The Developement of Real-time Information Support Cart System based on IoT

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Abstract

In the modern technology era, it is possible to connect objects and the internet anytime and anywhere through IoT of hyper-connected society. Accordingly, a smart shopping cart was designed and realized by applying IoT. Therefore, this paper builds the IoT shopping cart system according to the trend of IoT environment.. When RFID is installed in the Arduino and the tagged item is inserted into the IoT shopping cart, the product information and price are displayed on the Arduino linked Raspberry Pi. We built a web server on the Raspberry Pi to handle this data, and built an App on the smartphone to implement the IoT shopping cart environment. Consumers can receive pricing and product information through smartphone apps through raspberry pie, can make quick calculations through smartphone, and provide various information to consumers through apps.

Keywords: Arduino, RaspberryPi, RFID, IoT, App

1. Introduction

Just a few years ago, shopping carts were used exclusively in large department stores or hypermarkets. However, shopping carts are currently available in many shops including small supermarkets near to residential areas. An irony is that the contemporary people visiting supermarkets are unable to view product information with their own smart phones, which are the creation of the era of current information technology, while they are spending a long time lining up for payment before the counters. To overcome these inconveniences, the present study proposes a smart shopping cart.

In contrast to the conventional smart shopping cart, the shopping cart proposed in the present study was developed by using Arduino and Raspberry Pi. According to the Korea Association for Information and Communication Technology Promotion, the number of smart phone users in Korea is over 40 millions as of last year, which means that four out of five are smart phone users, considering that the population of Korea is about 50 millions [1]. J. M. Rifkin mentioned that the a new type of third industrial revolution will take place as the internet is combined with environment-friendly energy through Internet of Things (IoT), which will be at the core of sharing economy [2]. Accordingly, an IoT-based shopping cart may enable a rapid transaction by transmitting product information and transaction information to the users. The users may pay

the price without waiting before the counters, and the companies may increase the turnover ratio and provide specialized information.

2. Related works

2.1 Recognition System Environment (Arduino & Shield)

Open source hardware refers to a hardware that publicly opens the design, including the circuit diagram needed to developed a specific product, so that anyone can learn, use, and modify according to their purposes. The emergence and development of open source hardware have made it easy and convenient to develop embedded systems interconnected with sensors, greatly contributing to the advancement of IoT [6]. Shield, a board having a specific function, is a part including a connector structure that connects various additional modules that compatible in connection with Arduino. Shield is a part that has a specific input/output function and is an important part of Arduino. A connector that enables connection to the input/output connector of Arduino is employed, and individual parts are connected to the connector to connect the parts in a laminated structure [3]. In the present study, Shield was employed to use the RFID technology.

2.2 Web Server building with Raspberry Pi

Raspberry Pi 2, released in 2015, includes ARM Cortex-7 (Quad-core, 900MHz)-based Broadcom BCM2836 SoC, 1 GB RAM, Ethernet, HDMI, 40 GPIO, Micro SDIO, and four USB ports, providing performance six times better than the that of the previous model. When Raspberry Pi is compared with Arduino and Udoo from the viewpoint of smart home, Raspberry Pi is superior in terms of computing power, memory, multitasking, OS porting, and high-level language, but it is heavier and consumes more electric power [4-5].

Raspberry Pi 3, shown in Figure 1, was recently released. The CPU speed has been upgraded to 1.2 GHz, and Wi-Fi and BLE, which were attached as modules, have been embedded inside the board to secure versatility with regard to communication, which is the most fundamental feature of IoT.

Although LINUX operation system is often sued for Raspberry Pi, various operation systems may be installed. Raspberry Pi may be easily interconnected with other devices for the application with gaming devices, robots, video cameras, and RC cars. In particular, the Wi-Fi function embedded in Raspberry Pi is very advantageous because many recent IT devices are developed on the basis of the internet. Moreover, Raspberry Pi includes General Purpose Input Output (GPIO) so that most of the tasks performed by the conventional micro-controller board may be included either directly or indirectly through the control of the micro-controller board. In addition, Raspberry Pi may be used to develop various services and applications by establishing ZigBee-based HA for the remote control of air-conditioner and lightings and the verification of gate opening, and by connecting Raspberry Pi with Arduino for home alarm, temperature control, and video surveillance using web cameras [6].

Figure 1. RaspberryPi 3

3. System Design

In the present study, an IoT smart cart was designed and prepared by using Arduino, Arduino Shield (RFID), and Raspberry Pi. This article proposes methods of greatly reducing the waiting time before counters in supermarkets by providing useful information to consumers. Figure 2 shows the design architecture.
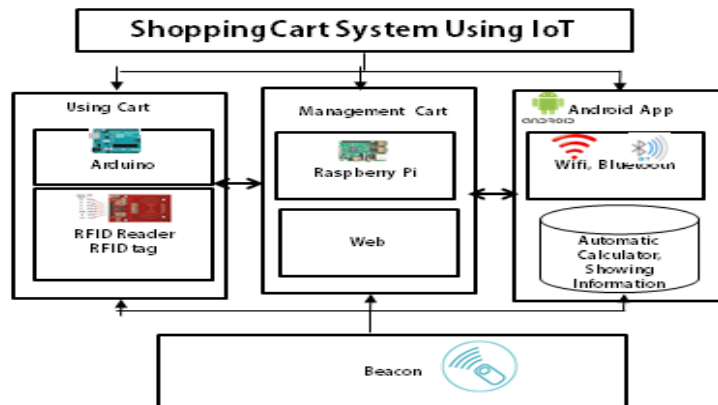

Figure 2. System Architecture

As shown in the design architecture, Arduino and Arduino Shield are installed to a cart in the Using Cart section. This is for the communication with product items and the calculation of the price.

In the Management Cart section, a method based on Raspberry Pi is suggested. This management method was also introduced to utilize IoT. The suggested method enables to manage carts through the web and notify the manager when a cart is lost or out of a specified range.

In the Android App section, addition of an Android app is proposed to provide product information to the customers using a smart phone and to promote rapid payment for the product price. This method does not increase the unit price of shopping carts by adding a monitor screen to the conventional IoT shopping carts. Rather, the software is provided through the smart phones that the consumers currently use.
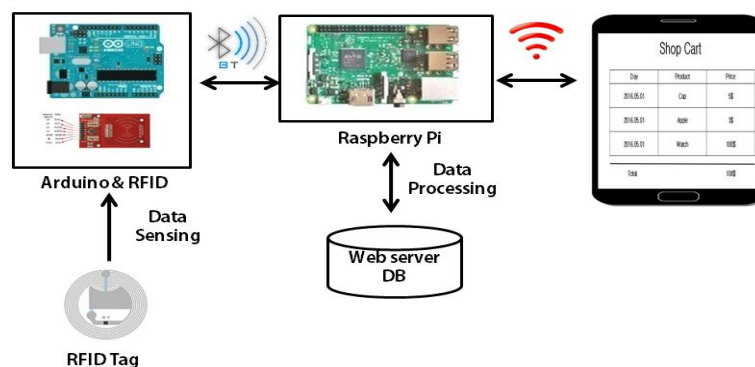

Figure 3. System Flow

Figure 3 shows the flow diagram between the systems. First, when the RFID tag is attached, the product name, price, and other data are transmitted to RaspberryPi via Bluetooth when the RFID shield is attached.

Raspberry Pi treats the data received previously divided by nominal numeric. Since RaspberryPi has built a web server, the data received from the user can be transferred to the user's app, and the user can check the product name and price of the product through the app on the screen of Raspberry Pi or through the app on the smartphone.

```
void setup() {
Serial.begin(9600);
Serial.println("NFC Tag Writer"); // Serial Monitor Message
nfc.begin();
}
void loop() {
Serial.println("\nPlace an NFC Tag that you want to Record these Messages on!"); // Command for the Serial Monitor
if (nfc.tagPresent()>0) {
NdefMessage message = NdefMessage();
message.addTextRecord("product:hat");
message.addTextRecord("price:5$"); // Ednding Message for you to Record
boolean success = nfc.write(message);
if (success) {
Serial.println("Good Job, now read it with your screen!");
} else {
Serial.println("Write failed");
}
}
delay(10000);
}
```

```
NfcTag tag = nfc.read();
if (tag.hasNdefMessage()) // If your tag has a message
{
NdefMessage message = tag.getNdefMessage();
Serial.print("\nThis Message in this Tag is ");
Serial.print(message.getRecordCount());
Serial.print(" NFC Tag Record");
if (message.getRecordCount() != 1) {
Serial.print("s");
}
Serial.println(".");
delay(10000)
}
```

Figure 4. NFC Write/Read pseudo code

Figure 4 shows the NFC Write/Read algorithm. The algorithm is used to save NFC values. The Arduino Sketch open library, shown in Figure 3, was used to read the product name and the product price from the tag including Arduino and RFID sensors.

Figure 5. System Deployment

Figure 5 shows the actual realization of the system. When the tag attached to a product is contacted with Shield, the product price is transmitted to the Raspberry Pi screen.

4. Performance Evaluation

Reading of the RFID sensor value and displaying of the information on the screen were tested to evaluate the performance of the IoT cart. Figure 6 shows that the RFID tag of a product was well read. The read value was displayed to a monitor screen.

Figure 6 shows the reading of the tag value through the RFID Shield connected with Arduino. The purchase date, purchased items and the price are shown on the web screen.

Shop Cart

Day	Product	Price
2016.05.01	Cap	5$
2016.05.01	Apple	3$
2016.05.01	Watch	100$
Total		108$

Figure 6. Shop Cart Calculation

As shown in Figure 7, the recognition rate was stable in the contact distance of 1 cm to 6 cm, but unstable in a contact distance longer than 6.5 cm. In addition, when the contact distance was 7.5cm or longer, the recognition was impossible. Therefore, the contact distance for recognition should be 6 cm or less for the commercialization of the system.
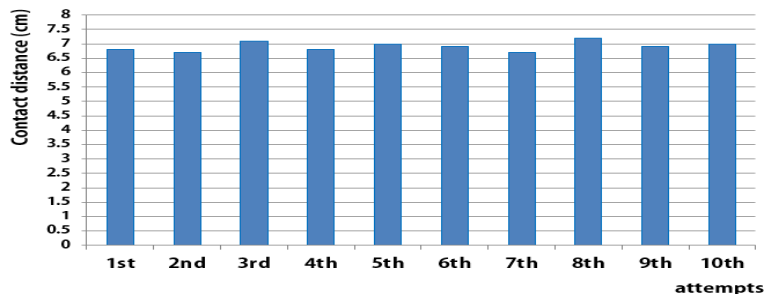

Figure 8. On the distance in Recognition of RFID

5. Conclusions

In the smart shopping cart system proposed tn the present study, the product information and the product price could be read through Arduino, RFID Shield, and NFC tag. The system was connected with a shopping cart so that the product price may be paid whenever and wherever in a supermarket even without going through a counter. In contrast to the conventional smart shopping carts, the shopping cart proposed in the present study may be managed by using Raspberry Pi.

One improvement that should be made for the system is that an application that may exchange the information about products and price with a smart phone should be prepared. Currently, a smart phone application is under development. Future studies will be conducted to interconnect the application with the smart shopping cart proposed in the present study.

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