D3.3 - Operational RFID System

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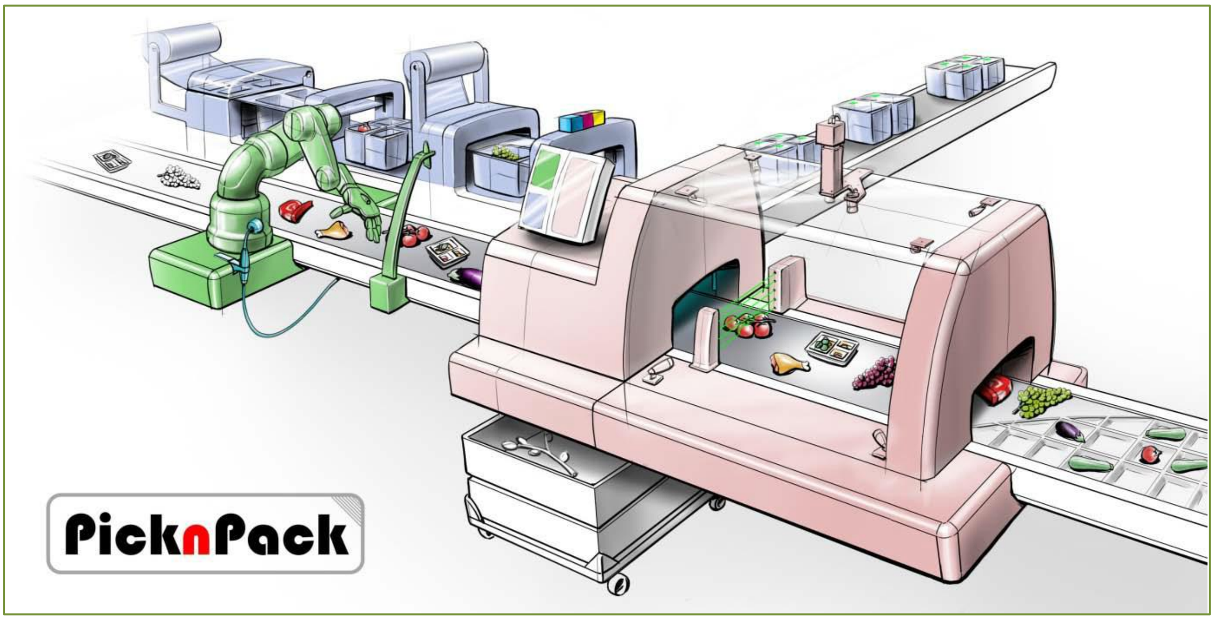

Flexible robotic systems for automated adaptive packaging of fresh and processed food products

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Dissemination level		
PU	Public	X
PR	Restricted to other programme participants (including the EC Services)	
RE	Restricted to a group specified by the consortium (including the EC Services)	
CO	Confidential, only for members of the consortium (including the EC Services)	

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1. Introduction

This document outlines the operation of the RFID enabled traceability system, relating to the delivery of:

- D3.3: Operational RFID system (M24)
- D3.4: Report on RFID system design and implementation (M24)

The associate milestone is:

- M3.3: RFID system in place (M24)

An RFID enabled traceability system has been developed as outcome of M3.3. The system is achieved by integrating the RFID hardware and software modules with the traceability software application (outcome of M3.2), which is interfaced with the database system (outcome of M3.1).

This report illustrates the operations of the RFID enabled traceability system. A brief introduction and the details of the operation steps are provided in the following sections.

2. The RFID Traceability System

With the technical progress in RFID technology and related areas, the RFID information tracking has gained widely use in transportation, logistics, healthcare, libraries, etc. Compared to the traditional information tracking methods, the RFID tracking method is faster in speed, further in distance, hands free operation, etc. This RFID traceability system is established based on the RFID readers and antennas by the leading manufactures. This section illustrates the system architecture, functionality, and process model of the RFID traceability system.

2.1 System Architecture

In the RFID traceability system, the RFID readers with multiple antennas located in the production lines are interfaced to a local area network with a router. The RFID traceability software application manages the RFID readers and receives tag information obtained from the readers. All traceability information is stored in the database. Users can search current and history information with the traceability application and handheld reader application.

The main task of the system is to track the RFID tag information, keep records in database, and assist the production line process. So, from the data flow and user operation perspective, the functional modules can be described with diagram in Figure 1. The system mainly consists of four modules: traceability software application, handheld reader application, database, and RFID module.

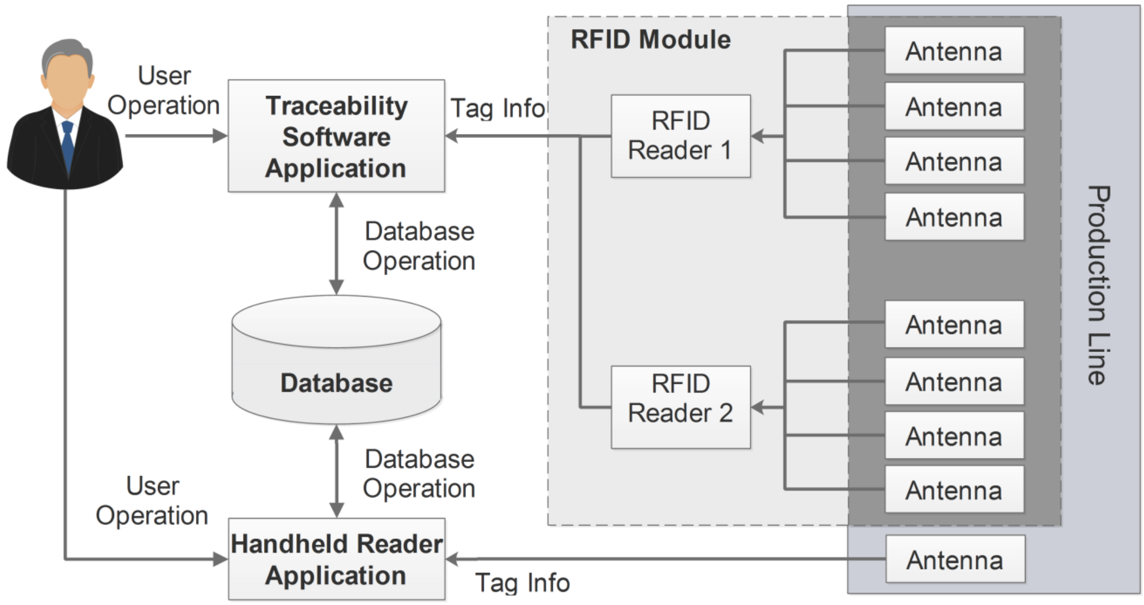


Figure 1 Diagram of the Functional Modules

2.2 Functionality

This system is required to be able to track the product information automatically when the production line is running. By locating the antennas in the production lines, the product with RFID tags are recorded and stored to the database automatically. Then, all related information such as supplier information, weight and quality, price, logistic unit information, and other optional information are linked together with few human assistants.

The function of the RFID tracking system is to record tag ID at different procedures of the production line process, and then provide all related information linked the tag IDs. The processes in the information tracking with RFID are summarised as follows:

- New material subdivision - With the RFID detected containers, the source material can be put into containers before packaging.
- Packaging - After providing the product information in 'Batch Setting' and 'Package Setting', user can start the system for packaging recording to create records in database.
- Logistic unit - User can select detected available containers and register selected containers as a logistic unit.
- Delivery - User can select a customer and sending place to create a database record of dispatching a logistical unit.
- Scan and Query - With unique RFID tag IDs, all related information stored in database can be retrieved with the traceability application or a handheld reader.

In all the above steps, the RFID tag ID is unique information to associate the different process and track the objects automatically in the production line.

2.3 Process Model

With RFID devices implemented in the traceability system, the production line process is then assisted with the RFID modules and product information is recorded in database automatically. The process model is designed as shown in Figure 2. The components with RFID icons are the processes enhanced with RFID tracing, and those without RFID icons are operated by human only.

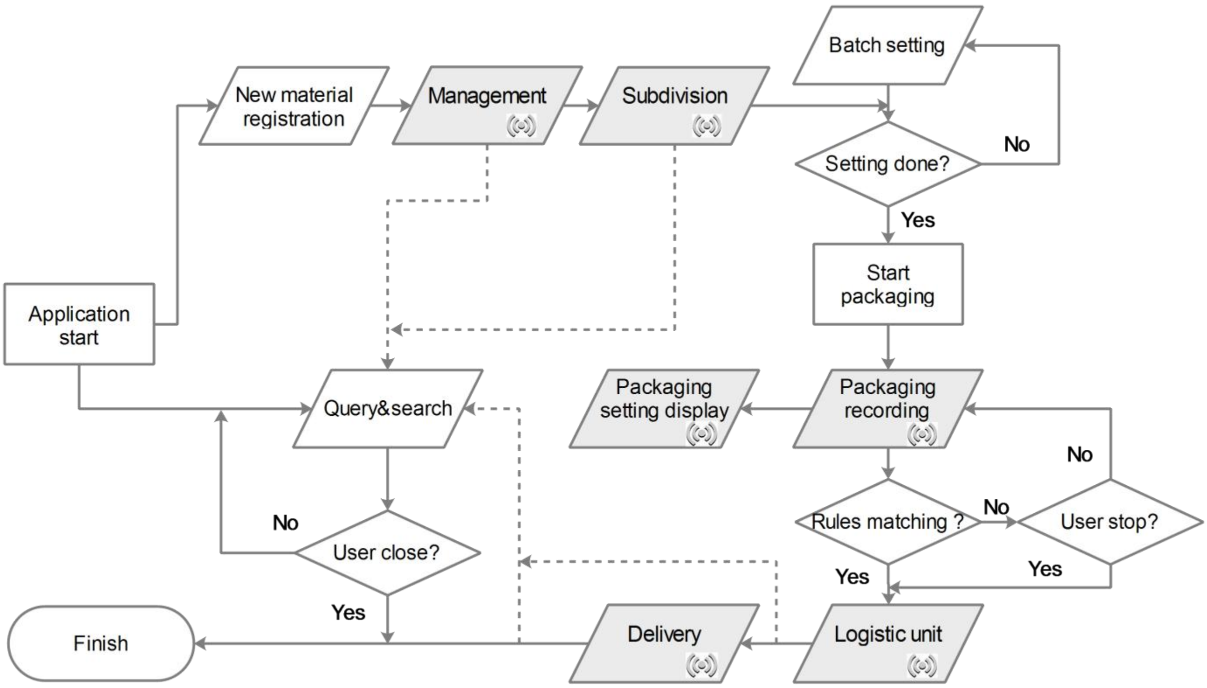


Figure 2 Process Model of the RFID Traceability System

When new material for packing arrives, user needs to manually register the materials with the system. The containers are also registered with RFID tags in the management process. Then, after the batch setting, the packing job can be started by clicking the ‘Start’ button. The RFID detected available container can be registered as logistic units by clicking ‘Register’ button. User can then select a valid customer and a sending place to create a record of dispatching a logistic unit by clicking ‘Send’ in delivery window.

All through the process, user can observe the information by query & search function. The records of registered containers in management, containers for subdivision, packing jobs, logistic units, and sent delivery units can be searched and checked by object IDs or tag IDs.

3. Operation Steps

This section provides the steps how to use the RFID enabled traceability system. There are 8 steps using the RFID traceability system: RFID configuration, container registration, new material registration, subdivision, packaging, logistic unit, delivery, and scan and query.

Details of functions and operations in each step are described in the sub-sections. Screenshots of the operation interfaces are provided as well.

There are operational interfaces for all the above steps in the main interface (as shown in Figure 3) of the RFID traceability system. The operation interface for each step of function can be called out by clicking the buttons on the top of main interface.

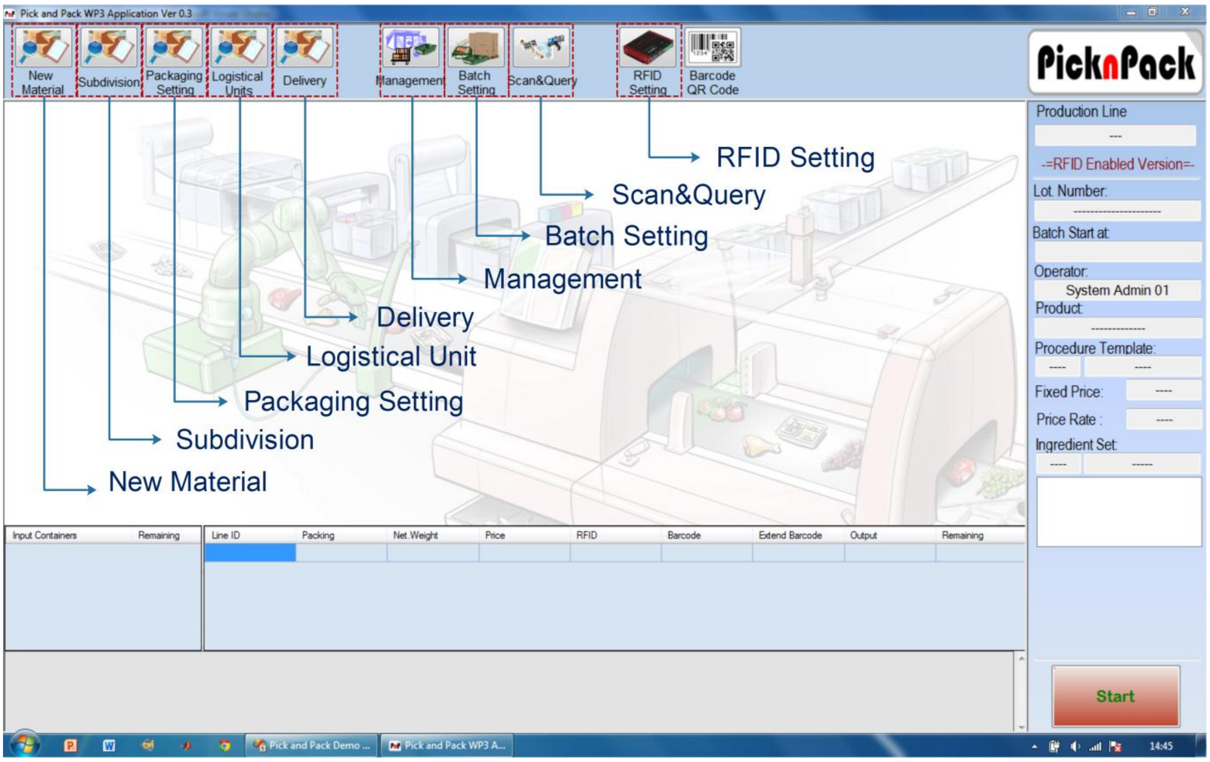


Figure 3 Main Interface of RFID Traceability System

3.1 RFID Configuration

Before the RFID hardware modules can be used for information tracking, they need to be configured. The configuration consists of two steps:

- RFID reader initiation, and
- Reader/antenna location setting

RFID reader initiation is to connect to the RFID reader and set some parameters with protocols and command sets of the reader. This process is completed with a background thread automatically without users' attention. When the initiation is finished, the readers and their state are shown in the interface for the user to perform the further operations.

In order to provide an interface for the users to observer the RFID readers and the tags recognised, a 'RFID Configuration' window is designed as shown in Figure 4. This interface, (1) shows the reader information, (2) lists the state change of the readers with timestamp,

(3) shows the raw tag messages, (4) gives the unused tag items with locations, (5) provides the object item messages, such as internal containers and external containers.

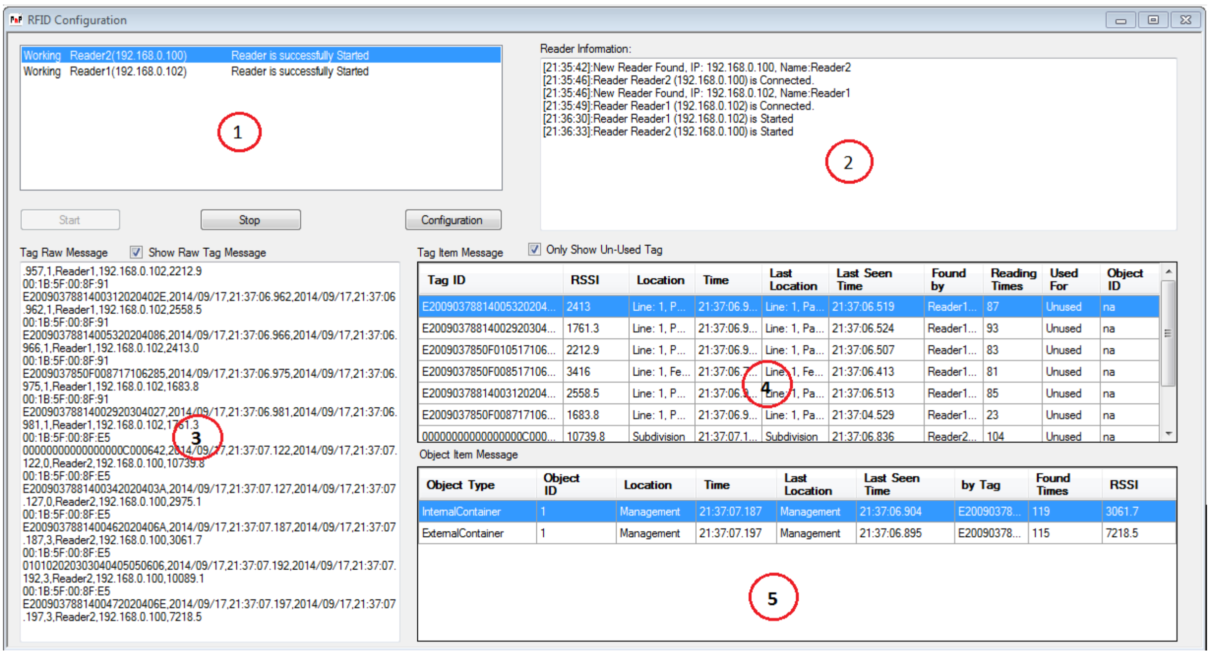


Figure 4 RFID Configuration Interface

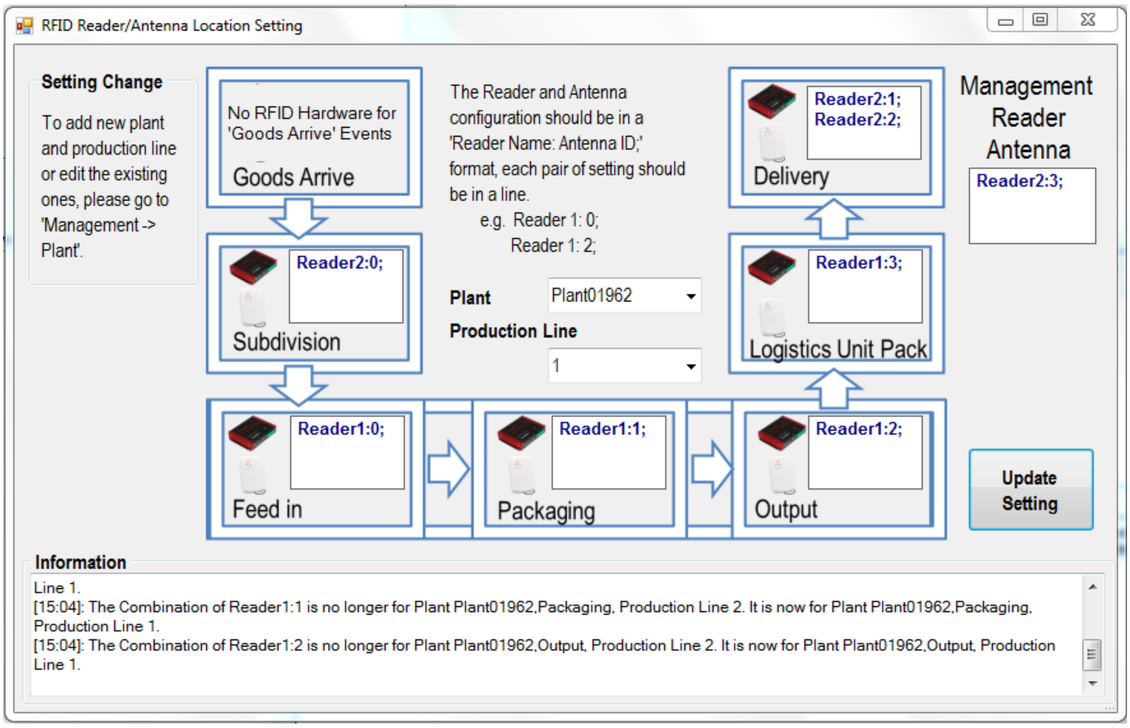


Figure 5 RFID Reader/Antenna Location Setting

Figure 5 gives the operation interface for reader/antenna location setting in the production line. The user can specify the plant and production line first, and then set the reader and antennas in the format ‘Reader Name:Antenna ID;’. The input data is accepted as the valid setting for the operations and the data is stored until new setting is initiated.

3.2 Container Registration

The container registration interface is in the ‘Management Window’, which could be called out by clicking the ‘Management’ button in the main interface of the traceability system.

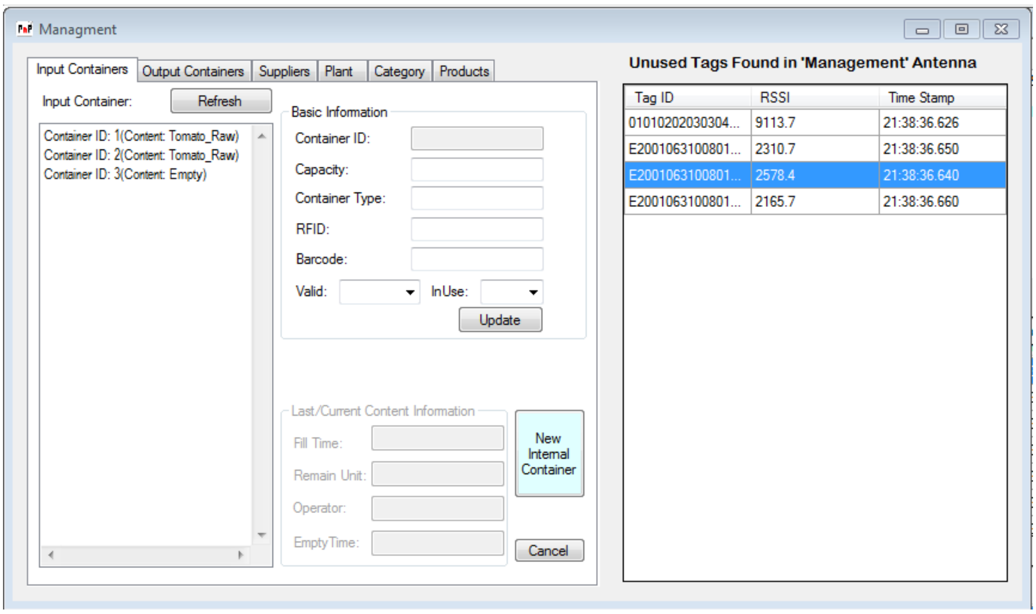


Figure 6 Input Container Registration Interface

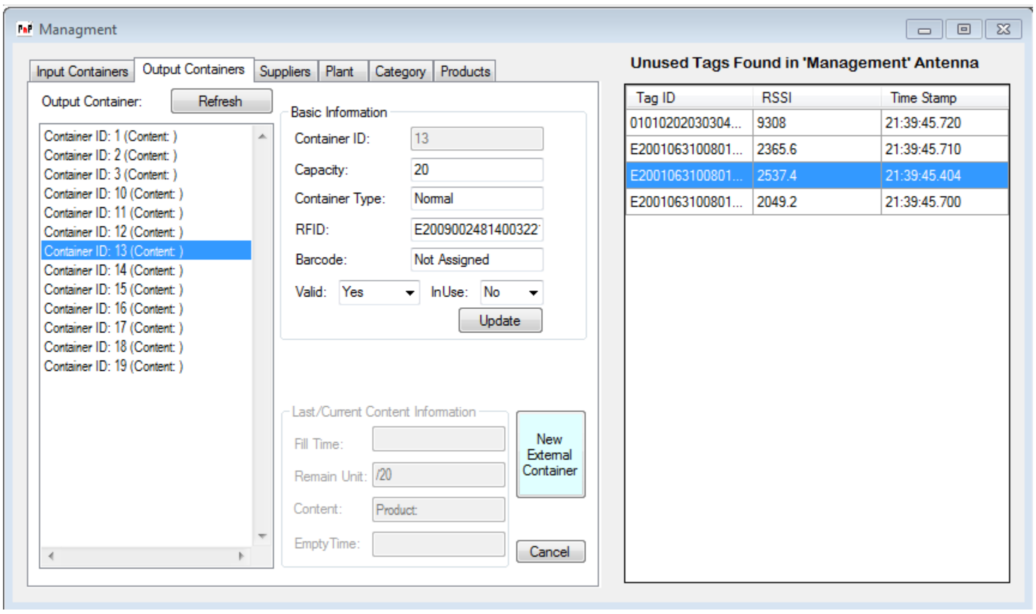


Figure 7 Output Container Registration Interface

As shown in Figures 6 and 7, on the left are the input/output containers and on the right are the list of detected Tag IDs. User can select a container and then assign a tag ID by double click one of the IDs in the list and click ‘Update’ button to confirm. Only the unused tag IDs are displayed in the list and it is updated in real-time.

In addition to container registration, users can create new suppliers, plants, production lines, and product information by manual inputs in the ‘Management Windows’.

3.3 New Material Registration

Before subdivision and packing, the incoming new material needs to be registered manually by the users to create records for the incoming goods batch.

As shown in Figure 8, the ‘New Goods Registration’ interface can be called out by clicking the ‘New Material’ button in the main interface. The information to input is: supplier information, weight and quality information, logistic unit information of the batch, and other optional information. The records for incoming goods batch can be created by clicking the ‘Update’ button when all necessary information is provided.

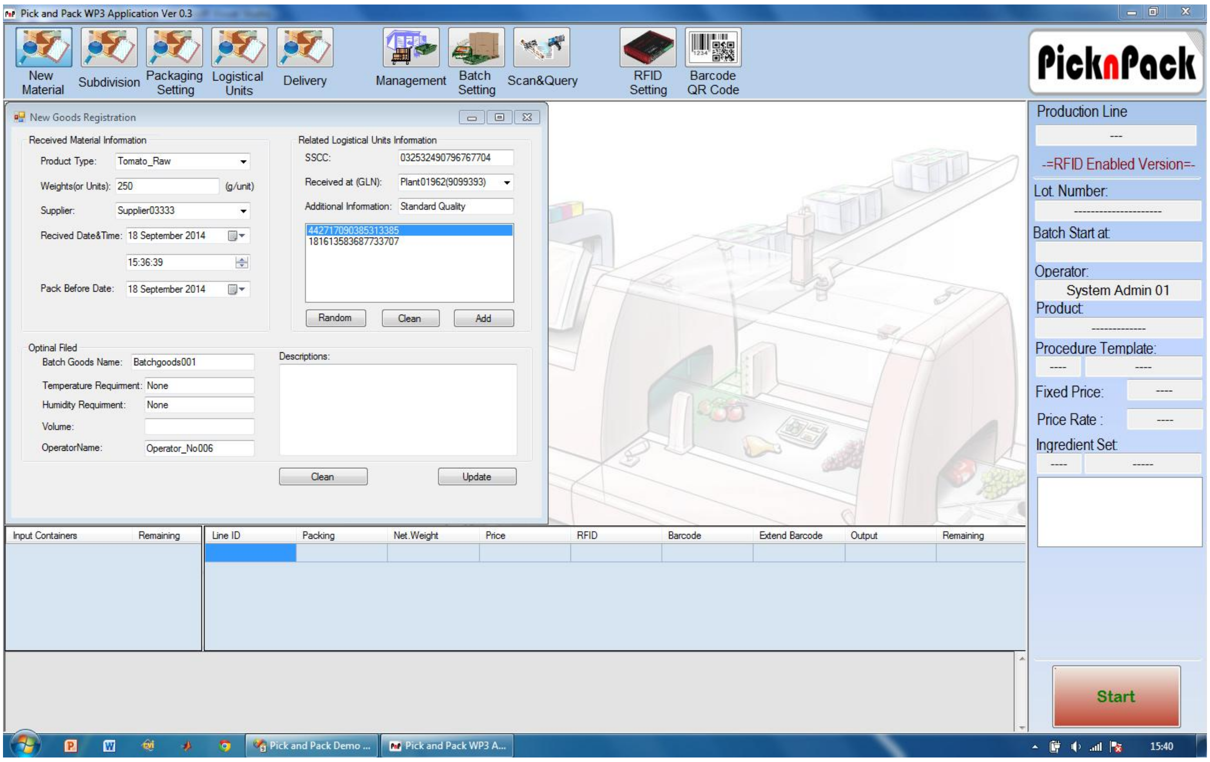


Figure 8 New Material Registration Interface

3.4 Subdivision

The source material needs to be put into containers before it is used for packing. This activity is referred to as ‘Subdivision’. The subdivision interface as shown in Figure 9 can be called out by clicking the ‘Subdivision’ button in the main interface.

Before the subdivision, the incoming goods batch should be selected. Users can query the last 10 incoming goods batches by clicking the 'Show Recent 10 Batches' button, or searching goods batches by date.

When users have selected a goods batch from the searched results, a list of valid containers is showing up in 'Detected Container Section'. The list shows containers detected in subdivision location only and it is updated in real-time. Users can pick up a container from the list and click 'OK' button to confirm the 'Subdivision'.

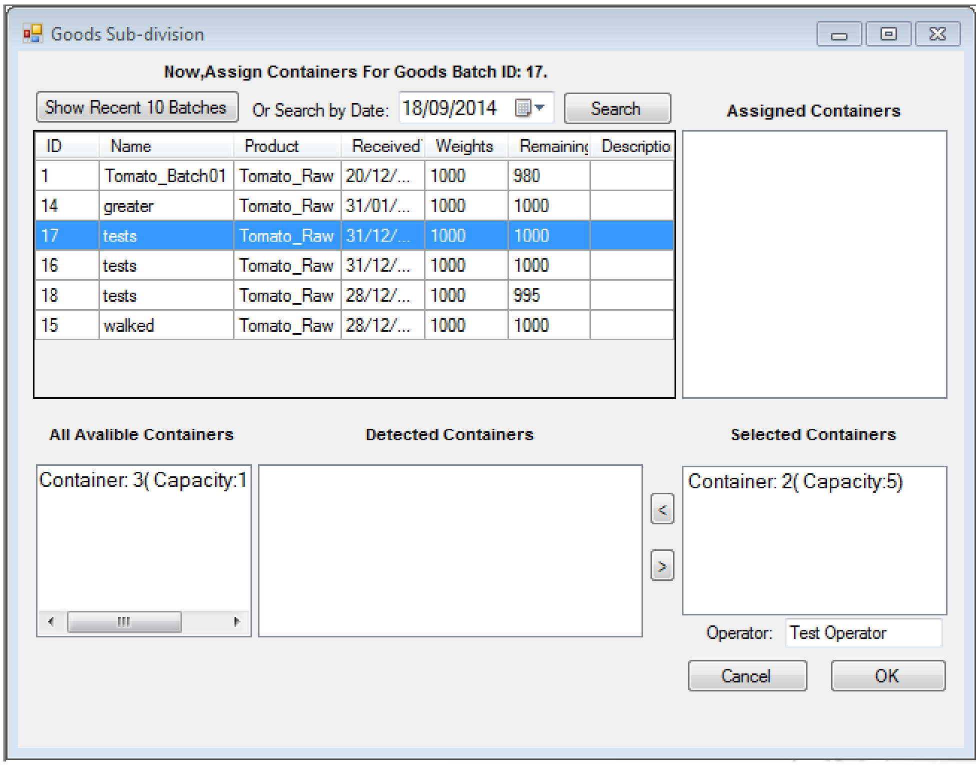


Figure 9 Subdivision Interface

3.5 Packaging

(1) Batch/Lot Setting

Before packaging record can be started, users need to configure the job setting which can be found in the 'Batch/Lot Setting' window as shown in Figure 10.

Four kinds of information are required in the batch setting: name of product, production line information, procedure set, categories of ingredients, and output product type and its GTIN number.

The production line is then ready for recording the packaging activities when users click 'OK' button to confirm the provided information. The main window is also updated as shown in Figure 11.

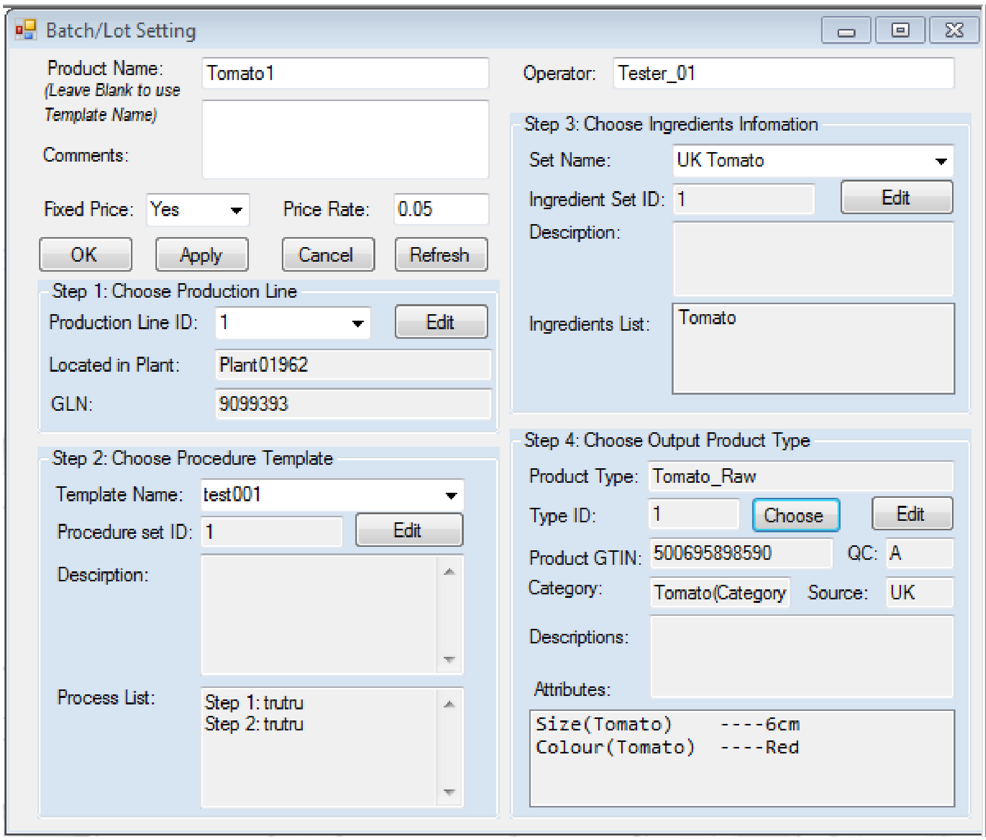


Figure 10 Batch/Lot Setting Interface

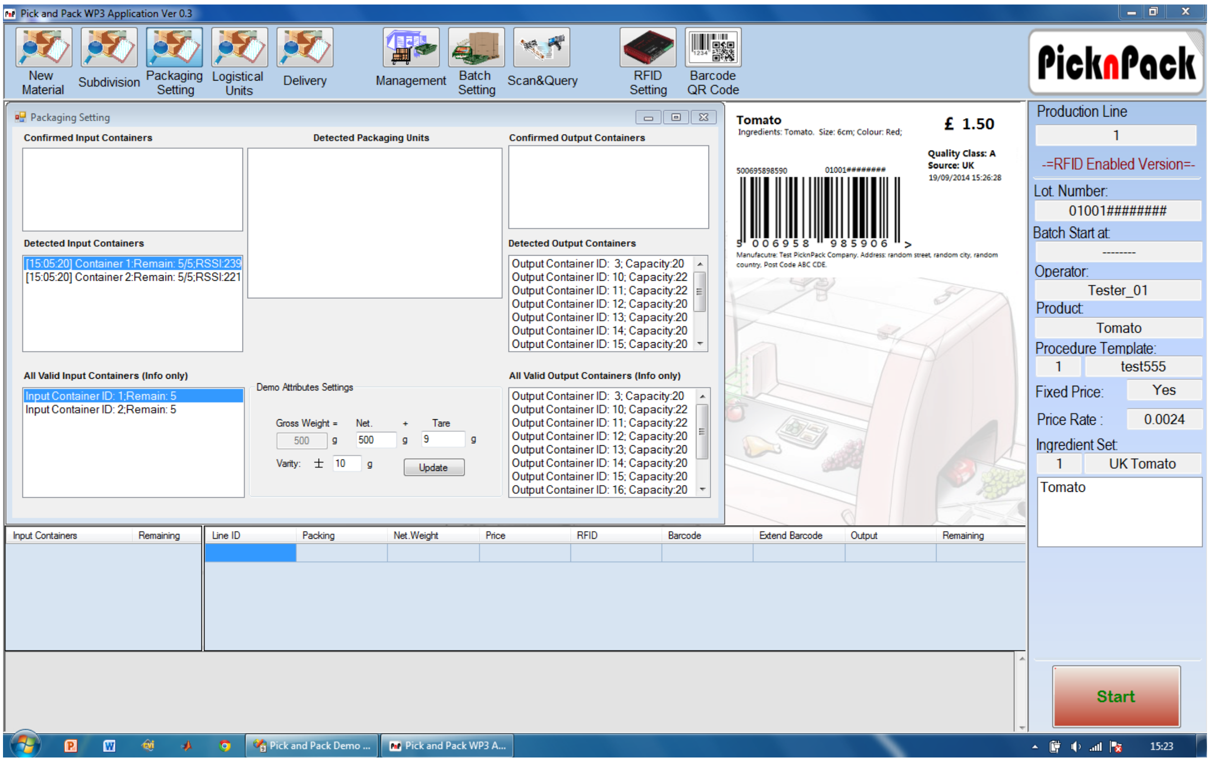


Figure 11 Updated Main Interface after Batch/Lot Setting

(2) Packaging Setting

The 'Packaging Setting' window is used to observe the RFID modules and display them in real-time. The interface can be called out by clicking 'Packaging Setting' button in the main interface.

When the packaging recording is started, the application will select all detected input containers as the 'source' and a container with the greatest RSSI listed in the output containers as the output container. The process is as shown in Figure 12.

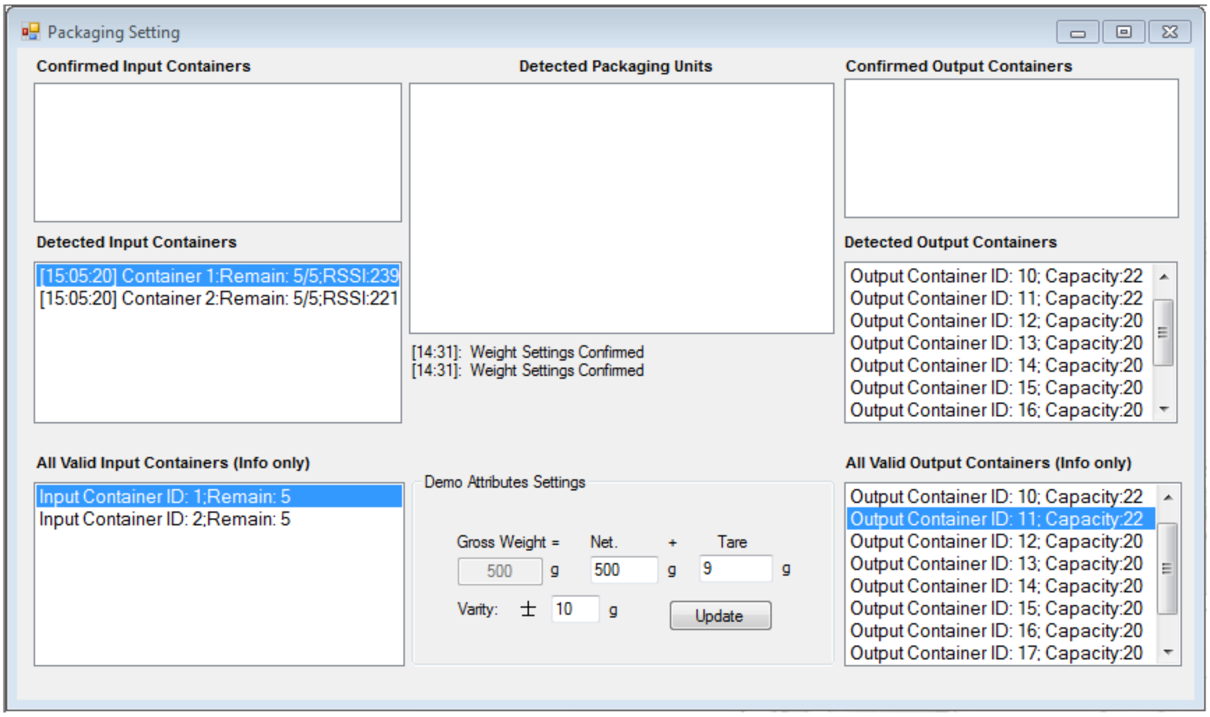


Figure 12 Input and Out Containers are Automatically Selected by the System

(3) Packaging Recording

The function of detecting and recording a product package relies on the RFID module. Each package should be assigned a RFID tag, and the RFID detection needs to follow the rules as below:

- The tag is new with no record in the database
- The tag is detected in the location of 'Package'
- The packaging job is running
- The input containers and output containers are both confirmed

If the above rules are matching, a package is confirmed and a record is created in the database. The display in the interface is also updated as shown in Figure 13. Packaging will be stopped if the rules are not matching. An example of packaging stop due to lacking of input container is as shown in Figure 14.

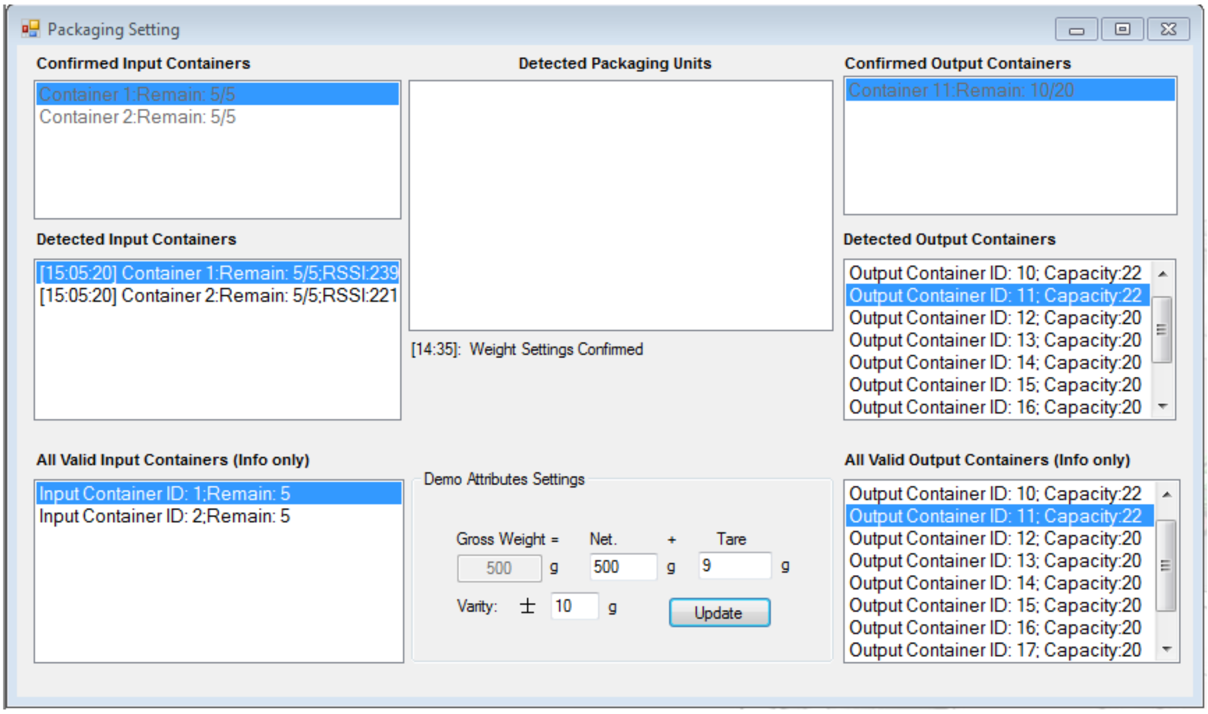


Figure 13 Packaging Recording Interface

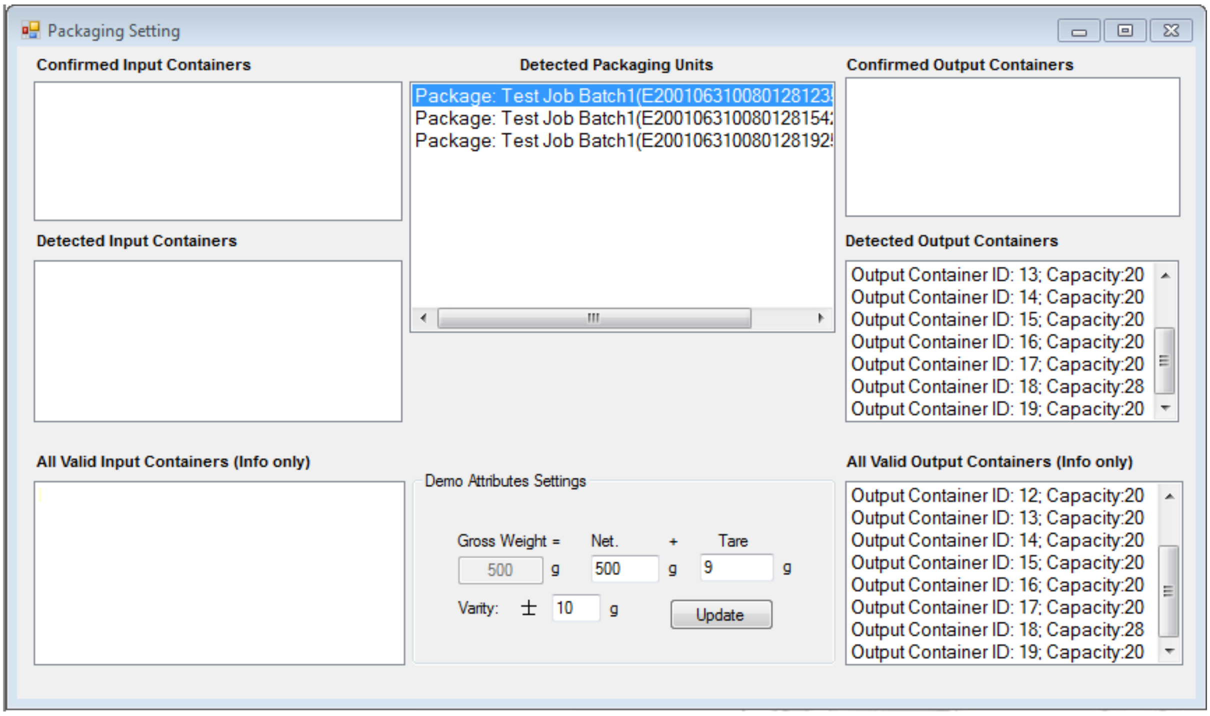


Figure 14 Packaging is Stopped

3.6 Logistic Unit

The function of logistic unit is to package the external containers into a logistic unit for delivery. Users can select the valid output containers in the list.

As shown in Figure 15, the detected contains and those available are listed in the 'Logistic Unit' window, and the list is updated in real-time. Users can select one or more containers from the 'Available Containers' section or 'Detected Containers' section. The selected containers can be registered as a logistic unit by clicking the 'Register' button.

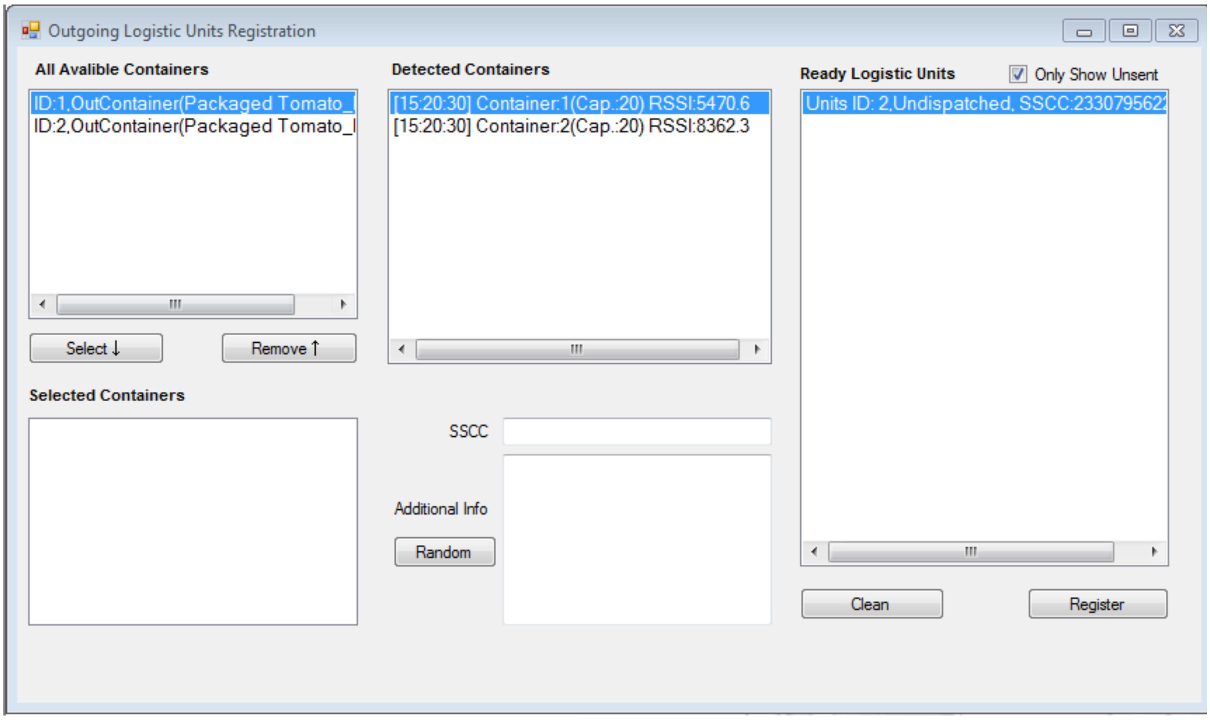


Figure 15 Logistic Unit Interface

3.7 Delivery

The prepared logistic units are then displayed in the 'Delivery' window as shown in Figure 16. In order to create a record of logistic unit dispatching, a valid customer and sending place must be selected. Then, a record in the database is created by clicking 'Send' button if all necessary information is provided.

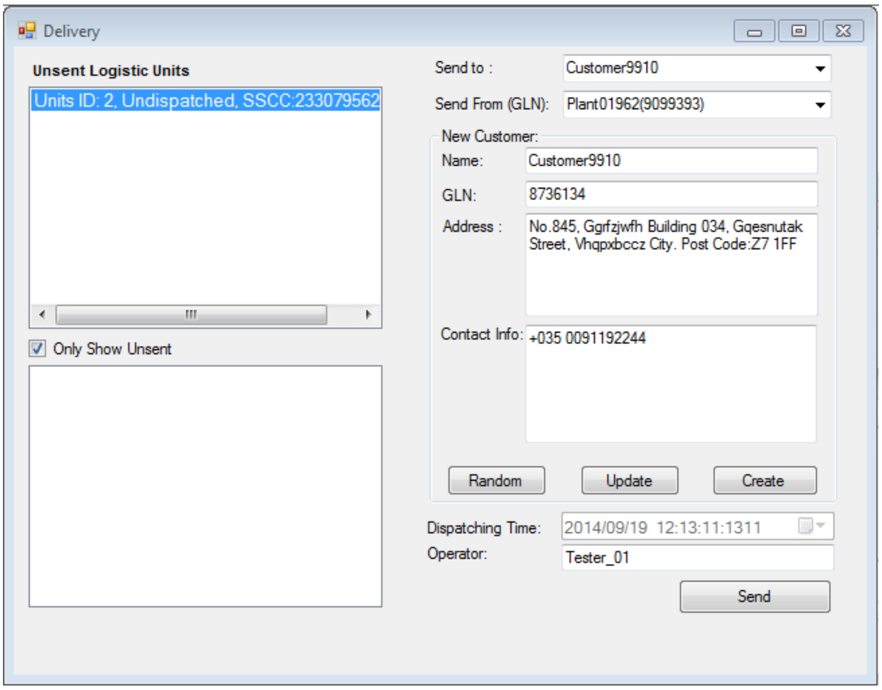


Figure 16 Delivery Interface

3.8 Query & Search

The query and search function can be performed by both the traceability software application and the handheld RFID reader application.

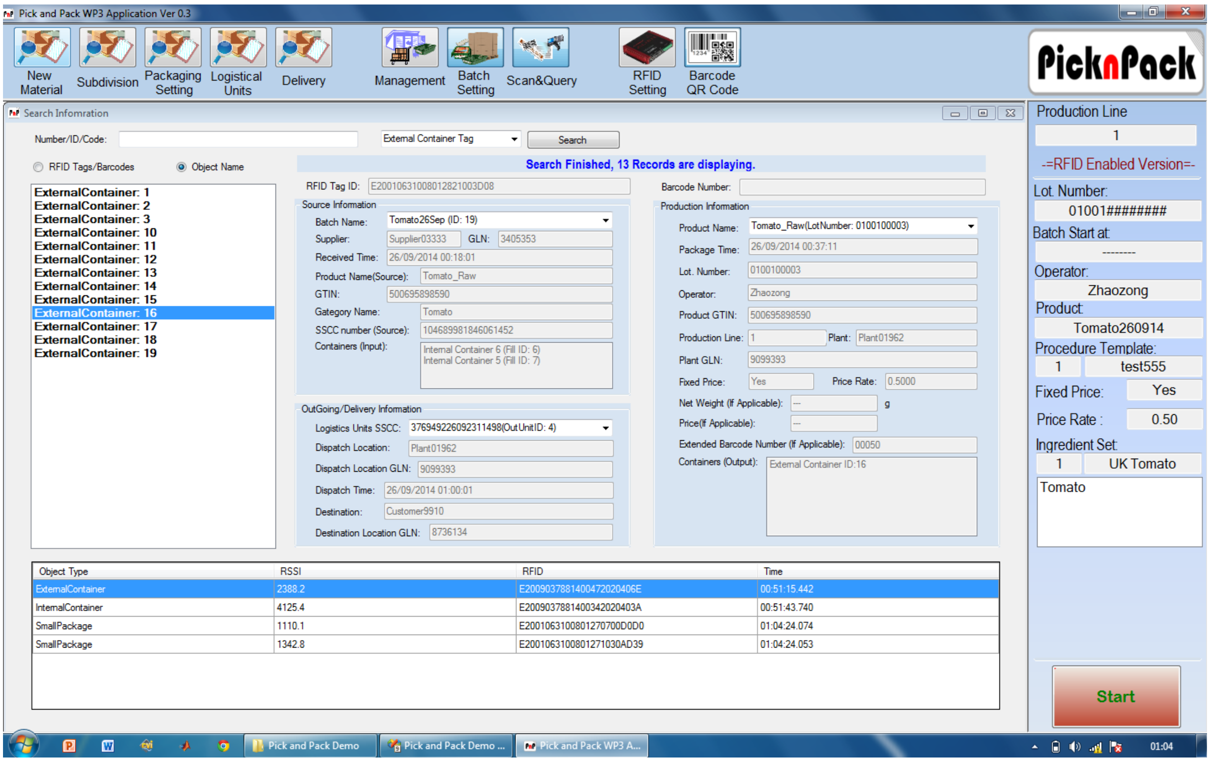


Figure 17 Query Interface

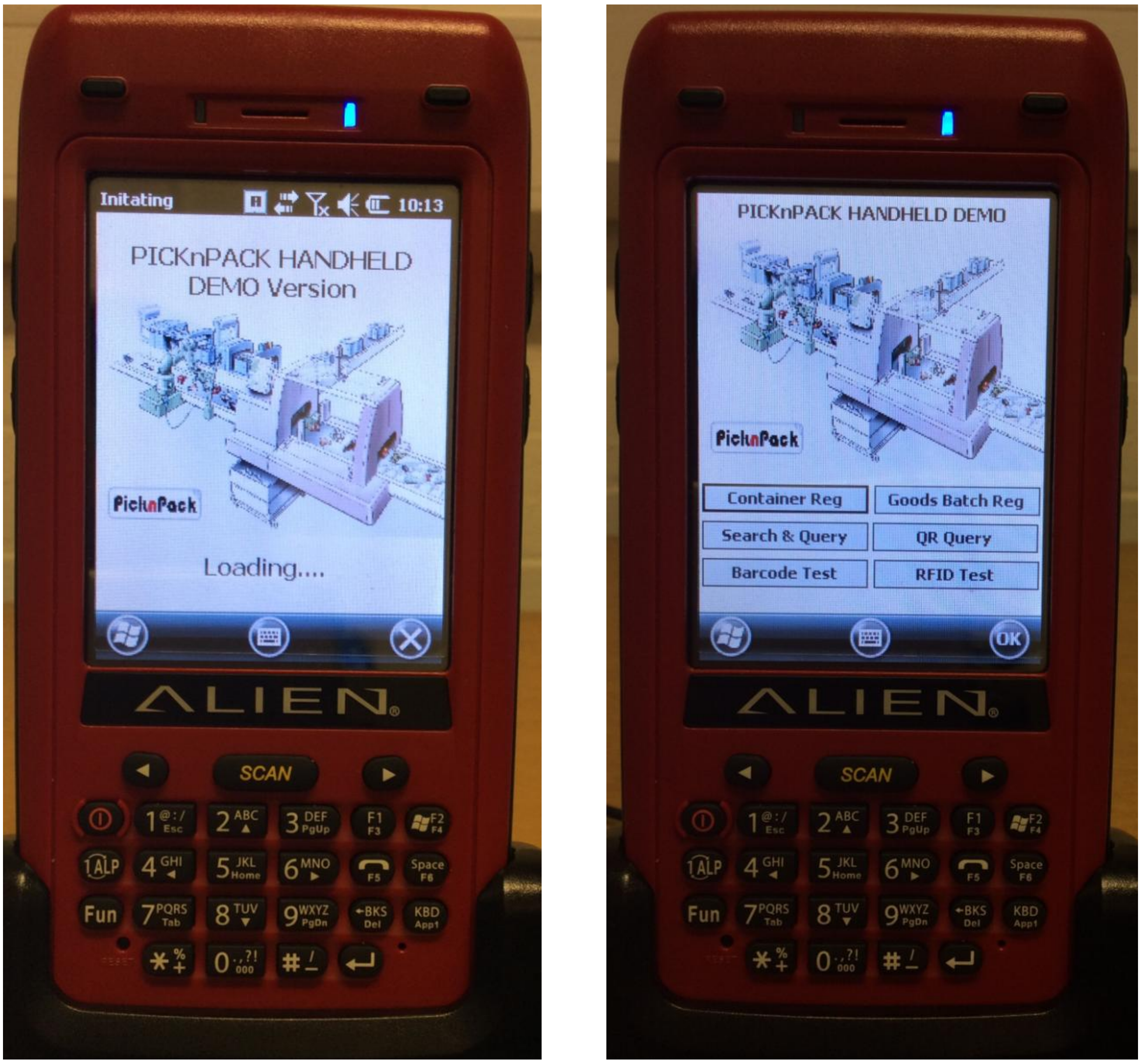
(1) Query & Search with Traceability Software Application

The 'Query & Search' function is used for the users to look up the information of a certain object. The interface of 'Query & Search' function is shown in Figure 17.

Users can input specific tag ID, Barcode, or other object ID to search the detailed information. Users can also retrieve details of objects by double clicking the object IDs list on the bottom of the window detected by the RFID readers when the packing job is running.

(2) Query & Search with Handheld Reader Application

Since handheld reader is lightweight, portable, and convenient, it is very useful for query & search in some situations where fixed readers are not available. The handheld reader application starts automatically when the handheld device is turned on as shown in Figure 18 (a). The main interface is as shown in Figure 18(2).



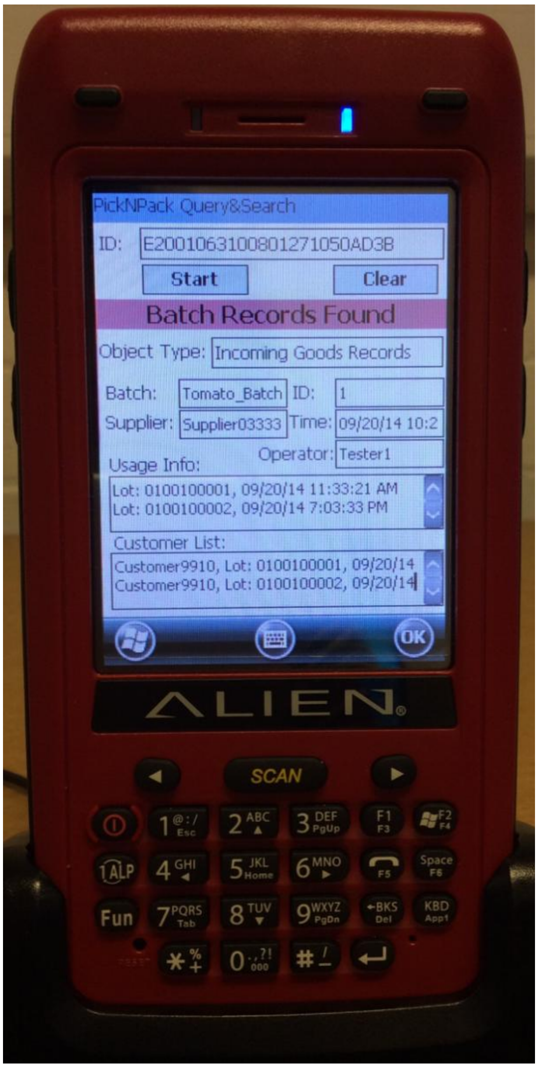
(1) System Booting (2) Main Interface

Figure 18 Start Page and Main Interface of Handheld Reader Application

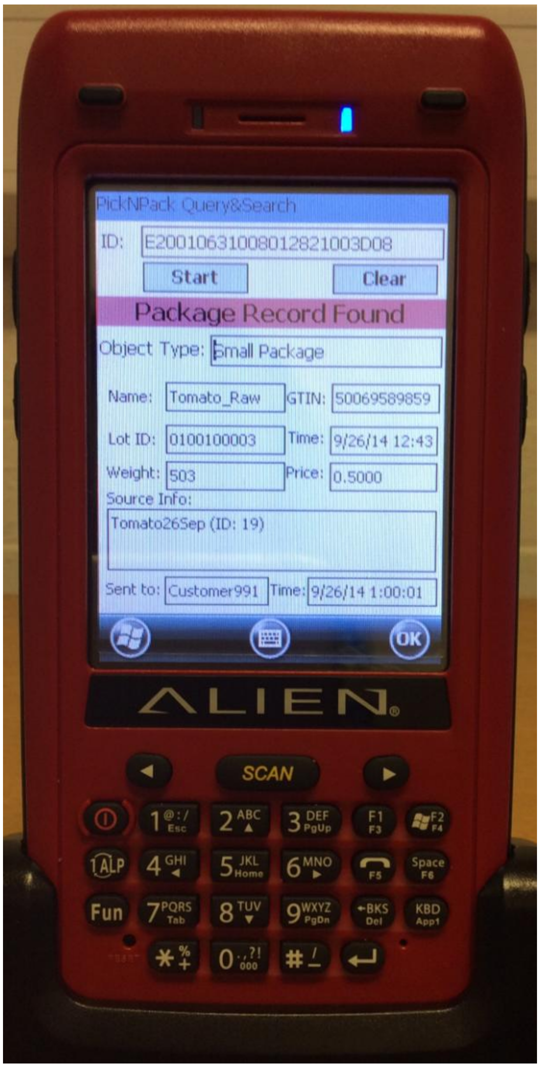
The application provides functions to scan RFID tags and QR code for product line information tracking. By scanning the tag and QR code on the containers with the handheld reader, type and information of the object is displayed for the user.

(1) RFID Tracking with Handheld Reader

As shown in Figure 19, (1) and (2) are the results of incoming goods and small package information tracking with handheld RFID reader. When RFID tags stick on the objects are recognised, the detail information of the object is retrieved from the database and displayed immediately. Since the handheld reader is WiFi and 3G enabled, the application can be used for remote tracking.



(1) Incoming Goods Tracking



(2) Small Package Tracking

Figure 19 Information Tracking with Handheld Reader

(2) Barcode Tracking with Handheld Reader

In addition to RFID tracking, QR code is another efficient way supported by the handheld devices with a built-in camera. The product information is encoded in the QR code with the traceability software application in production line process. Then, users in the following stages can obtain the encoded information with the handheld reader conveniently. The QR code method is a flexible way for end users of products to access product information with consumer electronics like smartphones. Example of QR code tracking is given in Figure 20.

Figure 20 QR Code Information Tracking

4. Summary

This report gives a brief introduction to the RFID enabled traceability system, and then illustrates the operation steps to use the system. By integrating the RFID module into the traceability system, the production line process can be managed and observed automatically and efficiently. In addition, the handheld reader enables the users to check the information flexibly. Testing of the system has been conducted in laboratory environment. The future work will focus on the optimisation of the traceability application to better fit the production line process.