STISIM Drive™

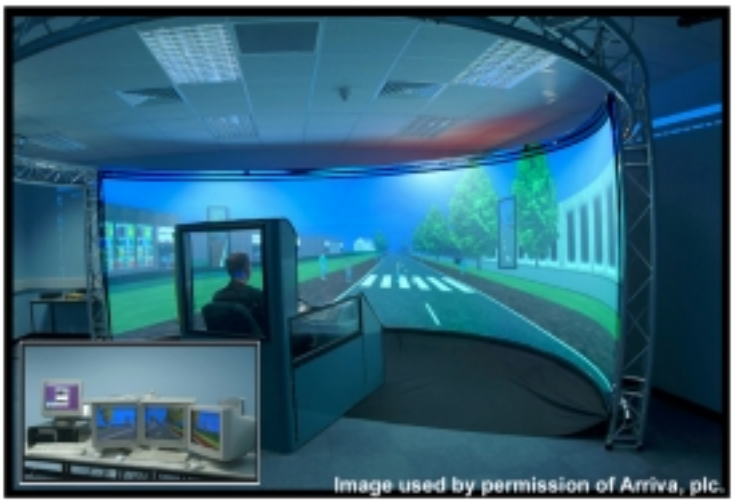
The Low-Cost, Interactive, Driving Simulator

A FULLY INTERACTIVE SIMULATION FOR RESEARCH, DEVELOPMENT, EVALUATION AND TRAINING

STISIM *Drive* is a personal computer (PC) based interactive driving simulator designed to represent a range of psychomotor, divided attention and cognitive tasks involved in driving. The simulation includes a vehicle dynamics model, visual and auditory feedback, optional steering "feel" feedback, and a driver performance measurement system. Driving tasks and events are easily programmable with a unique Scenario Definition Language (SDL) that allows the user to create driving scenarios by specifying an arbitrary sequence of tasks, events and performance measurement intervals.

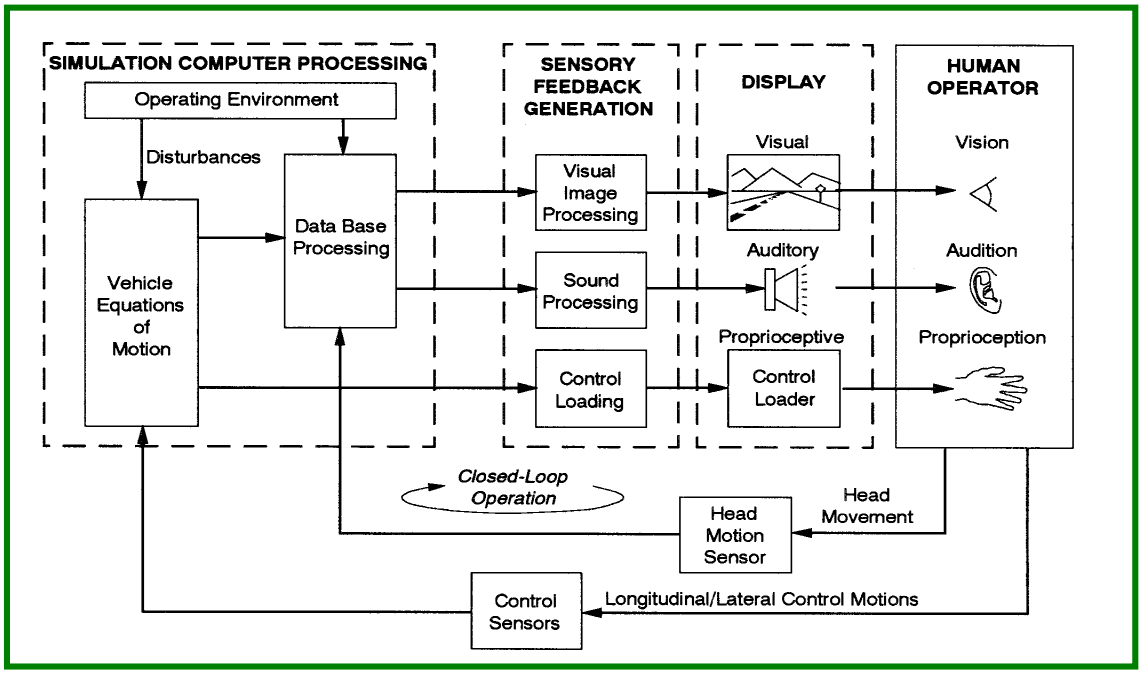
Functional Capability

The overall simulation is fully interactive (the driver controls both speed and steering) and includes: visual and auditory feedback to the driver (optional proprioceptive feedback in the form of steering "feel" is also available); a vehicle dynamics model; and an easy to use driving scenario development capability with driver performance measurement options. The simulation software and hardware have been optimized to provide the immediate, smooth, presentation of visual feedback as necessary for proper human operator-in-the-loop research and evaluation. Visual and auditory feedback are generated by specialized processing boards that are provided with the system. Game port, analog to digital, and high resolution digital interfaces are provided in order to allow the simulation to be used with a variety of driving control configurations.



Vehicle Dynamics Model

The standard vehicle mathematical model allows the user to specify steering and speed control characteristics that are meaningful to the driver. The steering dynamics include understeer that properly changes steering sensitivity as a function of speed, and an unstable heading divergence that simulates the effects of road crown and provides a means for adjusting steering workload. Speed control dynamics consist of an automatic or manual transmission, allowing specification of number of gears and gear ratios, throttle acceleration and deceleration limits, and an unstable speed divergence that may be used to set the workload of the speed control task. Auditory feedback is provided for engine speed and acceleration limits. Tire limits account for a maximum cornering capacity and stopping deceleration. Auditory screeches are associated with exceeding the tire limits during cornering and braking.



A comprehensive, validated, non-linear vehicle dynamic and tire model is also available. The model is based on STI's **VDANL**™ technology and can be used to simulate a variety of vehicles ranging from automobiles to heavy trucks and articulated vehicles. This vehicle dynamic model is run at the very fast update rates required for proper simulation of the dynamics using a dedicated processor linked to the simulation computer.

Visual Display

Standard or wide field-of-view visual display scenes may be presented using conventional computer monitors or projectors. A head-mounted display option is also available. A display processor board with three-dimensional (3D) graphics and texturing and shading capability is used to generate a realistic representation of the driving scene. The scene includes a roadway, horizon scene, secondary task displays, intersections, traffic control devices and interacting traffic. The driving scene is controlled by user-specified events and tasks as defined in event files using commands from the Scenario Definition Language (SDL). The SDL approach provides an almost unlimited flexibility in specifying driving scenarios and visual scenes without requiring any programming expertise.

Sound

The auditory display is presented using conventional PC-based sound components. A sound processor board is used to generate sounds based on commands from the vehicle dynamics module as well as reproduce prerecorded sound files. This approach allows the production of engine sounds, tire screeching, crash sounds, sirens and voice sequences needed in various applications.

Control Interface

Several control input interfaces are provided. In some Windows® systems a game port on the sound processor card allows the use of standard PC game port controllers. Interface cards are also provided that allow more precise driving control inputs using analog potentiometers or digital-optical encoders. These options allow the user to set up the simulation in conjunction with seating and control/display bucks or instrumented vehicle cabs. Table-top control options include a modular steering unit with full-sized steering wheel, turn indicator, and horn with an optional steering force-feedback mechanism to provide steering "feel." A modular pedal unit is also available.

Scenario Definition Language (SDL)

Events files written using the SDL are designed to provide a user-friendly environment for the specification of driving tasks, complex road/traffic events and overall driving scenarios. Expertise in graphical database development is not required. Events are specified in file lists as a function of distance traveled. For example:

distance 1, event code 1, attribute 1_1, attribute 1_2....., attribute 1_n
distance 2, event code 2, attribute 2_1, attribute 2_2....., attribute 2_n
. . . . . .
. . . . . .
distance n, event code n, attribute n_1, attribute n_2....., attribute n_n

Events include roadways, curves, hills, intersections, signals, signs, interactive traffic, pedestrians, buildings, fog, starting or stopping data collection, etc. Attributes include the distance at which an event is introduced, road markings, road grade, curvature, vehicle speeds, signal timings, etc. The event file format also has a subroutine feature that allows complex events that are composed of an arbitrary number of simpler events to be called as a single event. Special digital input and output, and analog output events allow the sequencing of external hardware with the simulation (when equipped with an additional interface board).

Driving Tasks

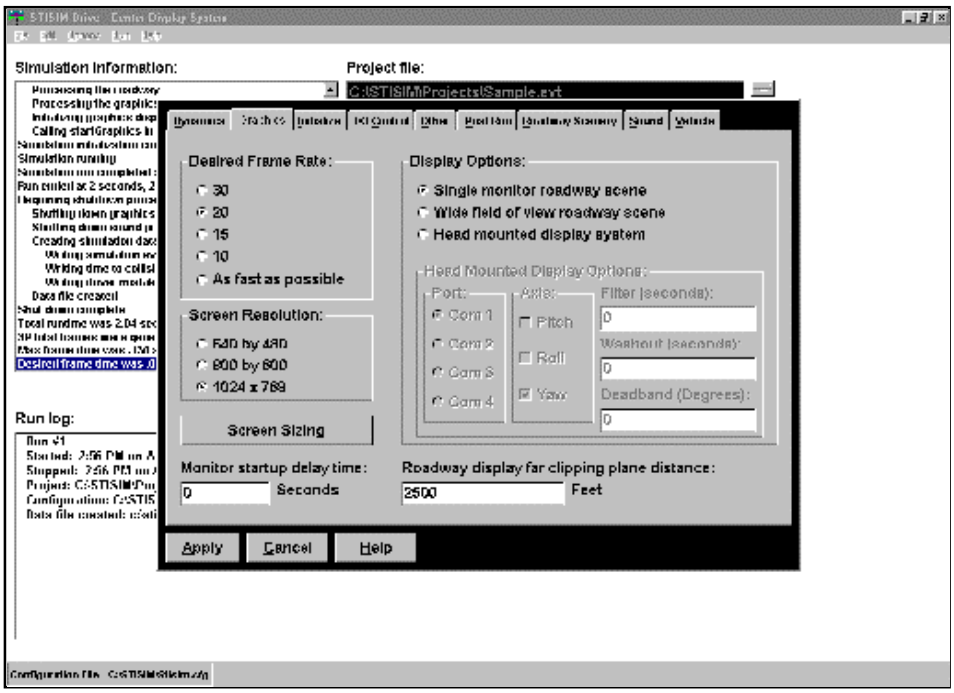
The events in the Scenario Definition Language allow specifying a number of driving tasks that permit measurement of psychomotor, divided attention, situation awareness and other cognitive behavior. Steering and speed control behavior may be measured on straight and curved road sections with varying visibility levels. Subsidiary peripheral signals may be presented that divide the driver's attention and require response with the horn and turn indicator. Interacting intelligent traffic may be programmed that require steering and braking for avoidance. The specification of lead and opposing vehicles can require the driver to make passing decisions while signal light timing can be specified to require stop/go decisions. Cross traffic and pedestrians may be specified to intersect the driver's path. Turning situations may be setup in combination with pedestrians and interactive traffic. Situation awareness may be tested by including interactive traffic/pedestrians and adjacent vehicles that interfere with lane changing.

Performance Measurement

Commands in the Scenario Definition Language can be used to specify data collection starting and ending at specific distances. One command specifies the measurement of mean and standard deviation of a range of vehicle motion and driver activity variables. Another command allows saving time histories of vehicle and driver variables between specified distances. A time-to-collision measure is obtained for all vehicle and pedestrian encounters. Overall scenario performance measures, such as total tickets, speed limit violations, accidents and total driving time, are collected throughout a run. During divided attention sequences (peripheral symbols that must be extinguished with the horn and turn indicator), response times and correct and missed responses are recorded. These data may be stored on disk and transferred to other software for further processing and analysis. The SDL output commands may also be used to synchronize events in the driving scenario with external data measuring devices.

Capabilities and Features

The simulation can be configured as required by the user through a Windows® user-interface. Configuration options include vehicle dynamic variations, visual scene variations (eye-height, mirror placement, resolution, etc.), sound options (allows user-specified sound files, muting of crash noise, etc.), and driving controls options. The system may be configured with a separate monitor for controlling the simulation and providing a real-time status display for an experimenter. An autopilot mode may be selected to simplify the setup of driving scenarios. Different configurations may be setup and stored for recall when necessary.



Hardware

STISIM *Drive* requires a PC with a high speed (minimum 400 MHz) Intel® or compatible processor with a minimum 128 MB of RAM, a hard-disk drive and CD-ROM drive. Wide field-of-view and comprehensive vehicle dynamic model options require multiple computers with network processor boards. Display options include standard enhanced VGA monitors, projectors and collimated, virtual image systems. Control options include modular tabletop units and an active steering feel system.

Systems Technology, Inc. (STI)

STI has been involved in research and consulting in vehicle dynamics, manual and automatic controls and human factors of aerospace and ground vehicles for over 40 years. Specific experience in the development of low-cost simulation devices and research on driver behavior has led to the development of **STISIM *Drive***. Over the past two decades STI has conducted driver behavior research associated with impairment (alcohol, drugs and fatigue), visibility, traffic control devices, intersection complexity, decision making, vehicle control and ITS. This research has inspired the many tasks and features built into **STISIM *Drive.***

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