



Robot Simulators on the Net

This list is an attempt to provide a centralized source of information on sites and groups that are producing **robot** simulation software which might be of interest to the academic or research community (eg freeware or shareware simulators sites). If you are new to this page, [see comment on simulators](#). Wherever possible we are maintaining links to the original developers site (to ensure the latest copies!). However, where developers do not have their own Web or ftp servers we are happy to keep code locally at this site. Most Simulators are well described by associated ReadMe docs. This list is maintained by Essex University and can only ever be as good as the information you provide, so please remember to keep us informed (eurobot@essex.ac.uk).



Autonomous Vehicle Simulation (ie Mobile Robots):

- [The ARS MAGNA Abstract Robot Simulator](#) - (email: Sean Engelson engelson-sean@cs.yale.edu) this simulator provides an abstract world in which a planner controls a mobile robot. Experiments may be controlled by varying global world parameters, such as perceptual noise, as well as building specific environments in order to exercise particular planner features. The world is also extensible to allow new experimental designs that were not thought of originally. The simulator also includes a simple graphical user-interface which uses the CLX interface to the X window system. The latest version of the software is available by anonymous ftp from <ftp://ftp.cs.yale.edu/WWW/pub/nisp/ars-magna.tar.Z> (about 0.5 Mbytes)
- [Autonomous Underwater Vehicle Virtual World](#) - (email: Don Brutzman brutzman@nps.navy.mil) This virtual world is designed from the perspective of the underwater robot, enabling realistic AUV evaluation and testing in the laboratory. 3D real-time graphics are our window into that virtual world. Visualization of robot interactions within a virtual world permits sophisticated analyses of robot performance that are otherwise unavailable. Sonar visualization permits researchers to accurately "look over the robot's shoulder" or even "see through the robot's eyes" to intuitively understand sensor-environment interactions. It is the author's hope to make this the beginning of a large-scale collaboration that uses the Multicast Backbone (MBone), Virtual Reality Modeling Language (VRML), DIS and the Web as ways to distribute 3D real-time graphics to a complete variety of operating systems & hardware. The virtual world and robot code (including Irix 5.3 binaries) are available at the NPS AUV Virtual World page. Three-level robot code compiles under gcc and has been tested under OS-9, SGI Irix and SunOS. A tutorial on the Underwater Virtual World was presented at IEEE AUV 96, June 3

1996 in Monterey. A [tutorial](#) and the original [dissertation \(ps\)](#) are available online together with the [software reference](#) accompanying the dissertation (in hypertext with connections to the latest software files). *Last accessed: July 1996*

- [The BASEMENT Vehicle Simulator](#) - (email: Mikael Sjödin mic@docs.uu.se or Mikael Emanuelsson Emma@Student.DoCS.UU.SE) according to the developers, this vehicle simulator is a tool for studying the the behavior of applications and the utilization of hardware resources. *Last accessed: June 1996*
- [BOTWORLD](#) - (email: Scott Benson sbenson@cs.stanford.edu) is a graphical simulator of a simple robot environment. The environment consists of several robots, called bots, bars, obstacles, and location beacons. These bots are equipped with motor effectors which allow them to translate forward and backward and to rotate about their axes, as well as grab and relocate bars and structures of bars. Bots can be set up to allow full sensing of the world, or to sense the world through a simulated sonar system. They can be controlled by LISP client programs which can be executed on different machines apart from the server and linked via TCP/IP. Message-passing and shared variable capacities allow communication among the bots. *Last accessed: Nov 1996*
- Crobots & the newer TclRobots (based on the tcl/Tk language) game for the PC by Tom Poindexter (tpoindex@nyx.cs.du.edu) test programming rather than human dexterity. The best source of information is [Tom Poindexter's Web page](#) (particulary for the very latest news and releases of TclRobots) and [Neil Fraser's CRobots Web Page](#) (nfraser@chat.carleton.ca) which is full of useful information, robot-code and links. *Last accessed: 28th Nov 1995*
- CodeWar by Rhett Jacobs (email: rdj@lab.cea.com.au) is a ``robot" type game, similar in flavour to programs such Tom Poindexter's CRobots and PCRobots. Programmers familiar with these programs will find CodeWar similar in aspects, but quickly realise that it allows competent programmers more facilities to extend themselves and their X-Craft. Rhett says his design goal was not to hold the hand of the competing programmers, rather, to provide an accurate simulation engine, and allow the programmers to do the rest. All communications are provided through TCP/IP sockets to a simulation server, with all competing programs running as separate processes. This means that X-Craft can be written in any language, and only binaries of competing X-Craft need to be submitted in competition play (in fact they do not even need to be submitted as they can be played across a network). Rhett now got a reasonably complete system up and running and is looking for programmers who would like to develop some X-Craft with which to use in the final distribution. The current system has been developed under Linux v2.0.20, X11R6 using Xlib and Xpm and thus should work on all UNIX systems. There is a developer's copy (crude, but functional) at <ftp://sunsite.unc.edu/Linux/incoming/codewar-0.1.tgz>. and interested programmers should contact Rhett at rdj@lab.cea.com.au
- C++Robots (conceptually based on CROBOTS) by Richard W. Rognlie is an ongoing "King of the Hill" (KotH) tournament in which players use the C++ language to create a control program for a robot whose mission is to seek out and destroy any other robots it finds. A good source of information is [Martin Müller Pedersen's Web page](#) (tusk@daimi.aau.dk)
- [EROS](#) Erann's Robot Simulator (email: Erann Gat gat@robotics.jpl.nasa.gov) is a robot simulation construction kit. It is designed to allow users to assemble their own robots from reusable software components and runs under Macintosh Common Lisp version 2.0 using Macintosh graphics and CLOS. This is part of [JPL](#) robotic work
- [Flakey](#) (email: Kurt Konolige of SRI konolige@ai.sri.com) is mobile robot simulator and controller based on the software used for the development of SRI's AI research robot robot of the same name. It is written in C, and requires Motif for the graphics. Additional information can be found in a set of [technical reports](#)
- [Khepera Simulator](#) (Ver 1.0) is a public domain software package written by Olivier MICHEL (email: om@alto.unice.fr). It allows to write your own controller for the mobile robot Khepera using C or C++ languages, to test them in a simulated environment and features a nice colorful X11 graphical interface. Moreover, if you own a Khepera robot, it can drive the real robot using

the same control algorithm (Khepera is a mini mobile robot developed at EPFL by Francesco Mondada, Edo Franzi and Andre Guignard of the Laboratoire de microinformatique, EPFL Lausanne; the K-Team). It is mainly aimed at researchers studying autonomous agents. This software is free of charge for research and teaching although commercial use is forbidden. Requirements include UNIX system & X11 library. *:Last accessed: 23rd Jan 1996*

- [LEE](#) (Latent Energy Environments) is both an Alife model and a software tool to be used for simulations (email: Filippo Menczer fil@ucsd.edu). It facilitates experiments in a broad range of theoretical, behavioral, and evolutionary biology issues. It is written in C code and runs in both Unix and Macintosh platforms.
- [MissionLab](#) from Georgia Institute of Technology is a system for simulation of military scout missions involving multiple mobile robots (email: [Douglas MacKenzie](#) or [Ronald Arkin](#)). It takes high-level military-style plans and executes them with teams of real or simulated robotic vehicles. MissionLab supports execution of multiple robots in simulation and includes device drivers for controlling multiple Denning MRV-2, MRV-3 and DRV-1 robots. The system relies on IPT, interprocess communications software from Carnegie Mellon University, for communication between the robots and mlab, the operator console. User manuals and supporting documentation are provided. The executables are suitable for SPARC-based Unix systems. The source can be recompiled under most Unix systems with X and Motif including Linux. It is available from the Mission-Lab web page link above, or via ftp from <ftp://ftp.cc.gatech.edu/pub/software/missionlab/mlab-0.85.tar.gz>
- [NuTank](#) - stands for NeuralTank (email: [Richard Keene](#)) In this program one is given the shell of a 2 dimensional robotic tank. The tank has various I/O devices like wheels, whiskers, optical sensors, smell, fuel level, sound and such. These I/O sensors are connected to Neurons. The player/designer uses more Neurons to interconnect the I/O devices. One can have any level of complexity desired (640k memory limited) and do subsumptive designs. More complex design take slightly more fuel, so life is not free. All movement costs fuel too. One can also tag neuron connections as "adaptable" that adapt their weights in accordance with the target neuron. Robot tanks are then introduced into the Scenario and allowed interact or battle it out. The last one alive wins. The entire program is mouse and graphically based. There are DOS & 32bit Windows versions available. A DOS version is available in [Shareware](#)
- [Robot Auto Racing Simulation \(RARS\)](#) - is a simulation of auto racing in which the cars are driven by robots (email Mitchell Timin: met7@cac.psu.edu Penn State Univ). Its purpose is two-fold: to serve as a vehicle for Artificial Intelligence development and as a recreational competition among software authors. The host software, including source, is available at no charge. RARS is written in C++ and runs under MSDOS and UNIX, including Linux, and on the Macintosh and Amiga. There is a [RARS anonymous ftp site](#) which contains code, announcements, car controllers, documentation, and tracks. There are several WWW locations devoted to RARS. For example try the [Mindwarp](#) or [Dave Gymer's](#) page. *Last accessed: Jun 1994*
- [PCrobots](#) (a 90K zip file) This a PC based mobile robot game which was supplied by a computing magazine (PCW) for a competition amongst their readers. The original article (which includes instructions) can be found in Personal Computer World (UK), Oct 1992, p378-382
- [SIEME](#) is a computer simulation platform that allows the user to create, test and modify the behaviors of the robots. The simulator has been designed by [Magnin Laurent](#). A simulated environment is defined using the Sieme syntax and there are a set of pre-written behaviors, which allow robots (MICROBs) to cooperate within a "soccer" team.
- [TechnoSphere](#) - an artificial life experimental simulation on a global scale. TechnoSphere is an arena in which digital creatures seek a future. Artificial life-forms compete for resources and develop their genetic potential for life. TechnoSphere is a world created by fractal geometry, inhabited by creatures grown from genetic algorithms and experienced by real people. The evolutionary development of the three-dimensional world will depend on the participation of an on-line public. It is a collaboration between Jane Prophet (University of Westminster), Gordon

Selley (London Institute), Andrew Kind (Excess Ltd), Julian Saunderson (Middlesex University) and Tony Taylor-Moran (London College of Printing and Distributive Trades). For more information email TechnoSphere@cairn.demon.co.uk

- [VirtualRobots](#) - is a 2D simulation of a mobile robot world (email: stanj@essex.ac.uk). It provides a "behavioral" simulation for developing and testing high-level mobile robot algorithms such as those for route planning and especially algorithms involving multiple, communicating robots. It uses the [PVM](#) (Parallel Virtual Machine) library to enable it to be run across any number of workstations thereby boosting its performance. The underlying architecture is object based making it relatively easy to extend and customize. For more information read [the manual](#) (about 40Kbytes) which contains an architectural overview and guide to the "Application Programmers Interface". It also contains suggestions for functions that you can develop to make the simulator more useful for all public domain users. Current developments include, improved sensor/actuator models (Davide Diemmi, Univ. Parma, email: diemmi%verdi.eng.unipr.it) plus a BT Plc project to support soft real-time distribution of a collaborating multiple user/robots version of this simulator across geographically widely distributed sites (more collaborating sites are needed). You can ftp [Source code for VirtualRobots version 4.0](#) (approx 1MB tar file) from the University of Essex. Technical queries are probably best answered by [Calvin Ching](#) who is currently with Motorola. The original viewers were developed for NeXTStep but an [XView module](#) (eg suitable for Suns; about 18KB tar file) was developed by Paul Martin (email: pamart@essex.ac.uk). Other viewers are currently under development.
- [Xmouse](#) - is a simple micro-mouse simulator running under X and was written by "Lloyd" Webber (adw@ukc.ac.uk). Xmouse is designed to run on colour X terminals (it works on monochrome but doesn't show as much information), and displays the maze the mouse knows, the complete maze, and the mouse on your screen. A number of mazes are included for you to try (in Xmouse/mazes) which came from the Essex archive (ftp.essex.ac.uk: pub/robots/Competitions/MicroMouse) *Last accessed: Jun 1994*



Robot Arm Simulations:

- [EASY-ROB](#) by Stefan Anton (email: 100744.135@compuserve.com) is a commercial Robot Simulation Tool with 3D graphic and animation. The user can design a robot kinematic, move the robot in joint and cartesian space, write a motion program, grab and release some thing, etc. A simple 3D-CAD System allows creation of basic elements such as block, cylinder, pyramide, cone and sphere in order to model a robot, tool and bodies. The user can rotate and translate the world view, zoom in and out and do a lot more. Online Help with Key is available. It runs on a standard IBM-PC (min 486DX recommended). No additional graphic power is required. A paper discussing simulation is also available; [RDS](#) - Realistic Dynamic Simulation of Robots. Last accessed: May 97
- [Encarnaco Robot Simulator](#) by Luiz Felipe Rudge Encarnacao (email: lfenc@antares.com.br) is a robot simulation that provides a full 3-Dimensional environment (wire frame graphics) with one fully moveable robot (5 axis). Control can be exercised via high level control mechanisms (ie grab, move and placing objects) or manually directed from the keyboard. There are several possible views (2 display areas and 15 possible virtual cameras). A camera can be placed in one "aeroplane" (ie allowing the user to "fly it" and use the resulting perspective as their view). With a mouse you point & click on an object and to make the robot grab it. Another click on some possible local will cause the robot to place the robot there. With keyboard you can control all parts of the robot and fly the "aeroplane". It runs on MS Windows 3 or above. Last accessed: June 96
- [Matlab Robotics Toolbox](#) by [Peter Corke](#) (email: pic@mlb.dmt.csiro.au) Last accessed: Oct

1994

- [Melbourne-Robots](#) a robot simulator written by undergraduates Andrew Conway and Craig Dillon on a Silicon Graphics workstation as for their electrical engineering project at the University of Melbourne. There is a latex user manual (inc. the mathematics) but not much in the way of installation instructions (ftp address no longer valid).
- [Robotica](#) is a collection of robotics problem solving functions for the Mathematica package. (Mark W. Spong email: spong@lagrange.csl.uiuc.edu). It has the capability of reading external simulation (e.g., SIMNON) output files and displaying the motion of the robot when subjected to the sequence of joint variables. It requires Mathematica and X-windows.
- [Simderella](#) is a popular simulator that was released to the world in 1993 by Patrick van der Smagt of the University of Amsterdam. It came out of his research into neural networks and robot control. The original software consisted of three programs, connel: the controller, simmel: the simulator, bemmel: the X-windows oriented graphics back-end. Simmel is the part which actually simulates the robot. It performed matrix multiplications, based on the Denavit Hartenberg method & calculated velocities with the Newton-Euler scheme.



Miscellaneous

- [Table Tennis Simulator](#) A two dimensional table tennis simulator created by students at Essex University



Organisations & Research Groups

- [VIA](#) (Vehicle Internal Architecture) is project within the Uppsala University funded (50%) Swedish Road Transport Informatics (RTI) Programme. Matching funding is provided by Saab-Scania, Mecel, Lawson Förlag & Konsult, Arcticus and Volvo. It includes simulation work.
- [CSE](#) (Core Simulation Engine) project is a collaboration between Heriot Watt, Essex University and various off-shore industries (under the umbrella of the UK Marine Technology Directorate) to develop a fully distributed simulation of a submersible vehicle.
- [UK Simulation Interoperability Working Group](#) is a service is being run by the Parallel Simulation Group at the Defence Research Agency (DRA) Malvern. Pages included are [UK simulation Society](#), [EUROSIM - The Federation of European Simulation Societies](#), [The Society for Computer Simulation \(USA\)](#) and [Public domain source code for Distributed Interactive Simulation](#). These pages do not directly address robotic simulation but might be useful to those with a basic interest in simulation . *Last accessed: July 1995*
- [Parallel processing & Simulation Group](#) DRA Malvern is a research facility studying the application of parallel and networked systems to simulation. The aims of the section are: to exploit the advantages of parallel architectures to speed up military simulators for training assessment, operational analysis, procurement and mission planning/rehearsal, to develop new simulation programming paradigms and languages, to advise on the application of Distributed Interactive Simulation (DIS) technology to connecting together simulations and track and study future standards for networking systems, to apply Artificial Intelligence techniques to produce simulators including intelligent entities. *Last accessed: July 1995*
- Carnegie Mellon's [Task Control Architecture](#) (documentation and software) eg as used on various robots, including Dante II which crawled into the Volcano a couple of years ago (with ive images on the internet!).



Publications & Conferences

- [Simulation Model Design & Execution: Building Digital Worlds](#) is a book by Paul Fishwick (Prentice Hall, 1995) which focusses on model design (using an extension of object-oriented design -- called multimodeling) and algorithms for serial and parallel model execution. The SimPack simulation toolkit is also discussed and a chapter is devoted to using SimPack programs. The Introduction Chapter, with embedded figures, is in Paul's Web home page. This chapter gives a good idea of the book's content and philosophy. *Last accessed: July 1995*
- [5th AI, Simulation, and Planning Conference](#) for high autonomy systems using distributed interactive simulation environments. High autonomy systems are large scale dynamic systems involving many interacting intelligent or controlled entities. *Last accessed: July 1995*
- Zomaya A, Modeling and Simulation of Robot Manipulators: A Parallel Processing Approach" World Scientific, Aug 92, ISBN 981-02-10043-4, 300pp (L29 UK)



Miscellaneous

- [KALI](#) (USA) - a gateway to multiplayer gaming across the internet! €Kali (TM) is a state-of-the-art TSR program created by Jay Cotton that allows people that use SLIP/PPP accounts, ethernet connections, T1 lines, or ISDN lines to play IPX network compatible games across the internet, 24 hours a day, 7 days a week!
- Uppsala Univirsity (se) [Simulator Resources on the Net](#)
- [DIS Standards](#) (Distributed Interactive Simulation)
- [shape changing robotics technology](#) Joseph Michael's futuristic ideas and [animations](#) *Last accessed: Jun 1994*
- Steve LaValle's [Robot Animations](#) *Last accessed: July 1995*
- [Computer-Based Simulations](#) provides a general listing of other non-robotic simulators. *Last accessed: July 1995*

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