SeeTrain

System Description

Apr 27, 2005
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1. Purpose & Scope

This document provides technical information on SeeTrain, a vision-based system Container Code Recognition System (CCRS) for identifying containers on rail cars.

The system is configured for a single-track installation, with equipment installed on both sides of the track. Its main purpose is a portal system in the gates of the marine container terminals, so all traffic of containers on rails into or out of the terminals will be reported to the terminal operating system (TOS).

*This document does not apply to the multi-track intermodal system (SeeRail), which is covered by a separate document. See section 3.5 for more details.*

2. Referenced Documents

2.1 Freight Containers - Coding, Identification and Marking [ISO 6346 1995(E)]

2.2 SeeGate container recognition system for port gates (HTS various documents)

2.3 SeeTrain Installation Manual (HTS publication)

2.4 SeeRail Installation Manual (HTS publication)

2.5 SeeRailCar Technical Manual (HTS publication)
3. Overview

3.1. Product description

SeeTrain is a sophisticated image processing system that tracks and reads the Container ISO 6346 identification numbers that are carried by trains.

The identified numbers are displayed on the system display, and can be transferred to other Windows applications (with DDE messages), or via the network (with TCP/IP using networking option). The image file(s) can also be saved on disk.

Each system can control a single rail track, with trains moving at both direction, and can detect single or double container - or no container at all.

For two levels (double stacked containers), two SeeTrain systems are installed and work in parallel.

The recognition message can be correlated to rail car tag readers by correlating the results by the time tag.
3.2. Installation Infrastructure

The system is installed at both sides of the rail track.

The computer is installed in an air-conditioned cabinet at a short range from the camera array.

3.3. Camera and sensor Configuration

There are several sets of camera and illumination units that will provide the images of the rail and the containers:

- 4 Container identification camera and illumination units on both sides of the track. On each side and each level there are two camera and illumination units: one unit is looking at the back or front doors, and one is looking at the sides.

- 4 IR sensors that are required to detect the containers start/end at each level; mounted just lower than the container roof.

These units are mounted on poles at both sides of each track – on 4 corners. Between the poles, on the sides, there are horizontal bars (at each level) that are used to hold the elements. A photo of this configuration can be seen below, taken from one of the California installations:
In the above picture the camera and illumination units can be seen at both sides of the track, mounted at the height of the container ID. There are 2 identical installations – one for each level (and controlled by a separate SeeTrain system).

On both sides of the track there are also two RFID readers that read the railcar numbers. These readings are transmitted to a central computer, which ties the readings to the recognition results, using the time stamp as a key. These are seen as white tall units on both side of the track.
A top view of this configuration can be seen in the following illustration. There are 4 cameras on each level, located at 4 corners. The side cameras take images of the side markings, while the back container cameras take images on the back/front. This configuration is doubled for each level.

![Figure 3.3.1: Top view of cameras (for each level)](image)

An example of the side container camera and illumination units, with one of the 4 IR sensors, is shown in the following photo.

![Photo 3.3.2: Side container cameras (example from another installation)](image)
3.4. Image capturing

An example of the back/front view is shown in the following photo. It was captured on the lower level system from the back door side.

The system automatically captures a number of images under various illumination levels (out of 4 available levels) using the synchronized solid-state illumination that is integrated within the camera/illumination unit.
3.5. Other Rail solutions

There are other system configurations available for other types of rail applications. They are detailed in the references list.

- **SeeRail** – multi-track system, where the equipment cannot be installed on both sides of the track. This system is used for intermodal installations, and the train speed is higher (up to 40-50MPH) than the SeeTrain system (5-10MPH). *See Photo below.*

- **SeeRailCar** – rail car identification optical recognition system. This system can read and save images of the railcars, as a backup for the RFID readers. *It can be added as an additional reading system to either SeeTrain or SeeRail recognition systems.*

To determine what is best for your installation – please contact us for more details.
4. System Architecture

4.1. Overview

SeeTrain is a turn-key system. It handles a single track and single level of containers. A typical site will include two such systems for each track, operating on a different level (stack of containers).

It consists of the following elements:

- **PC** Pentium running Windows XP or 2000 Pro. We recommend at least Pentium 4 3G with 1-2G Ram.

- **SeeContainer recognition DLLs** - which are used to analyze the images and extract license plate string on the Containers.

- **Camera and Illumination** units to capture the images. Each unit is Weather protected (IP 65) and the cameras are equipped with an internal heating unit.

- **Frame Grabber** - which captures the images from the camera units

- **I/O card** – input/output board with multiple I/O discrete lines. This board supports the sensors and illumination control. It is connected via a cable to a terminal interface board with easy connections and indicator lights.

- **Sensors** to indicate the presence of the containers (several IR sensors).

- **SeeTrain** The SeeTrain Windows application interfaces the hardware elements (frame grabber, camera/illumination unit(s), IO card and sensor). It controls the illumination, reads the video inputs and passes the images to the DLL in order to obtain the recognition results. The application displays the image and recognition results. It then exports the results using serial communication, messages or disk files. Its man-machine interface supports on-line setting control, which can easily adapt the application to various types of configurations.
4.2. Breakdown

A breakdown of the SeeTrain system is shown in the following illustration, which shows a typical configuration of a SeeTrain system (the number and type of camera and illumination units is different than the actual installation). *It is described below.*

![SeeTrain configuration diagram](image)

**Figure 4.2: SeeTrain configuration (see text)**

4.3. Operation

The SeeTrain application runs as a background Windows application in the PC (shown in the center of the above figure), and interfaces to a set of camera/illumination units which are interfaced by the frame grabber. The application controls the sensors and the controls via an I/O card that is connected through a terminal block to the inputs and outputs.

When the Container(s) pass the container sensors, a set of images are captured by the frame grabbers. The set of images both compensate on the variation of the ID text, and additionally reduce the recognition error. In parallel, the recognition software analyze these images, converts the images to recognition strings, and verifies the results using check-digit algorithms on each of the markings.

Additionally, the program automatically classifies what type of event (none, single level and double level containers) has occurred. It also selects the best image for display and archiving.
The application then reports the recognition information via inter-application DDE messages to Client application(s), which manage the data and pass it on to the port computer.

*Note that the remote database and the Client specific applications (as shown above) are not supplied and would be developed by the integrator.*

The client application should ‘listen’ to the messages from each track and each level. The track and level is represented in an integer (“lane” number) so this application can merge the results using the “lane” key and tie them to rail car readers using the time stamp.

### 4.4. ID markings

The system recognizes the following standard:

- Readable ISO 6346 standard **Container** IDs (4 letters, 6 digits, 1 check digit). They will be read from both sides and the front/back for increased recognition.

### 4.5. Recognition Speed

The recognition speed per container is designed at about 4-5 seconds, assuming a fast Computer (Pentium 4 3G with 1GRam) and a large set of images (24 for each level). The application buffers the images and recognizes them “off-line”, and sends out the result after each container completes the recognition cycle.
5. Software

5.1. Overview

SeeTrain runs as an application in the Windows 2000 Pro or XP operating system. It controls the hardware and recognition software, and display the results and setting in its displays. Its components include:

- SeeTrain Application software
- Recognition DLLs for both Rail and Container markings
- Images archive directory (includes daily subdirectories with log file)

In addition to the application, additional Networking, operation and maintenance utilities can be provided (SeeService, SeeMonitor, SeeCleaner, SeeData - details can be found in the website).

5.2. Main Display

The main window is designed to display as much information as possible in a friendly user interface (the user does not need to switch between any child windows during normal operation). The window is divided into several display panes, where each pane is responsible for a single system task.

The different panes are:
- Image Display - shows a selected image from the cameras. The user may display the last event or one of the past results.
- Train History Log - display a list of all train events and recognition results
- Identification Window - the last identified numbers
- Status Window - system messages and events

Examples of the main window are shown in the following photos:
Another example of a side container recognition event can be seen in the following picture:
5.3. Building Applications with SeeTrain

5.3.1. Overview

SeeTrain runs as an application with a window. It can run as a stand-alone application, but better: it can share the recognition results with another application (the 'client' process, as in the "client-server" model, which is the management program).

To process the recognition results the client application simply intercepts DDE (Dynamic Data Exchange) messages that are sent by SeeTrain to the 'Client' application(s).

![Diagram of Building applications with SeeTrain]

Figure 5.3: Building applications with SeeTrain

5.3.2. DDE message

Each container will generate one message containing the recognition result:

- the date and time (see more details on this in the next pages),
- the track/lane number where the system is installed (identification integer, e.g.: 1 or 10)
- status and confidence of the recognition
- the ISO 6346 container code (LLLUDDDDDDC, where L=Letter, U=letter ‘U’, D=Digit, C=Check digit)
• the optional container image file path (in jpg format in different optimization levels),

This DDE structure is identical to the SeeGate DDE message. A detailed header file can be obtained, which lists all the DDE message fields. Therefore, the integration with these messages will be identical to the SeeGate systems that could be installed in gates in the port and interface with the same management program.

Note that more than one client application can use the DDE message mechanism. Each application will intercept the recognition message and execute a different task.

The integration on basis of the DDE message mechanism is simple. We also provide client sources for VC++ or VB that show how to intercept these messages, provide sample applications, and the SeeTrain simulation program, which allows testing it.

5.3.3. Networking

The messages can also be sent (a DDE-net solution) via TCP/IP network to one or more Central servers. The networking solution is provided as an option (with the SeeData component).

The same Client applications that work locally can also work on the Central computer, since the DDE message interface is the same for all nodes. The only difference between the messages is the track installation number which is unique to each recognition PC.
5.3.4. Time stamp

SeeTrain/Rail recognition systems have a time stamp (the date/time field) in the DDE message. This field is useful for reporting purposes, and will be different from the actual time of the message since there is a delay between the capturing and the reporting of the recognition results.

The time stamp also allows the integrator to merge results from the recognition system and the RFID readers in order to match the container numbers to the appropriate railcar.

The time tag was designed to mark the time where the center of the railcar passes the center of the portal. This is important for a successful match of the railcars to the recognized containers.

There are 3 scenarios - which are shown in the following diagrams:

1. Twin 20 feet containers.

Let T1 be the time stamp where side cameras starts to capture bank a. Let T2 be the time stamp where side cameras starts to capture bank b. DDE time stamp will be T=(T1+T2)/2, which is the center of both 20 feet containers.

2. 40 feet container

Similar to twin20, application captures twice as if there were 2 banks.
DDE time stamp will be $T = (T_1 + T_2)/2$, which again is the center of the railcar.

3. Single 20 feet container

DDE time stamp ($T$) will be when the cameras start to capture the container side. This will be when the center of the container is in the center of the portal system.
5.4. SDK - Development aids

5.4.1. SeeTrain Client

A sample client, SeeTrainClient application, is provided as part of the SDK (Software Development Kit). This application stores the message data into a log file (each rail in a new row). It is identical to the SeeGate Client program.

To check the functionality of the above messages, activate SeeTrainClient application which is included the software product release package. This sample Client application receives DDE messages and saves them into a log file. It also can send DDE messages to SeeTrain as described above. The client application runs in parallel to SeeTrain application.

5.4.2. SeeTrain Simulation

A simulation program of the SeeTrain application is also provided. This simulation bypasses all the hardware interfaces and provides a full operation of the application and its outputs based on a predefined scenario file and images. This program can be useful for programming, integration and test. (It is similar to the SeeGate simulation program which is available on the web-site for downloading).

The simulated version is easy to use. An integration with the simulated version is virtually identical to the real system, therefore it simplifies the software integration and cuts the time to market.
6. Support and more Information

You can contact us for more information and assistance at:

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