Introduction

Automatic Guided Vehicle Systems are one of the most exciting and dynamic areas in material handling today. AGV Electronics AB in Göteborg Sweden has a long tradition in this field.

Automated Guided Vehicle Systems by AGV Electronics provide material movement for customers in a wide range of industries like: automotive, chemicals/plastics, newsprint/newspaper, commercial print, paper, food & beverage, pharmaceutical, warehouse and distribution center, and manufacturing.

With the introduction of TRAM, AGV Electronics adds an important piece in systems design, a complete AGV traffic management package. This document is intended as an introduction to the TRAM concept.
What is TRAM

The TRAM software is developed to control Automated Guided Vehicle Systems by AGV Electronics using the ACE *) concept and runs on all common Microsoft Windows operating platforms including Windows 2000, Windows 2000 Server, Windows XP and Windows 2003 Server utilizing standard PC hardware.

TRAM is an AGV Control and Management System in which Automatic Guided Vehicles (AGVS), follow a pre-defined guide path. Navigation is achieved by following inductive guide path or magnets, as well as laser guidance. TRAM is designed to manage AGV’s without direct human intervention and it has a broad base including routines to handle all common tasks found in an AGV project. TRAM works in a wide variety of industrial applications.

The TRAM package performs the following main tasks:

- AGV Traffic Control & Monitoring
- Graphical Views for System Overview
- Transport Order Management
- Plant System & Equipment (I/O) Interfaces
- Extensive Event Logging and Diagnostics
- Data and Performance security via automatic backup
- Complete Emulation for faster development
- Setup Wizard for System Design and Maintenance

The TRAM software has an intuitive graphical and user-friendly interface. Graphical views provide the operator with an easy way of making sure the system is working properly. The main screen shows statuses of all vehicles based on a colored object representation. Statuses from I/O units, connected to the TRAM system, are represented by colored graphical symbols. This feature is used, for example, to show door open/close/closing status, presence of a load on a station, and much more.
**TRAM 2006**

TRAM 2006 is the latest released software package for controlling AGV Electronics AGV’s. A team of engineers has developed the package based on their personal experiences in more than 100 AGV projects done over the last 30 years. This unique background ensures that experiences made over several decades have not been lost but integrated in this package. At the same time, younger engineers, used to today’s programming methods and products, have ensured the end result to be state-of-the-art.

TRAM 2006 includes a large number of standard modules handling all common tasks found in an AGV system: from device communication modules to AGV management modules and history and statistics handling. The user interface is divided in modules specifically tailored to fit its purposes like setup procedures, user operator interface routines and emulation handling routines.

See description below for some of the modules.
TRAM setup

TRAM Setup is the main tool for system design and development. It is an intuitive graphical tool with on-line help. A CAD layout, imported into the TRAM Setup routine, is the base for all settings. TRAM Setup uses a visual representation of project layout and characteristics.

The purpose of the setup routine is to graphically create and/or edit objects. The view of the layout can be navigated by scrolling or zooming into the smallest detail. All objects, when clicked on, are presented in object class related property grids. This interface is used for editing any type of object; from AGV guide path characteristics to object settings like doors and sensors.

A project setup is divided in three major steps:

- Gathering significant data such as creating a project CAD, add AGV guide path and to add positions, segments and locking objects.
- Identify all objects such as pick/deposit positions, chargers, doors and signal and to populate object properties using TRAM setup edit routines
- Establish and verify object relations
TRAM setup - The toolbar

To control the graphical interface, the operator has a toolbar from where all functions can be controlled. The tool bar is divided in five sections.

1. CAD tools: screen scaling, pan, zoom in/out, custom zoom, request object properties and measure point-to-point distance.

2. Object tools: delete, move and modify x/y coordinates

3. Insert traffic control objects: location, segment and area locking objects

4. Insert project management objects like chargers, pick/deposit positions, doors etc.

5. Special tools: Show a route, defined segment locations

Having all significant data on hand, even a complex structure can be setup within a day.
TRAM server

TRAM server incorporates a complete vehicle management package including job allocation and object management such as doors and elevators. AGV traffic control is based on standard modules continuously comparing AGV status and other object status with project settings. Each significant status change detected will result in a real-time reaction.

A TRAM server can be configured as a dual system with two PC’s running in parallel. In such a system, one PC is allocated the RUN activities and the second is handling all warm backup processes. In case of a RUN system failure like hard disk crash or power supply failure; the second PC can be restarted to immediately taking over the duty of previous RUN system. Data is not lost and AGV’s will continue working from where they stopped.

In any AGV system, TRAM will have to communicate with and control a variety of objects using different communication methods. TRAM supports the use of both radio and Wireless Network based AGV communication. Ethernet, RF or standard field bus I/O based communication methods are used to interface to doors, sensors and other object classes.

Dynamic routing is a standard part of TRAM. This feature allows an AGV to take alternative routes for the same destination based on segment property settings and current traffic situation. A blocked segment will influence approaching AGVS to be directed to alternative routes. Optimal job assignment is key to a well-balanced, high throughput AGV system. TRAM is using property settings defined and verified in the setup phase, which leads to an optimized look-for-work logic. TRAM is constantly reevaluating assignments and will, again based on property settings, reassign an already allocated job when a better-suited AGV is found.

After performing system maintenance or reconfiguration, a system restart might be necessary. The restart procedure, from system stop to system fully operational takes less then one minute. The restart is autonomous. Interaction with AGV’s is not necessary. TRAM will analyze data gathered at startup. The AGV’s will continue with previous assignments once the restart phase is completed.
TRAM clients

TRAM client is a user-friendly, intuitive graphical interface, which gives detailed information to supervisors, maintenance staff and anyone else that needs to know current system status. A mouse click on an object and all detailed information is displayed.

A TRAM client can be installed on any workstation PC connected to the TRAM Server. Or, if preferable, it can also run on the TRAM Server.

TRAM Client is accessible in different languages based on property setting in the user profile. User profile settings are also used to determine user privileges, R or R/W, on a per routine basis.

TRAM client view: AGV’s real-time motions
TRAM message handling

In case of significant events, TRAM can alert users in a number of different ways. By default, all messages are logged in the TRAM event log and can be displayed at any moment. Each message has a property setting. Based on message type settings, a secondary action can be to send the message as an email or converted to a signal sent to an external device.

Optional: based on project specific requirements, additional methods can be added to interface to local pager systems, OPC servers and SMS receivers.

TRAM event logging

All significant events are logged and can easily be accessed at any moment. This logging provides a source of historical information useful in evaluating failure rates and performance.

Examples of significant information possible to extract:

- AGV error statistics
- Equipment errors statistics
- Average transport execution time for specified pick and drop positions
- Transport statistics week/day/hour

TRAM emulation

Depending on the complexity of the project, it may be preferable to emulate the system that will be installed prior to the actual physical installation of the AGV system. The TRAM emulation package is different to a simulation program. It actually uses the exact TRAM property settings finally used by the installed AGV system.

The main advantage of the TRAM emulation package over a simulation program is that the actual AGV management software is running. Defined path property settings can be consistency checked. Potential problem areas will be visible and modified. The system is finally optimized and verified prior to commissioning. Using the TRAM emulation package reduces onsite interruptions as well as implementation time.
Service & Support

TRAM is continuously logging data automatically. There is no need for any periodical maintenance.

TRAM can be remote controlled or monitored from anywhere. Remote access can be based on solutions using Internet as communication media or direct modem connections.

Service & Support options available:

• Technical support via telephone 8.00 to 17.00, CET
• 24 Hour Remote Support Options
• Emergency Site Visits
• On-site Preventive Maintenance Service Programs

*) ACE – AGV Command Executive is a command language and a communication interface for the on-board vehicle control.

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