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Items Searching In Factory Warehouse Using Arduino Module

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ABSTRACT

The smart store system (F^3 Storage System) provides an inventory system function, and is supported by voice recognition for items searching purpose in the warehouse. This system is aimed to improve effectiveness in item searching process for the warehouse management. An inventory system structures is employed in this system to enable items management. Voice recognition facility helps the worker to search item in an effective way. Worker can use voice recognition function to search the item in the warehouse, and searched information of the item will be displayed in the liquid crystal display (LCD) screen. Meanwhile, the location of the item will be physically indicated by the light emitting diode (LED) light function. The developed system also contains a barcode system to enhance the process of scheduling warehouse activity. Such facilities will enhance the capabilities of existing inventory management systems in warehouses. Prototyping model is used to assist project development. Arduino technology is used to enable integrated hardware and software to read data or input. With Arduino technology, traditional search items by using text and search functionality are enhanced to allow speech functionality. This functionality makes the search process faster and more efficient.

1. Introduction

Warehouse was among the most needed facility for every industrial area to store the raw materials and manufactured goods. [1]. Every activity involving storage of goods on a large-scale requires a systematic, orderly manner and conveniently available. In other words, warehousing means holding or preserving goods in huge quantities from the time of their purchase or production till their actual use or sale. Normally the warehouse keep records of any incoming and outgoing items in the log book and system. Then, the items are categorized and labelled according to the standard system used by the organizer to store the items in the warehouse. When the items are requested, the worker will search the items in the record to confirm availability of the items. If the items are available, the worker will search the items in the warehouse based on the information in the record. However, with huge number and multiple types of items, it makes item's storage and searching in the warehouse is difficult and troublesome when it is not organized sufficiently. Therefore, the inventory system is needed for managing the warehouse [2]. Most of the organization or factory had started depending on the inventory system to manage the record and searching process efficiently. Besides, the inventory system provides functions which is easy to understand and manage. It provides various function such as calculation, storing and so on to ensure items are stored properly.

Most of the existing inventory system focused on the virtual data recorded in the system [3]. Every incoming and outgoing item will be recorded in the system. Human had created a software for data storing such as Database Management System (DBMS) by providing function for data backup of the item in the warehouse to prevent data loses, multiple inventory platform exchange, and have security protection to prevent interruption or stealing [4]. The item data does keep safe in the DBMS, but the DBMS does not provide the physically view where the items being in the warehouse [5]. For a worker to search the data of the item in database is easy. However, it is somewhat difficult for worker to search and locate the item, especially in the large scale of item store. Longer searching time is required to locate the item correctly. Such situations can be a real problem in large warehouses. For example, in the production of any plant, it is inconvenient if the machine breaks, and the machine parts need to be replaced immediately for the smooth production of the plant. Items for faulty machine parts should be searched quickly in the warehouse for replacement process. Failure to find replacement parts for damaged machines may result in delayed production and losses.

Thus, a system which can locate exactly the item stored in warehouse is needed to assist above mentioned limitations in the existing system. A smart store system known as F3 Storage System (Fast, Feasible and Fulfill) is developed in this project. This system is an embedded system, which is applied to the warehouse and will record all item's information such as item name, quantity, and location. The system works by combining physical and virtual data information for items in the warehouse. Besides, the system also supports voice recognition function to ease the worker to search the item in the warehouse and display searched information of the item in the LCD screen. The system is expected to improve effectiveness in item searching process at the warehouse.

The rest of the paper is organized as follows. Part II describes item searching process in the warehouse, method and technology used to support the development of the system. Part III explains prototyping model as development methodology. Part IV presents finding on analysis and design of the system. Part V exhibits the implementation of the system and its testing, while Part V gives a conclusion.

2. Literature Review

This section discusses the finding of literature reviews relating to the developed system.

A. Items' Searching Process in Warehouse

Current inventory system is performed manually by keying-in the data using keyboard for any received incoming or outgoing for the items [6]. Recorded item's information is then managed in the system database before assign each item to a specific location in the warehouse. Through the system checking, worker can ensure the availability of the items before searching process. In searching process, system will display information of the selected items once received input from worker. If the items are available, worker can search the items based on the information provided by the system.

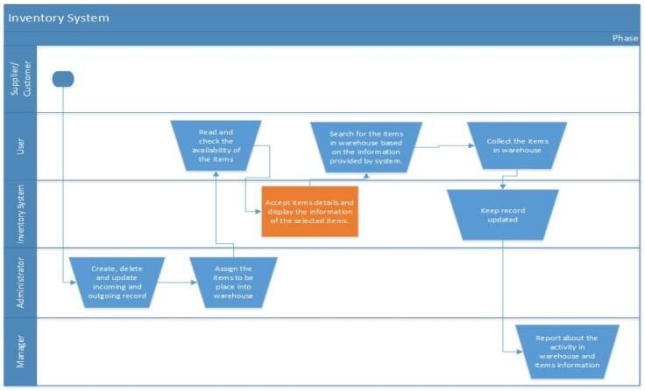

Figure 1: As-Is Model

Worker will collect the items and update the ongoing of the items. Every weekend, system will generate weekly report based on the activities conducted in the warehouse as a record and will be documentation as future references. The current searching process is illustrated in the As-Is model in Figure 1.

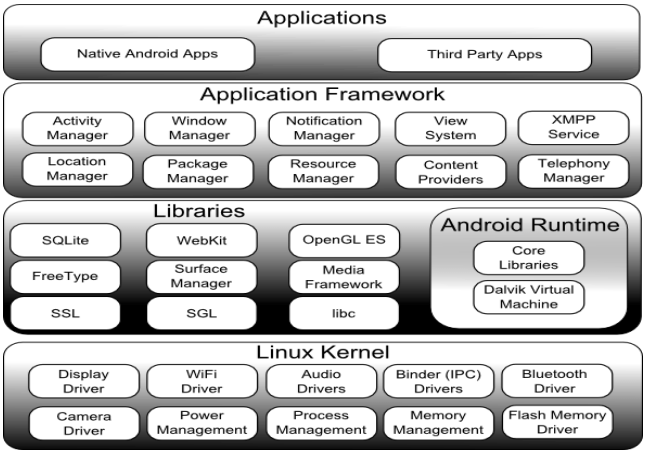

Figure 2: Android Platform Architecture [8]

B. Android Technology

Android is a worldwide used operating system and a software platform for mobile based device such as smartphone [9]. Android comes with an Android market which developed by Google to support applications develop by third party. Android application was written using java programming language and became an open source software for developed to develop new applications under android itself. Nowadays most smartphone support Android technology and smartphone is a part of life and being used as daily needed tools on every minute. With this

opportunity, the proposed system can be widely used as portable application by integrated with the Android based platform.

Figure 2 illustrates the architecture component for the Android platform [8]. There are four layers contained in the Android architecture. The first layer is the Android application which comprised of built-in application or third-party application. The second layer is application framework, built using java programming language and provides high level services and APIs in the application. For third layer is libraries layer which providing support for the core features. Android runtime also part of this layer and consist of core libraries and the Dalvik virtual machine. And for the last layer is Linux kernel. The Linux kernel used to communicate between Android device with other peripheral devices.

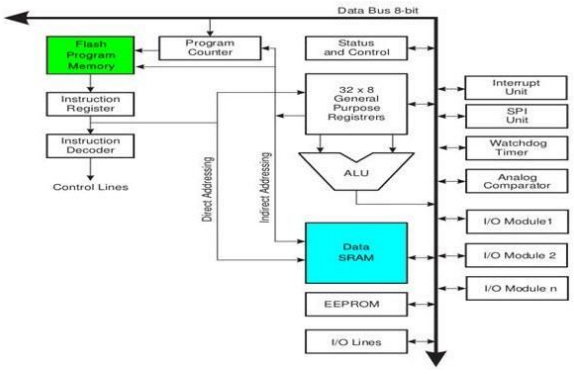

Figure 3: Arduino Architecture [11]

C. Arduino

Arduino is an open source electronic platform based on hardware and software [10]. To enable the hardware and software to integrate within itself required Arduino board for read the data or input and generate in software based. Arduino programming language are the language used to operate or instructing the hardware device through the software. With Arduino technology, the proposed system will be able to develop items searching system which using speech to locate items locations through LED light as the output.

Based on the Figure 3, Arduino architecture was using Harvard architecture where the program code and program data have separate memory which is program memory and data memory. For the program code is stored in the flash program memory while for the program data will store in the data memory.

3. Methodology

The software process model that is chosen to be used in this project software development life cycle (SDLC) is system prototyping model [7]. Generally, system prototype is built, tested, and

then reworked as necessary until an acceptable prototype is finally achieved from which the complete system or product can be developed. Figure 4 illustrates the system prototyping phases.

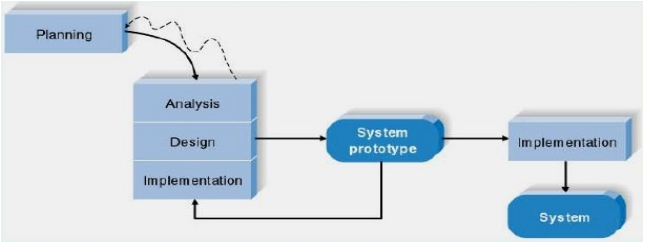

Figure 4: System Prototyping Phases

There are total of six phases from the prototype model. As shown in Table 2, each phase has its own assignment and output that need to be produced during the entire project development. Besides that, the output had been completed within the specific days that have been given.

Table 2: Prototyping Phase and Its Activities

Phase	Activity	Deliverables
Planning Phase	Find out why inventory system should be re-engineering, what are the new features that can be extracted from the existing inventory system to be applied into the proposed system and how the project will be developed.	The proposal for F³ Storage System also known as smart store system which is include as following: 1. Problem Statement 2. Objective 3. Scope 4. Methodology
Analysis Phase	Find out what should be develop based on the existing inventory system and how to build the new features for the existing inventory system. Discussion on who will use the system (Tester, administrator, user), main purpose of develop the system (improve existing system) and how or where the system will be used for (Warehouse, for record and searching).	The analysis phase in proposal for F³ Storage System include as following: 1. Data Flow Diagram 2. Entity Relationship Diagram 3. Requirements Traceability Matrix 4. Hardware & Software specification
Design Phase	Discussion on the function will be used by system (hardware, software and network), the user interface for the system, what information needed for system to record.	The design phase will in the proposal for F³ Storage System include as following: 1. Administrator Interface 2. Warehouse Management Interface
Implementation Phase	Implement all the function and features by develop the system.	Code program and device setting. Test case.
Documentation Phase	Discussion on what should be documentation for future reference and maintenance process.	Full report

4. System Analaysis and Design

This section discusses the requirements analysis and design. Diagrams and charts are presented to assist the description of analysis and design. The developed searching process is illustrated in the To-Be model in Figure 5.

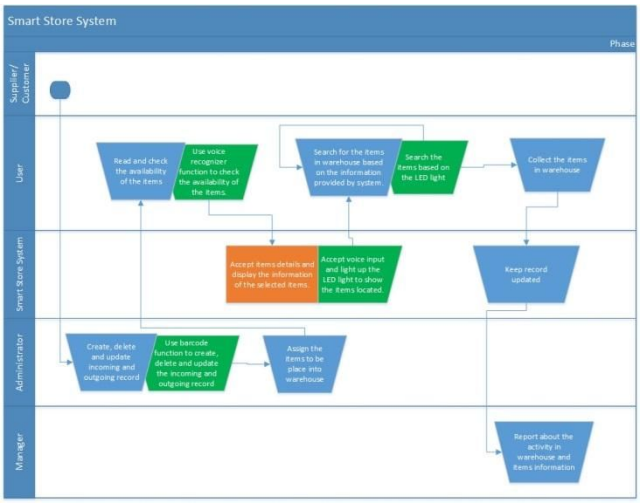

Figure 5: To-Be Model

A. System Design

The system is included two entities such as `worker` and `administrator`. Figure 5 illustrates context diagram for this system.

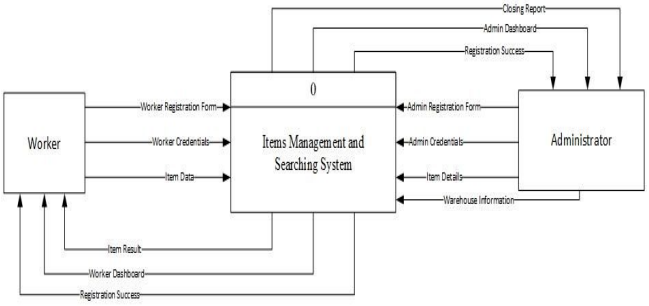

Figure 5: Context Diagram

The system encompasses of seven processes, two external entities and four data stores. Four main processes are `Manage Warehouse`, `Manage Item`, `Generate Report`, and `Search Items`. All processes are stated in the Figure 6.

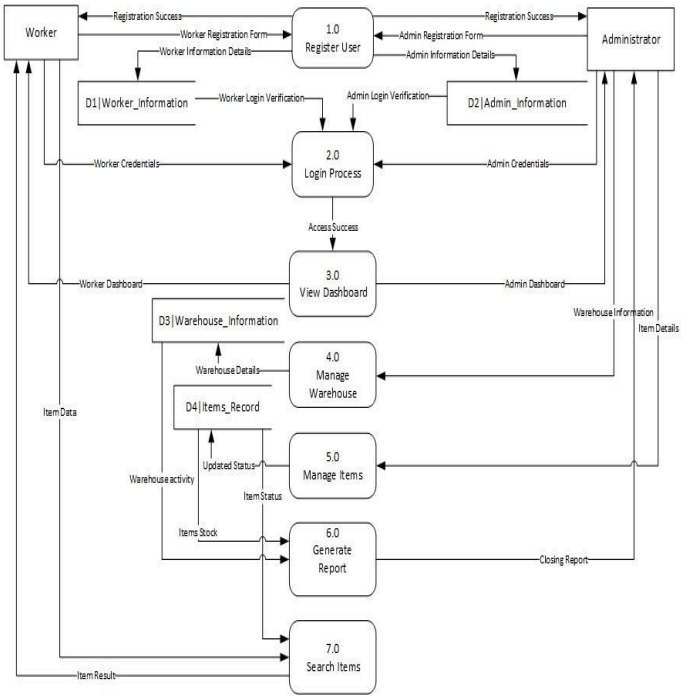

Figure 6: Data Flow Diagram Level 0

Requirement Traceability Matrix (RTM) as shown in Table 3 is a document that defined all the tested requirements of the system in the test protocols.

Table 3: Requirements Traceability Matrix For Smart Store System

Allocated	Descriptions
REQ_100	**Registration**
• REQ_101	• System display new registration form
• REQ_102	• Database update user details
• REQ_103	• User enter details in the required field
• REQ_104	• System display pop-up message of successful
• REQ_105	• System display pop-up message of error
REQ_200	**Login**
• REQ_201	• User required to login into the system
• REQ_202	• System display user dashboard for the valid login
• REQ_203	• System display error message for invalid login
• REQ_204	• System verify user login through user login data
• REQ_205	• System verify user info through user profile
REQ_300	**Manage Item Details**
• REQ_301	• System display item information interface
• REQ_302	• System display add new item information interface
• REQ_303	• Add new item information for new item
• REQ_304	• System display error message for existing item information
• REQ_305	• System display update item information interface
• REQ_306	• Update existing item information
• REQ_307	• Delete existing item information
• REQ_308	• Update existing item status
• REQ_309	• Add new item status for new item
• REQ_310	• Add new item location for new item
• REQ_311	• Update existing item location
REQ_400	**Manage Item Searching**
• REQ_401	• System display item searching interface
• REQ_402	• Get selected item data through voice recognition
• REQ_403	• System display item location if item data found
• REQ_404	• System display error message if data not found
REQ_500	**Generates Report**
• REQ_501	• System display warehouse documentation interface
• REQ_502	• System display weekly report page
• REQ_503	• System display monthly report page

B. Database Design

The system is included four entities which are `Admin_Information`, `Worker_information`, `Items_Record` and `Warehouse_Information`. All entities with its characteristics are stated in the Entitity Relationship Design in Figure 7.

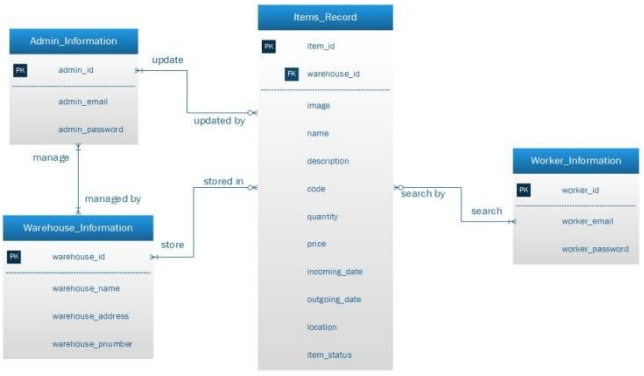

Figure 7: Entity Relationship Diagram

5. Implementation and Testing

Implementation and testing phase are where all the requirements have gathered and tested to make sure the system's requirements is fulfilled.

A. Implementation

The code and interfaces implemented to build the interaction between users and system via web-based and mobile-based.

(i) User Registration Process

Figure 8 and Figure 9 display the interface design for process `Register User` in the web-based application.

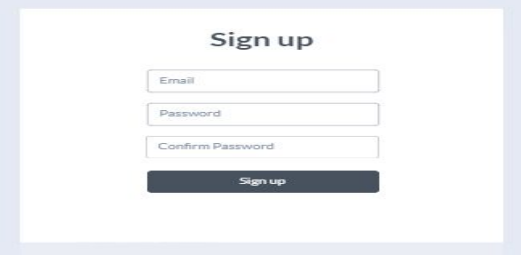

Figure 8: Registration Interface

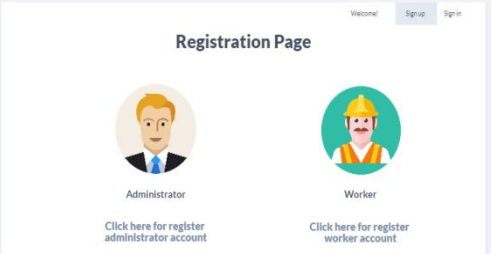

Figure 9: Registration Page Interface

(ii) Administrator Dashboard

Figure 10 and Figure 11 despite the interface design for process `View Dashboard` in the web-based application.

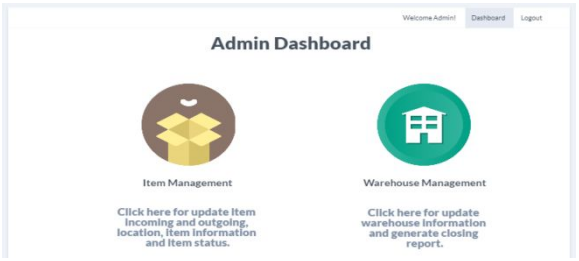

Figure 10: Administrator Dashboard Interface

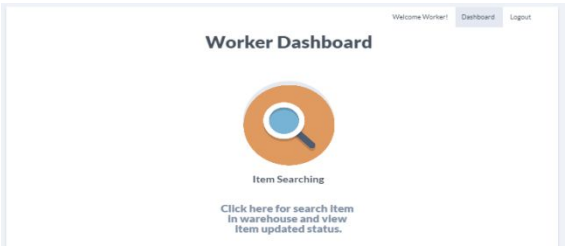

Figure 11: Worker Dashboard Interface

(iii) Items Management

Figure 12 and Figure 13 illustrate the interface design for process `Manage Items` in the web-based application. While Figure 14 is used to register item's information.

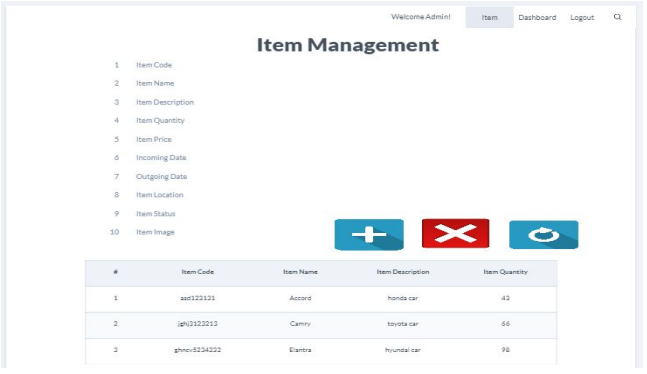

Figure 12: Item Management Interface

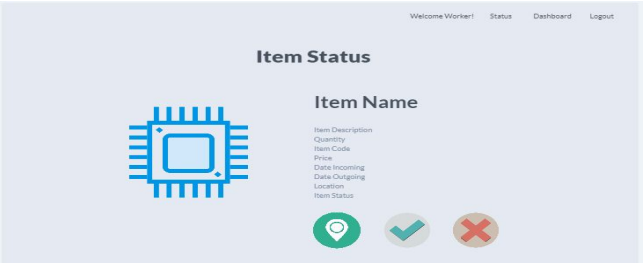

Figure 13: Item Status Interface

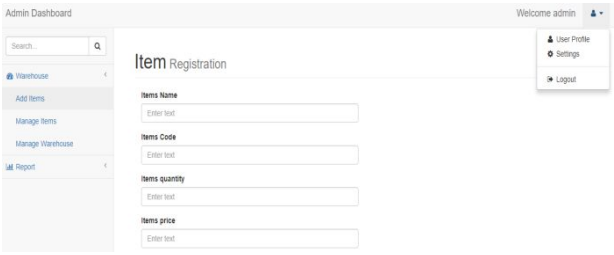

Figure 14: Items Registration Interface

Item management interface allows administrator to view, edit and delete the items in the database as show in Figure 15.

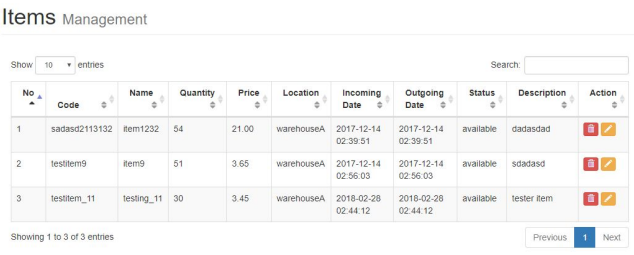

Figure 15: Item Management Interface

(iv) Warehouse Management

Figure 16 portrays the interface design for process `Manage Warehouse` in the web-based application.

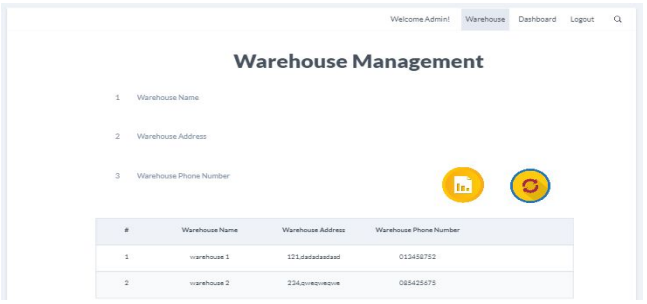

Figure 16: Warehouse Management Interface

(v) Items Searching

Figure 15 shows the interface design for process `Search Items` in the web-based application. Searching result is displayed as in Figure 16.

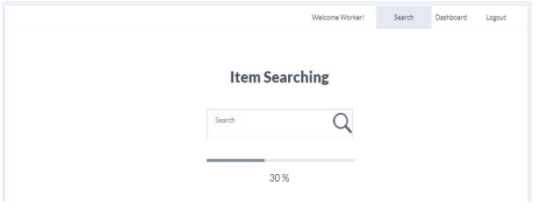

Figure 15: Item Searching Interface

Figure 16: Searching Result

Figure 17 shows the `voice recognition` interface for mobile-based application that allows workers to search items using voice as an input.

Figure 17: Voice Recognition Interface

`Barcode reader` interface shown in Figure 18 allows the workers to retrieve item's detail by scanning the barcode on the item. The details of the item will be displayed.

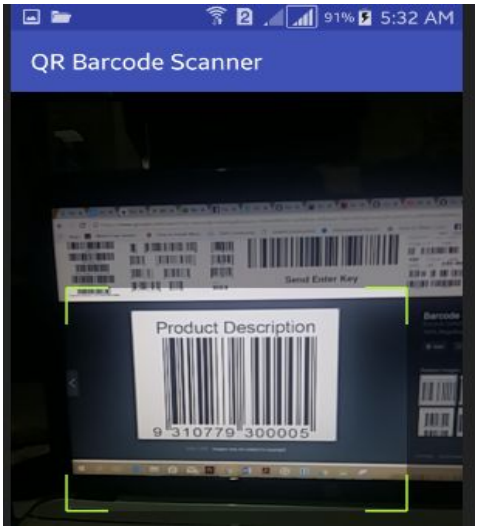

Figure 18: Barcode Reader Interface

B. Testing

The testing process is to test the functionality of the developed system. The testing process driven by requirement tracedability matrix of the system as shown in Table 3. The result is decribed in Table 4.

Table 4: Test Case

Test Case	Num. of Test Cases Passed	Pass (%)

STD_TEST_100	6/6	100
STD_TEST_200	5/5	100
STD_TEST_300	2/2	100
STD_TEST_400	6/6	100
STD_TEST_500	4/4	100
STD_TEST_600	4/4	100
STD_TEST_700	4/4	100
Total Test Case	31	100

6. Conclusion and Recommendation

In the current inventory system, focus is given more on the data recorded in the database. It functions as a logical process rather than a search function works as a physical form process. This is because the inventory system works to manage the goods in an efficient way through the system. With the advancement of Internet technology, existing inventory systems can be more innovative by combining logical and physical designs. This can shorten the search and provide effective process. This system enables workers to search items in warehouse using voice recognition function to allocate the location of the items in warehouse. Besides that, barcode reader can show item details by scanning the barcode of the items. Furthermore, the system is built-in with tag system to avoid any unrecord items from outgoing or dispatch. In further, the developed system supports in any kind of industrial areas towards Industry 4.0 trend.

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