The NEPTUNE Mobile Robot

Gregg W. Podnar
Robotics Institute
Carnegie-Mellon University
Pittsburgh, PA 15213

Neptune is a functional vehicle for autonomous mobile robot research. As a reliable mobile base, it supports experiments in perception, real-world modeling, navigation, planning and high-level control. It is self-propelled, with computer control of direction and motivation.

One of the prime design goals was the minimization of the number of subsystems. By doing so, reliability was enhanced.

Structure

Neptune's basic structure is best likened to a child's tricycle. The three 10-inch (25cm) pneumatic tires are used to provide spring, compliance, and traction on soft ground.

Steering of the fork is accomplished by one motor. The fork-mounted wheel is driven by a second motor. This allows sharp turning which facilitates navigation in cluttered environments. The other two wheels are parallel and rotate freely. The fork can turn at least 90° left and right, and the wheel can be driven forward or back. Together, these two features enable the vehicle to rotate about a vertical axis through a point located directly between the two passive wheels. The overall width is 22.5 inches (57cm), and the length is 32.5 inches (83cm). The turning length 'curb-to-curb' is only 42 inches (107cm).

Power

To eliminate on-board power storage and recharging, mains power is supplied through an umbilical. This 120VAC is distributed for all on-board electrical equipment via outlets mounted in the vehicle frame. Each piece of equipment provides its own power conversion/protection.

Motors

Using 120VAC motors eliminates the need for massive power conversion equipment. Synchronous motors were chosen for drive and steering as this replaces a feed-back and servoing system (Run a motor for a length of time, and *calculate* the revolutions.). The elimination of optical encoders or resolvers enhances reliability.

Control

An on-board processor accepts commands from a serial data link through the umbilical. This processor controls the motor relays and monitors fork position. It also provides control and monitoring for other vehicle-mounted equipment (such as switching between two television cameras).

Communication

Together with the Power, the umbilical carries cables for digital and video signals to and from off-board computers.

Construction

Neptune is made from two basic assemblies, the **Fork** and the **Frame.** Both parts were designed to have an excess of structural fortitude to withstand abuse and provide secure mounting points for auxiliary experimental equipment.

The frame is made of four pieces of four inch square aluminum tubing which are are welded together. Likewise, the four major fork pieces are aluminum and are welded. This was done mainly for strength but it also reduced the required machining. Once all the pieces were made, assembly of the mechanical parts took less than a week.

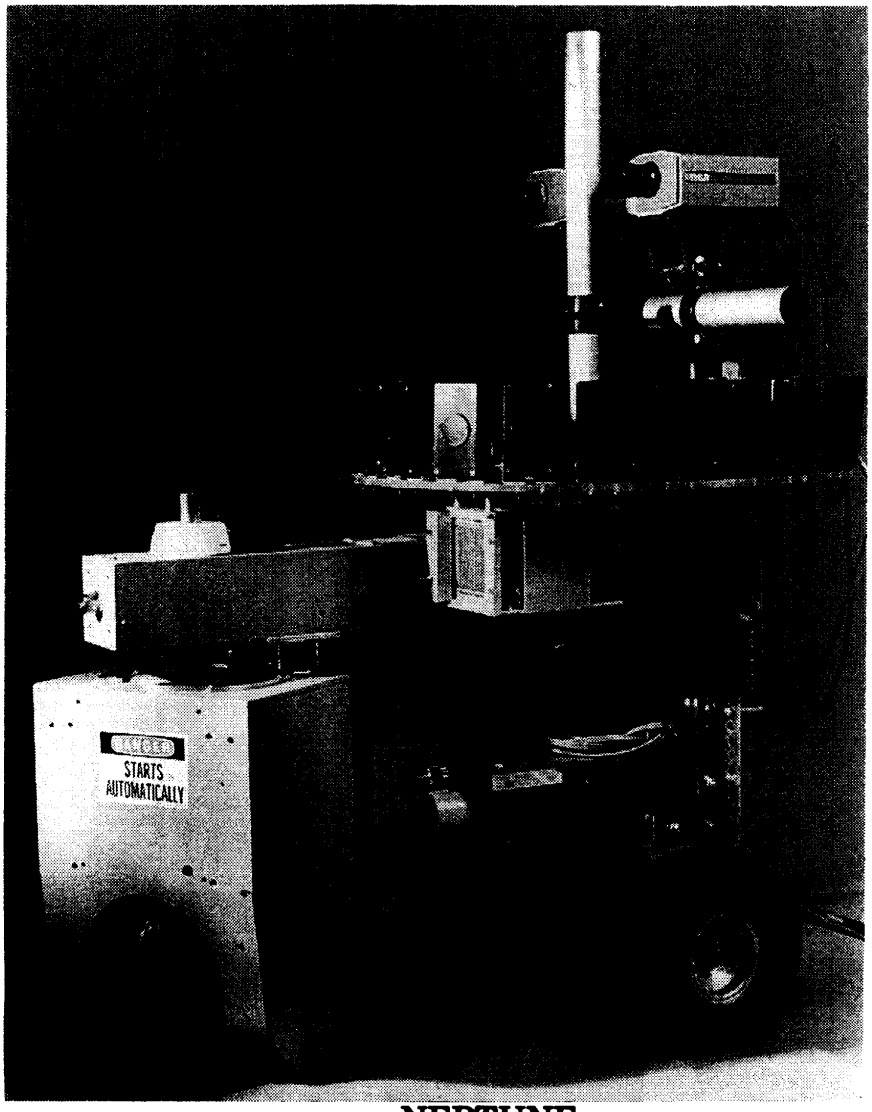
Prefabricated Components

For mounting the rotating shafts (two axles and the fork neck), off-the-shelf, housed bearings are used. In the same way, the chains and sprockets for driving and steering are standard components. The wheels and tires are units manufactured for handtrucks. Delivery time on these items is short, on the order of one to three weeks. By employing pre-fabricated components, shop time was minimized. It took one machinist about one full week to make all the other parts.

Performance

The Drive motor provides 1800 oz.in. of torque. With the 4:1 reduction gearing, about 90 pounds of pull is developed at the drive wheel. Fully loaded with cameras and a ring of 24 sonar sensors, *Neptune* weighs about 200 pounds and easily manages a 10° slope. It travels at about nine inches per second; about 1/2 MPH.

Neptune has had different configurations of sensor systems mounted on it to perform a variety of experiments. It has navigated in hallways, cluttered labs and sidewalks. It was even used in the rain with the addition of an umbrella to protect the electronics. It has reliably served our research purposes since early in 1984.



NEPTUNE