

Politecnico di Torino

Project and Laboratories
on
Communication Systems

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Self-checkout for supermarket

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1 System development

Figure 1: Connection among I/O devices

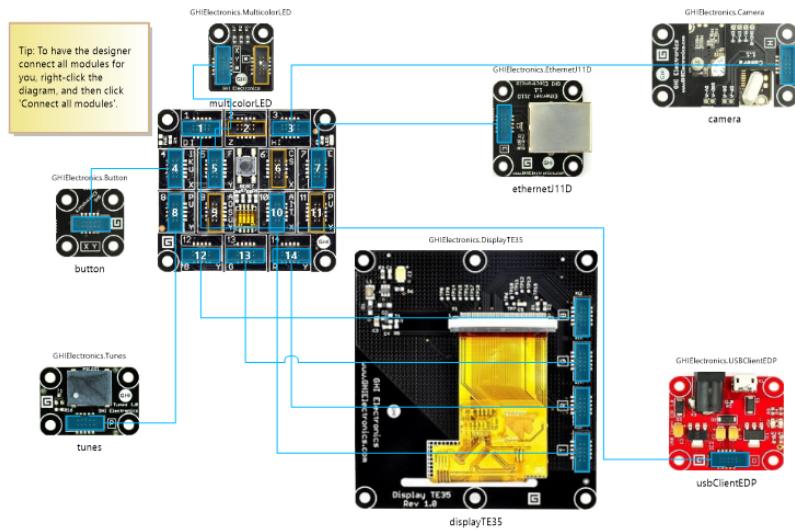
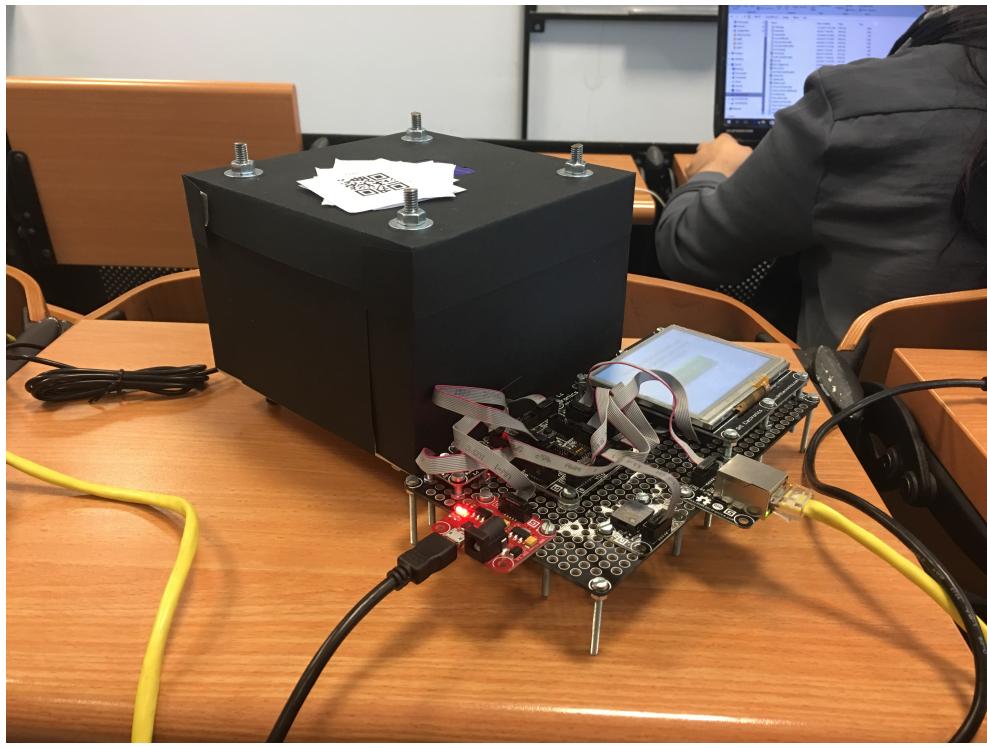


Figure 2: Complete system



2 Client side

The client is characterized by FEZ Spider II and some components connected to the board. The components directly connected to the board are:

- Ethernet J11D module: used to establish an Ethernet communication between client and server.
- Camera: It's useful, because it allows the user to take pictures of QR code and Barcode. The first one was used to authenticate the user, while the second one has been used to identify the products the user is going to buy. The user, pressing the button, will take a picture which will be sent to the server. In this way the server could manage this picture in order to give some information to the client that will be shown to the user.
- Button: pressing the button the camera will take a picture.
- Display TE35: This I/O device makes the system user-friendly, because it allows the user to interact with the system. The step followed by the user are the following one:
 1. Initial window that appears on the display
 2. The display shows a window that asks the user to authenticate himself putting the QR code in front of the camera (figure 3). If the authentication succeeds the user can start his purchase, otherwise he has to repeat the scan of his QR code (figure 4).

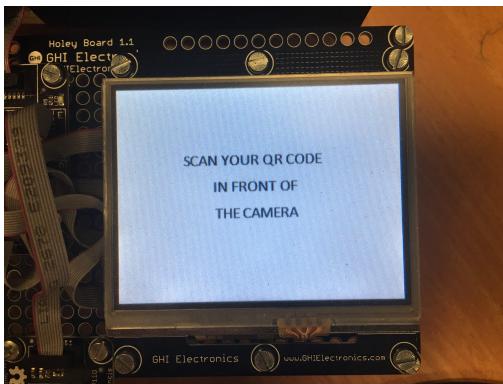


Figure 3: Scanning of QR code

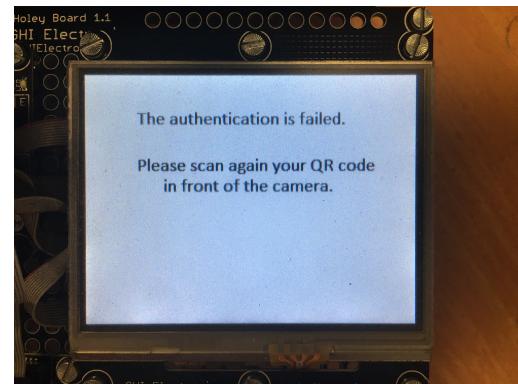


Figure 4: Scanning of QR code failed

3. The user scans each product that will appear on the screen (figure 5). He also has the chance to delete those products he does not want to buy anymore using the button shown in the following images (figure 6).

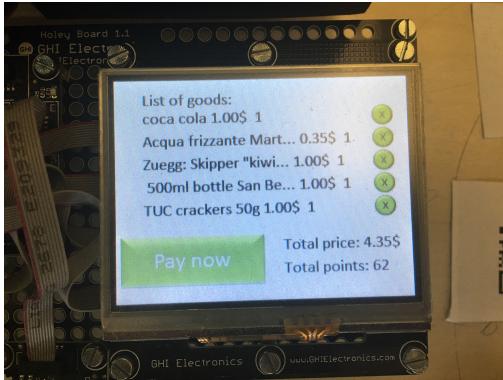


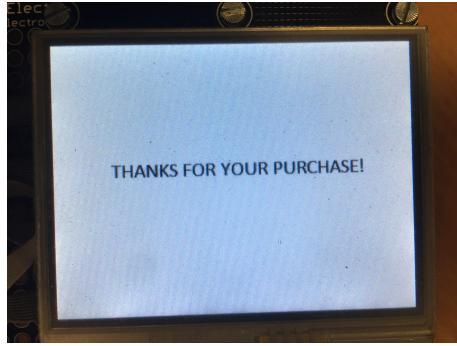
Figure 5: Before deleting the product "coca cola"



Figure 6: After you delete the product "coca cola"

4. After pressing the button "Pay now" your purchase succeeds and another user can start a new purchase (figure 7).

Figure 7: Buying successfully



2.1 Management of the errors

The client is also able to manage some mistakes that could occur during the transaction. The display shows a window that explain the error that occurs with a text message.

1. Connection down. This problem could occur every time the Ethernet cable is disconnected. After you connect the cable the display will resume running from the window the user was watching before disconnecting the Ethernet cable (figure 8).
2. The user fails his authentication. In this case the user has to repeat it (figure 4).
3. The user fails the authentication of the product. In this case the user has to repeat it (figure 9).



Figure 8: The connection is down.

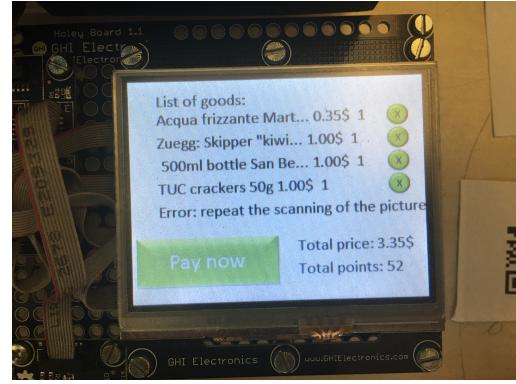


Figure 9: The identification of the product is failed.

3 Server side

The board interacts using an ethernet cable with a server application that runs on a PC. This application receives requests from the board and performs some actions to provide an answer back.

3.1 Interactions with the board

There are two types of interactions with the board:

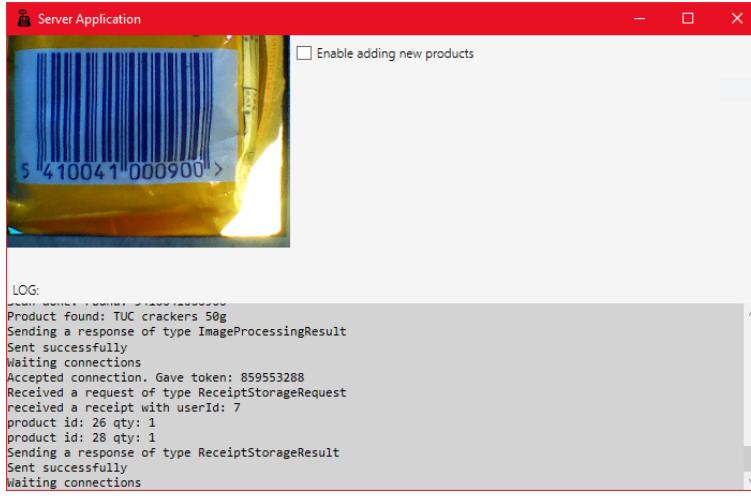
- the board requests to identify a customer/product by sending an image.
- the board requests to store a receipt.

In the first case, the server application uses the Zebra Crossing library to detect 1D/2D codes. If the code is a barcode (1D) it makes a search in the database for a product with this barcode and returns to the client the informations about it. If instead the code is a QR (2D), the application searches in the database for a customer with this code and returns to the client the informations about this customer.

When instead a request to store a receipt is received, the application stores the entries into the database. The insertion in the tables will trigger some actions to manage the items in the shop and also to increase the points of the customer. This is explained with more details later.

3.2 GUI

Figure 10: GUI application



The application has a basic GUI (figure 10) that shows:

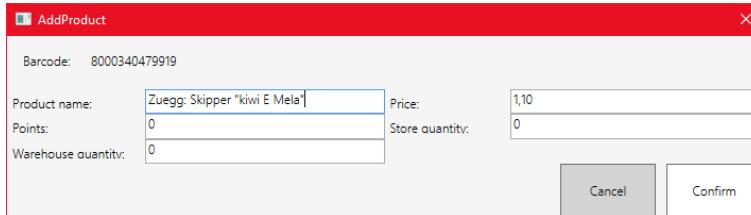
- a log in order to understand what's going on.
- the last image received from the board.
- a control for managing the addition of a new product.

3.3 Adding products

The application runs on a PC and through the GUI can be used by the shop personnel to simplify the addition of new products in the shop. There are two ways for the operators to add new products: they can use the website and complete the dedicated form, or they can scan the barcode using the application, after having enabled the option: “enable adding new products”.

In the latter, when a barcode is detected and no entries in the database have this barcode, an online search is performed using a open contributive web service (<https://upcdatabase.org/>) and a new window is shown (figure 11). If the search has succeeded, the window will contain as initial values the ones found online, still editable, otherwise the operator can insert the values manually.

Figure 11: GUI application



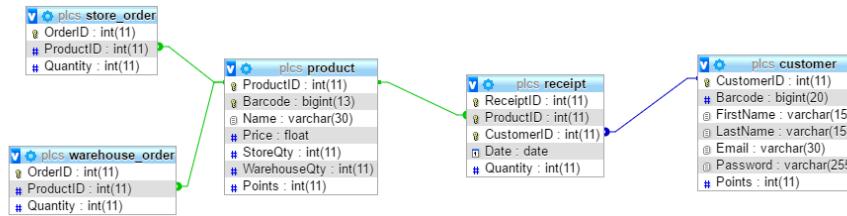
Using this method, the addition of product is faster than manually filling all the fields in the website, and since new products are added to this database every day the probability of finding an online match increases.

4 Website: Buy&Buy.com

4.1 Database Design

The figure 12 shows the relational database model for the website. It consists of 5 tables which are discussed below:

Figure 12: Relational database model



1. Product:

It contains the main product catalog for the supermarket.

2. Customer:

It contains the registered customers of the supermarket.

3. Receipt:

It stores the list of products purchased by customers on each day.

4. Store_Order:

The maximum quantity of each product present in store is 10. Whenever a purchase is made, the quantity of products in store decreases and eventually these products are ordered from warehouse. This table stores the products to be ordered from warehouse along with their quantity.

5. Warehouse_Order:

The maximum quantity of each product present in warehouse is 50. Whenever the products are supplied to the store, the quantity in warehouse decreases and the products to be ordered from the supplier are stored in this table.

4.2 Website Functionalities

The website provides 2 interfaces, one for customers and another for the administration.

4.3 Customer view

Each customer is able to view his purchases and his profile, as shown in the figure 13 and figure 14:

Figure 13: Customer's purchase

S.No.	Date	Product Name	Price	Quantity
1	2017-06-18	TUC crackers	1.2 euro	1
2	2017-06-23	coca cola	1.5 euro	2
3	2017-06-23	Acqua San Benedetto	0.25 euro	3

Figure 14: Customer's profile

The screenshot shows a customer profile page with the following details:

Barcode	100000
First Name	u1
Last Name	user
Email	u1@gmail.com
Points	22

4.4 Administration view

The manager is able to perform the following actions (figure 15):

- View Customers.
- View Products.
- View Purchases.
- Add Product.
- Remove Product.
- Update Product.

Figure 15: Customer's actions

The screenshot shows a list of customers with the following data:

S.No.	Barcode	First Name	Last Name	Email	Points
1	100000	u1	user	u1@gmail.com	22
2	100001	u2	user	u2@gmail.com	0
3	100002	u3	user	u3@gmail.com	0
4	100003	Sorath	Asnani	sorath@gmail.com	0
5	100004	Martino	Mensio	martino@gmail.com	0
6	100005	Giuseppe	Carella	giuseppe@gmail.com	0

On the left, there is a sidebar with the following buttons:

- View Customers**
- View Products**
- View Purchases**
- Add Product**
- Remove Product**
- Update Product**

4.5 Triggers

The following functionalities are handled by introducing triggers into the database:

- Validation checks before registering new customers.
- Validation checks before inserting new products.
- Preparing the orders for store when a purchase is made.
- Preparing the orders for warehouse when the products are supplied to store from warehouse.
- Increasing the customer points when a purchase is done.

5 Product information

- **Applicability:** the system has been designed for automatic shopping in supermarkets with high attendance.
- **Market perspective:** development of a system that is able to speed up the buying phase of the customers in a supermarket.
- **Ease-of-use:** the system developed is very user-friendly. The user can interact with it through a touch screen LCD on which every step of the purchase is explained in a comprehensive way. It has a lot of functionalities and it allows the user to execute a purchase thinking about his needs. For example this system allows the user to delete a product he already scanned by simply pressing the delete button. This system has also been developed thinking about the employees, in particular the system administrator. He can monitor the available products in the stock. Moreover the Website warns the administrator on the available quantity of products of the same type.
- **Costs:**
 1. LCD: 150\$
 2. Tunes module: 10\$
 3. FEZ Spider II: 150\$
 4. Button: 5\$
 5. Camera: 50\$
 6. Ethernet module: 20\$
 7. Firmware on the processor: 500\$
 8. Server Side: 500\$
 9. WebSite and database: 1000\$
 10. Assistance: 300\$ per year and it also covers damages for two years.
 11. Total cost: 2685\$