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Autonomous Navigation Technology 'Brains' Behind Service Robots
John Williamson, Contributing Writer -- 7/16/2007

Robots — or autonomous guided vehicles (AGVs) — used for pallet positioning, deep stacking, load transfers and a variety of other applications traditionally rely on inflexible and expensive environment modification such as inductive lines in the floor, reflectors, tele-operation or teaching defined routes. These obligate the machine to stay on the defined trajectory. Predominant drawbacks to such systems are unpredictable obstructions in the pre-defined path. While collisions can be avoided in most systems, a better way called Autonomous Navigation Technology (ANT®) has been developed by BlueBotics SA, a spin-off of the Swiss Federal Institute of Technology in Lausanne.

The service robots are a refinement of an earlier application of the technology in the form of 11 RoboX fully autonomous "tour guides" used at the Swiss National Exposition in 2002, where they logged 13,000 hours of guide work covering approximately 1,800 miles.

Allowing for full autonomous navigation, BlueBotics' ANT method integrates data from multiple types of sensors such as wheel encoders, laser scanners and tactile sensors. With real-time calculations performed on sensor data, this technology offers a high level of navigation autonomy, as well as high-precision positioning.

The result is a robot that automatically navigates around obstacles while moving to its programmed destination. It uses natural or positioned "features" in the work environment rather than reflectors to select the optimal path to perform its assigned functions. This enables the vehicle to move within a certain area of freedom in order to reach its goal instead of simply following a predefined line.

Piezoelectric systems in plastic bumpers as well as mechanical switches, are common for industrial robots. For BlueBotics' AGVs the innovation or heart of the guidance system is an integrated contour measurement and safety scanner system provided by SICK AG, Waldkirch, Germany. Safety with integrated navigation support is achieved by continuously laser scanning the surroundings. Depending on the type and shape of vehicle and on the operating environment, the AGVs use either a single 180 degree, two 180 degree or a single 270 degree scanner to locate features or landmarks. The system permits localizing a vehicle using references at distances up to 500 ft. Ultrasound sensors are used for motion control in areas where glass walls could defeat the lasers.

In addition to the scanners, the AGV navigation platform consists of a Compact PCI rack, batteries, bumpers and drive actuators using motors.

The BlueBotics-developed navigation system comprises several components. The "map" of the working environment is a graph-like structure with nodes representing positions the AGV has to reach to perform its task. It contains information about the features in the environment the robot uses to calculate where it is and where it has to go.

Path-planning and motion algorithms working on different levels of abstraction take readings into account in two levels: trajectory following and the dynamic window approach. This guarantees operators choose a speed that permits the robot to stop before hitting visible obstacles.

As an option, BlueBotics provides a navigation function that takes sensor readings within a grid around the robot. This is based on the "elastic band" concept, which essentially deforms in real time to a short and smooth path that maintains clearance from obstacles. This allows the AGV to avoid dynamic obstacles. Should it develop that such obstacles will not permit the AGV minimum clearance along the path, the navigation function is called upon to re-initialize the path.

Supporting the AGV's ability to function in unmodified environments is its global feature-based multi-hypothesis localization system. This enables the robot to achieve high localization accuracy with an added benefit. In case the robot loses track of its position it can generate hypotheses about its current position and relocate itself.

Built into the AGV is a security system to protect the safety of humans, objects and the robot itself. All components relating to the movement of the robot are defined as safety critical with safety on three levels: the operating system, software implementation and hardware redundancy.

A wireless communication system connects the AGV with either a traffic manager handing requests from enterprise resource planning

(ERP) system or directly with ERP, depending on customers' requirements.

ANT-empowered systems are compatible with equipment of virtually unlimited size, capacity and application. In addition to transport, ANT is applied to cleaning, inspection, research, healthcare and surveillance systems. A specialized unit called the "Shrimp" has six motorized wheels and is applicable to space exploration, rescue and firefighting. It is being used by NASA, as well as companies and universities in the U.S. and Canada.

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This forklift has a payload of 2,600 lb and can handle pallets to a height of 7 ft. It uses autonomous navigation technology to move safely through work areas at a speed of up to 4 ft/sec.

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