interrupts.. Prices vary $29 to $139, plus development system prices vary from is $ 49 to $ 249. Order from Micromint www.micromint.com.

6. Handyboard. This is a relatively painless way to using the Motorola 68hc11 chip. The Handyboard contains the microcontroller, an LCD for debugging, 1 Amp motor drivers, a rechargeable battery pack, and 32K of battery backed RAM. Additionally, the package comes with good documentation and a free ware version of Interactive C, a multi-tasking version of C for the Handyboard. Cost of the basic packages is $299 from Gleason Research, www.gleasonresearch.com. Add on are available for additional costs. For technical details visit the handyboard site at http://handyboard.com/.

Are There Mobile Robot Kits Available ?

Many beginners prefer not to build a robot base and are more interested in programming an existing mobile platform and adding sensors and functionality. In contrast to the other parts of this miniFAQ, I don't have any personal experience with these kits and offer no evaluation of their merits. Kits and pre-built platforms offer a fast entry to building a working robot, at the expense however of higher cost and a generic design that probably isn't best suited to your intended application. Bought platforms can in many cases be modified and expanded, and are less frustrating to build for those without the tools, experience, or inclination for home construction. These products are available from the manufacturer, toy stores, and some of the suppliers above such as Acroname (www.acroname.com), Budget Robotics (www.budgetrobotics.com), Robot Books (www.robotbooks.com), and Robot Store (www.robotstore.com). You may also find these and other kits by searching the Internet.

1. Kits from $ 149 to $ 695. Robot powered by a Basic Stamp microcontroller. Available from Parallax Inc. (www.parallax.com).

2. Lynxmotion (www.lynxmotion.com/) offers a variety of walking and rolling robots, as well as robotic arm kits and grippers.

3. LEGO Mindstorms Robotic Invention System, available at toy stores. LEGO claims that, "A first-time user with basic PC skills can design, program, and build a simple robot within one hour." This product is suitable for interested children as young as ten to twelve with parental guidance. There are many books and user groups on the LEGO system.

4. Rug Warrior Pro. Available from A.K. Peters (www.akpeters.com/). An advanced kit, about $ 500, featured in the book, "Mobile Robots: Inspiration To Implementation".

5. OWI Robot Kits. A variety of small, inexpensive, single function robots Available from Robot Store, www.robotstore.com.

6. Seattle Robotics Society Workshop Robot. The Seattle Robotic Society offers an upgradeable "Workshop Robot". The Level 1 robot is available for $ 105. See details at: www.seattlerobotics.org/WorkshopRobot/kits.php.