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SMART SHOPPING CART

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ABSTRACT

According to Vision 2030, the economic pillar is core and hence the need to ensure that goods can be accessed by customers without wasting the time of both the buyer and the seller. In Supermarkets, people push or pull baskets to the places they want to browse through the super market products. It is very difficult to search for a particular product in the super market and spending long hours is unavoidable due to the long hours in queuing. The drawbacks of the bar-codes scanning are that each customer has to wait in the queue of the checkout counter. While billing, if the customers have to remove some products because it exceeds their budget, again some more items will be required in order to check which products have to be removed from the basket. The main aim of this study was to evaluate the use of a smart shopping cart designed using Radio frequency Identification Detector (RFID) technology. Once the product is dropped in the smart shopping cart, the RFID reader automatically detects the product labels printed on the inside of the product RFID tag. After the RFID reader senses the product RFID tag, it automatically generates the bill on the LCD screen producing an alarm and lights on the buzzer and LED lights respectively. When a user blocks the Light dependent resistor (LDR) and removes a product, then the bill of a given product tag read by the RFID reader is deducted automatically. The RFID reader was replaced by the Ultrasonic sensor and the proximity sensor in order to test their suitability index and their response time in milliseconds. The general objectives of this research is to determine the best sensor to use in scanning objects on the shopping carts, their response times and suitability index. The specific objectives of this study were to: investigate sensor response times versus reliability in a classifiable system; to investigate the most suitable sensor for the designed shopping carts and to investigate the time taken in shopping using the smart shopping basket and the ordinary shopping cart. Studies that have been conducted previously indicate that practicing prudent time management techniques has led to an increase in production in various economies. The data was collected from experimentation and from QuickMart Supermarket, Kisii County, Kenya. This study analyzed data using tabular and graphical analysis by the help of a Microsoft excel 2013. Where the work of other authors was used, due acknowledgement was done. The study concludes that the smart shopping cart is a time-saver method of shopping in supermarkets. While billing on this smart shopping cart, if the customers have to remove some products because it exceeds their budget, the Light dependent resistor is blocked to ensure it receives no light and the RFID tag passed on the RFID reader and therefore the item is deducted from the bill. This study recommends that the more dominant RFID readers with the upgraded limits should be utilized if there should be a progressive increase in the number of items in the cart so as to achieve the Vision 2030 on the economic pillar. Prudent time management is the key pillar to ensure the economy of a country thrives.

Index Terms **–Liquid crystal Display, Radio Frequency Identification, Light Dependent Resistor.**

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

According to Devi, Kaarthik, Selvi, Nandhini and Priya (2017), supermarkets employ shopping baskets to help customers select and store the products. The customers have to drop the products which they wish to purchase and then proceed to checkout. At present in every super market, once the customer has entered in to the mall, he/she has to select the trolley and select the items he/she wishes to purchase and then drop them into the trolley. Once all the items have been selected the customer has to wait at the bill counter till he/she gets his/her turn to make payment (Komal, Vinayak & Supriya, 2015).

Fig 1.1 An incredibly long supermarket queue

In order to make payment at times, it takes a lot of time, therefore the waiting time of the customer significantly increases which makes the customer to hesitate visiting the mall again .This is the common procedure followed in general marts where the employee of the super market will scan all the products using bar-code in the basket which leads to waiting (Paxal, Jasmine, Nirav & Manmitsinh, 2015). In general, a bar-code is a machine readable strip of data printed in parallel lines, used to represent a multitude of information. Technology has enabled human beings to construct equipment that can help remind them of their busy schedule (Komal, Vinayak & Supriya, 2014).

Ariely and Wertenbroch (2002) argue that traditionally, a bar-code scanner is used by retailers to keep track of inventory and speedup data entry. Bar code scanning applications are product-centric. (Mahajan, Watkins & Geyer, 2014). The drawbacks of the present procedure are each customer has to wait on the queue of the checkout counter.

While billing, if the customers have to remove some products because it exceeds their budget, again some more items will be required to check which products have to be removed from the basket (Verbruggen & Hermans, 2012).

Barcode (Prevailing Technology)	RFID (Suggested Technology)
• An individual is needed to study the barcode upon the commodity. • Barcode must be perceptible on the exterior of the commodity. • Line of vision is necessary to study a Barcode. • The legibility of ciphers can be damaged by filth, humidity and decay and during wrapping. • The accessibility range is up to few inches. • Barcode does not have read and write capability. • The damaged tags won't work properly. • The content updating can't be done.	• Involuntary perusal of RFID tag from the commodity. • RFID is placed in the interior of the commodity. • No line of vision is entailed for this. • This is not influenced by the similar conditions. • The accessibility range is up to few meters. • RFID tag having read and write capability. • The damaged tags will work flawlessly. • The content updating can be done.

Table 1.1 Barcode versus RFID

So this project sought to develop a model for an automated shopping cart with RFID technology rather than bar-code scanner which aims to reduce the total waiting time of customers, total man power requirement for markets in order to improve efficiency of shopping malls. In a world where technology is replacing the ways we pursue everyday activity, the future of retail industry also lies in more automated devices (Mahajan, Watkins & Geyer, 2014).

1.2 Statement of the problem

1. In Supermarket, people push or pull baskets to the places they want to browse through the super market products.

2. It is very difficult to search for a particular product in the super market and spending long hours is unavoidable due to the long hours in queuing.

Fig 1.2 Crowding problem in supermarkets

3. The drawbacks of the bar-codes scanning are that each customer has to wait in the queue of the checkout counter.

4. While billing, if the customers have to remove some products because it exceeds their budget, again some more items will be required to check which products have to be removed from the basket

1.3 Objectives of the study

1.3.1 General objective of the study

To determining the best sensor to use in scanning objects on the shopping carts, their response times and suitability index.

1.3.2 Specific objectives of the study

i. To investigate sensor response times versus reliability in a classifiable system.

ii. To investigate the most suitable sensor for the designed shopping cart.

iii. To investigate the time taken in shopping using the smart shopping basket and the ordinary shopping cart.

1.4 Research Hypothesis

Development of smart shopping cart improve people's lives.

1.5 Research question

i. Does development of smart shopping cart improve people's lives?

ii. What technologies are used in the development of computerized 'smart shopping cart' system?

iii. Is the ordinary shopping cart more efficient than the smart shopping cart?

1.6 Variables of the study

Dependent variables

Response time of the sensor in milliseconds

Suitability Index of the sensor

Type of shopping cart

Independent variables

Type of sensor

Type of sensor

Time taken to shop

1.7 Significance of the Study

- Reduces manpower required in billing section. This can reduce the expenses incurred by the management. Users can be aware of the total bill amount during the time of purchase. Reduces time spent at billing counter and Increases customer satisfaction.
- So based on this database, the cost price of the product is well known the bill will be generated automatically. Finally the customer will clear his payment easily. So the waiting time of a customer is reduced.

1.8 Organization of the study

The study is divided into five chapters. Chapter one brings out the introduction to this study. This chapter will include the background of the study, the statement of the problem, the research objectives, the hypothesis, the significance, the scope and the variables of the study. Chapter two will entail the Literature review of the study. Chapter three of the study will have the research methodology of this study. Chapter 4 will include the Data analysis and discussion while chapter 5 will entail the conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter is divided into three parts which include the introduction, the empirical literature review, and related shopping cart designs. A critical review of previous literature contributions by other scholars is also presented through the empirical literature review hence providing a knowledge gap for the current study.

2.2 Empirical Literature Review

Devi, Kaarthik, Selvi, Nandhini and Priya (2017) investigated the Intelligent Shopping cart system which infuses a Shopping cart (trolley) with a bar-code scanner placed at checkpoint. The researcher noted that it made it possible for the user to self-scan the bar-code of the purchased products which he aspire to purchase. A wireless transmission smart-device makes note of all the scanned items in the particular trolley (with allotment number) and is linked with the Supermarket's backend database which contains features of the products such as Cost Price. The scrutinized products are automatically billed in the wireless smart device for their purchases, thereby significantly reducing total waiting time and transmitted to the Shop's central Billing program. However, this study failed to highlight the drawbacks of the bar-codes scanning which are; each customer has to wait on the queue of the checkout counter; While billing, if the customers have to remove some products because it exceeds their budget, again some more items will be required to check which products have to be removed from the basket.

Paxal, Jasmine, Nirav and Manmitsinh (2015) conducted a research on the barcode technology currently being used in supermarkets. The researchers noted that Barcode must be perceptible on the exterior of the commodity. The researchers also noted that Line of vision is necessary to study a Barcode. However, the implementation of Radio Frequency Identification (RFID) technology has been widely used on a wide variety of processes. The proposed RFID technology is placed in the interior of the commodity. No line of vision is necessary for RFID technology. One or more scanners attached to the input bin scan the product for identity. The computer retrieves product specific information on its display. Therefore, the current study evaluated the use of shopping cart with an RFID reader.

Fig 2.1: Automated shopping trolley

2.3 Related shopping cart Designs

Devi, Kaarthik, Selvi, Nandhini and Priya (2017) asserts that most modern shopping carts are made of metal or a combination of metal and plastic and have been designed to nest within each other in a line to facilitate collecting and moving many at one time and also to save on storage space. The carts can come in many sizes, with larger ones able to carry a child. Approximately, 24,000 children are injured in the United States each year in shopping carts. Some stores both in the U.S. and internationally have child carrying carts that look like a car or van with a seat where a child can sit equipped with a steering wheel and sometimes a horn (Paxal, Jasmine, Nirav and Manmitsinh, 2015). Small shops, where trolleys would be impractical, often supply only baskets, or may offer a small cart which uses an inserted shopping basket within the frame of the cart to provide either choice to a customer. An alternative to the shopping trolley is a small hand-held shopping cart. A customer may prefer a basket for a small amount of merchandise.

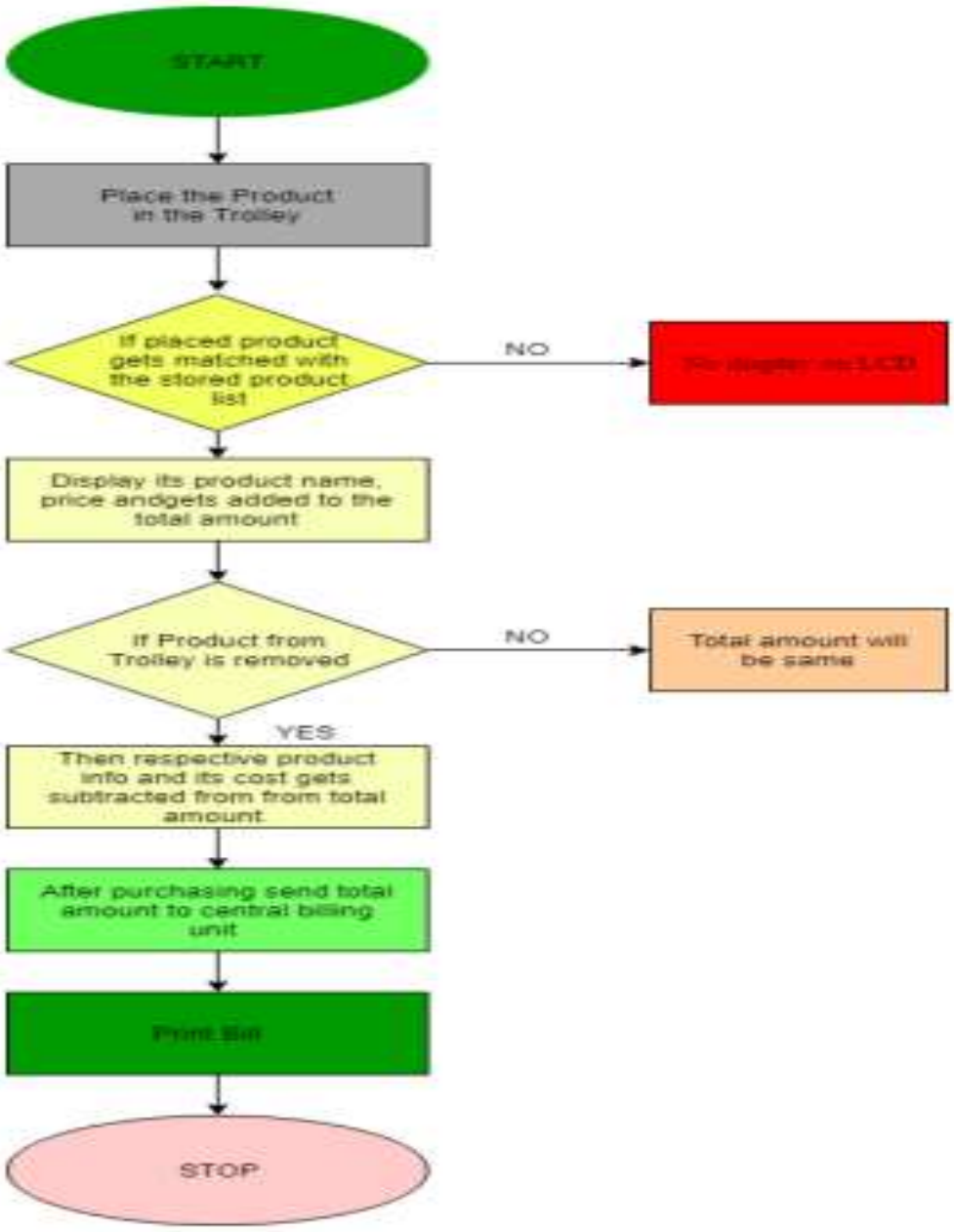
Shopping trolleys are usually fitted with four wheels, however if any one wheel jams the cart can become difficult to handle. Most trolleys in the United States have swivel wheels at the front, while the rear wheels are fixed in orientation, while in Europe it is more common to have four swivel wheels. This difference in design correlates with smaller retail premises in Europe (Devi, Kaarthik, Selvi, Nandhini and Priya, 2017). This study sought to investigate the use of a smart shopping cart with an RFID reader because previous studies failed to highlight the drawbacks of the bar-codes scanning which are; each customer has to wait on the queue of the checkout counter; While billing, if the customers have to remove some products because it exceeds their budget, again some more items will be required to check which products have to be removed from the basket.

CHAPTER THREE

METHODOLOGY

3.1 Flowchart

Fig 3.1 Flowchart



3.2 System coding

This coding controls the functioning of the smart shopping cart. The Arduino UNO is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board and hence the code below was written using C++ programming language to program the Arduino UNO which controls the smart shopping cart:

/*CODE BY MOIGE AND LAVINE */

```
#include <LCD.h>
#include <Wire.h>

#include <LiquidCrystal.h>
LiquidCrystal lcd(12, 11, 10, 9, 8, 7);

#define RED 2
#define GREEN 3
#define BLUE 4

char input[12];
int count = 0;

int a;
int p1 = 0, p2 = 0, p3 = 0, p4 = 0;
int c1 = 0, c2 = 0, c3 = 0, c4 = 0;

double total = 0;
int count_prod = 0;

void setup ()
{

pinMode(RED, OUTPUT);
pinMode(GREEN, OUTPUT);
pinMode(BLUE, OUTPUT);

  pinMode(A4, INPUT_PULLUP);
  pinMode(4, OUTPUT);
  pinMode(5, OUTPUT);
  pinMode(6, OUTPUT);

  lcd.clear();
  Wire.begin();
  Serial.begin(9600);
  lcd.setCursor(0, 0);
  lcd.print(" AUTOMATIC BILL");
  delay (2000);
  lcd.setCursor(0, 1);
  lcd.print(" SHOPPING CART ");
  delay (2000);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("WELCOME TO");
  delay (2000);
  lcd.setCursor(3, 1);
  lcd.print("SUPER MARKET");
  delay (2000);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Plz Add iTem");
```

```
}

void loop()
{
  count = 0;
  while (Serial.available() && count < 12)
  {
    input[count] = Serial.read();
    count++;
    delay(5);
  }
  int a = digitalRead(A4);

  if ((strncmp(input, "9B CC 4F 0A", 12) == 0) && (a == 1))
  {
    digitalWrite(GREEN, HIGH);
delay(500);
digitalWrite(GREEN, LOW);
delay(500);

     lcd.setCursor(0, 0);
    lcd.print("Butter Added       ");
    lcd.setCursor(0, 1);
    lcd.print("Price :- 10.00      ");
    p1++;
    digitalWrite(4, HIGH);
    digitalWrite(5, HIGH);
    digitalWrite(6, LOW);
    delay(2000);
    total = total + 10.00;
    count_prod++;
    digitalWrite(4, LOW);
    digitalWrite(5, LOW);
    digitalWrite(6, HIGH);

  }
  else if ((strncmp(input, "2700227A344B", 12) == 0) && (a == 0))
  {
    if (p1 > 0)
    {
      lcd.clear();
      lcd.setCursor(0, 0);
      lcd.print("Butter Removed!!!        ");
      digitalWrite(4, HIGH);
      digitalWrite(5, HIGH);
      digitalWrite(6, LOW);
  }
delay(2000);
      p1--;
      total = total - 10.00;
      count_prod--;
      lcd.clear();
```

```
    digitalWrite(4, LOW);
    digitalWrite(5, LOW);
    digitalWrite(6, HIGH);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Total Price :-");

    lcd.setCursor(0, 1);
    lcd.print(total);
   }
   else
   {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Not in cart!!!        ");
    digitalWrite(4, HIGH);
    digitalWrite(5, HIGH);
    digitalWrite(6, HIGH);
    delay(2000);
    digitalWrite(4, LOW);
    digitalWrite(5, LOW);
    digitalWrite(6, LOW);
    lcd.clear();
   }

if ((strncmp(input, "4000350ABAC5", 12) == 0) && (a == 1))
{
  lcd.setCursor(0, 0);
  lcd.print("Milk Added       ");
  lcd.setCursor(0, 1);
  lcd.print("Price :- 20.00      ");
  p2++;
  digitalWrite(4, HIGH);
  digitalWrite(5, HIGH);
  digitalWrite(6, LOW);
  delay(2000);
  total = total + 20.00;
  count_prod++;
  digitalWrite(4, LOW);
  digitalWrite(5, LOW);
  digitalWrite(6, HIGH);

}

else if ((strncmp(input, "4000350ABAC5", 12) == 0) && (a == 0))
{
  if (p2 > 0)
  {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Milk Removed!!!        ");
    digitalWrite(4, HIGH);
```

```
    digitalWrite(5, HIGH);
    digitalWrite(6, LOW);
    delay(2000);
    p2--;
    total = total - 20.00;
     count_prod--;
    lcd.clear();
    digitalWrite(4, LOW);
    digitalWrite(5, LOW);
    digitalWrite(6, HIGH);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Total Price :-");
    lcd.setCursor(0, 1);
    lcd.print(total);
   }
   else
   {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Not in cart!!!        ");
    digitalWrite(4, HIGH);
    digitalWrite(5, HIGH);
    digitalWrite(6, HIGH);
    delay(2000);
    digitalWrite(4, LOW);
    digitalWrite(5, LOW);
    digitalWrite(6, LOW);
    lcd.clear();
   }
  }

if ((strcmp(input, "03007C2DA0F2", 12) == 0) && (a == 1))
  {
   lcd.setCursor(0, 0);
   lcd.print("Tea Added       ");
    lcd.setCursor(0, 1);
   lcd.print("Price :- 25.00      ");
   p3++;
   digitalWrite(4, HIGH);
   digitalWrite(5, HIGH);
   digitalWrite(6, LOW);
   delay(2000);
   total = total + 25.00;
   count_prod++;
   digitalWrite(4, LOW);
   digitalWrite(5, LOW);
   digitalWrite(6, HIGH);

  }

  else if ((strncmp(input, "03007C2DA0F2", 12) == 0) && (a == 0))
```

```
 {
  if (p3 > 0)
  {
   lcd.clear();
   lcd.setCursor(0, 0);
   lcd.print("Tea Removed!!!        ");
   digitalWrite(4, HIGH);
   digitalWrite(5, HIGH);
   digitalWrite(6, LOW);
   delay(2000);
   p3--;
   total = total - 25.00;
   count_prod--;
   lcd.clear();
   digitalWrite(4, LOW);
   digitalWrite(5, LOW);
    digitalWrite(6, HIGH);
   lcd.clear();
   lcd.setCursor(0, 0);
   lcd.print("Total Price :-");
   lcd.setCursor(0, 1);
   lcd.print(total);
  }
  else
  {
   lcd.clear();
   lcd.setCursor(0, 0);
   lcd.print("Not in cart!!!        ");
   digitalWrite(4, HIGH);
   digitalWrite(5, HIGH);
   digitalWrite(6, HIGH);
   delay(2000);
   digitalWrite(4, LOW);
   digitalWrite(5, LOW);
   digitalWrite(6, LOW);
   lcd.clear();
  }
 }
}
```

3.3 Material

i. Shopping cart

ii. Arduino Uno Mega 2560 (Micro-controller)

iii. RFID reader –Radio frequency identification reader

iv. RFID tags (to be attached to a product)

v. A 4 inch LCD screen

vi. Red, blue and green LED Lights

vii. Buzzer

viii. LDR (Light dependent resistor)

ix. Power supply/Power bank

x. Connecting wires

xi. Ultra-sonic sensor (Control experiment)

xii. Proximity sensor (Control experiment)

3.4 Procedure

The hardware components used to implement this project are an RFID reader. A Power bank or power supply is used here in order to supply power to the LCD screen. A 4 inch LCD screen is used in order to display the prices of the products. Products attached to an RFID tag are dropped in the smart shopping cart by the customer who wishes to purchase. Once the product is dropped in the smart shopping cart, the RFID reader automatically detects the product labels printed on the inside of the product RFID tag. After the RFID reader senses the product RFID tag, it automatically generates the bill on the LCD screen producing an alarm and lights on the buzzer and LED lights respectively. When a user blocks the Light dependent resistor (LDR) and removes a product, then the bill of a given product tag read by the RFID reader is deducted automatically. The RFID reader was replaced by the Ultrasonic sensor and the proximity sensor in order to test their suitability index and their response time in milliseconds.

3.5 Block diagram

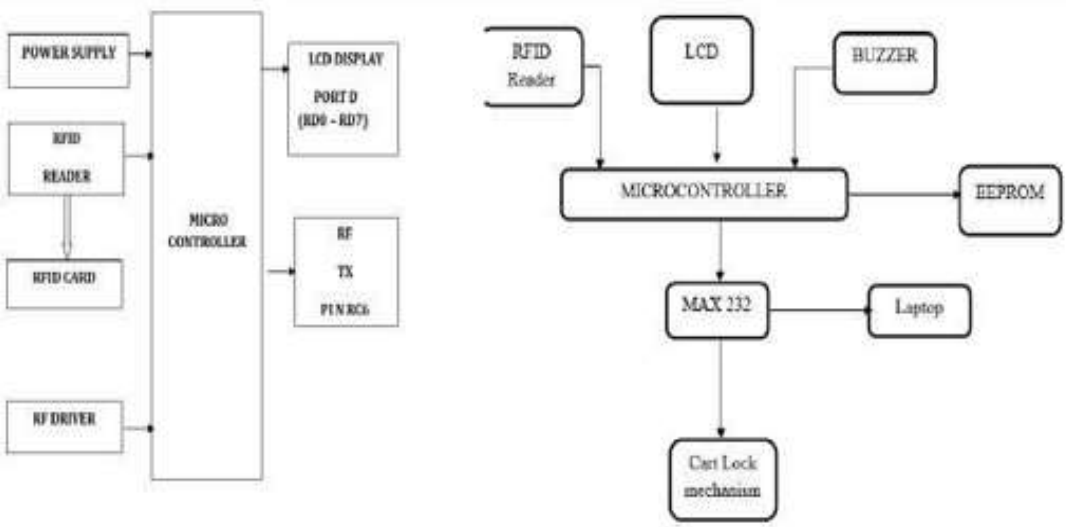


Fig 3.2 Block diagram

3.5 Observation

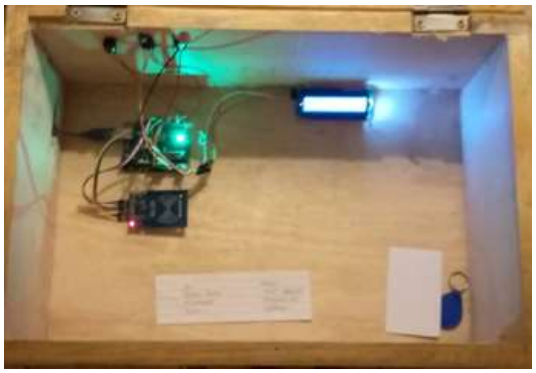


Fig 3.3 after construction

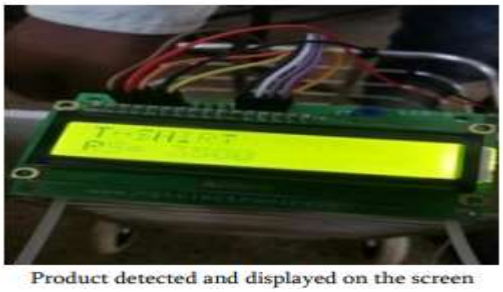


Fig 3.4 LCD screen of the smart shopping cart

3.6 Limitations and constraints

- Some labels take longer to be detected by the RFID reader, therefore ensure standardization of labels
- The resistor needs to be covered totally for the item to be removed to be deducted from the bill therefore an innovative covering is used to cover the resistor
- The connecting wires on the smart shopping cart interfere with products being placed on the smart shopping cart. The connecting wires can be enclosed below the shopping cart in a grill like structure to ensure they are not touched by the products being placed in the shopping cart.

3.7 PRECAUTIONS

i. Understand vulnerabilities of your smart shopping cart.

ii. Set unique passwords

iii. Protect Wi-Fi network.

iv. Use only reputable smart card technology brands.

CHAPTER FOUR

DATA AND DATA COLLECTION

4.1 Data collection

The data below was collected by a primary source - experimentation with the aim of determining the best sensor to use in scanning objects on the shopping carts, their response times and suitability index. The suitability index is a scale from 1 - 10 showing how appropriate a sensor is with 1 being least appropriate and 10 being most appropriate. The data was analyzed using Microsoft excel 2013 and the results are as shown.

Table 4.1 Suitability index and response time (ms) versus Sensor type

Sensor type	Suitability index	Response time in milliseconds
RFID card	8	100
Ultra sonic sensor	6	100
Proximity sensor	3	400

4.2 Data analysis

The independent variable is the sensor type while the dependent variable is the suitability index. Note that the suitability index varies as a result of the sensor type, making the sensor type the independent variable. The ultra-sonic sensor is very reliable but cannot tell apart the different products. The motion sensor is much slower but can be triggered by any motion and counts even human movement as an item. All these factors make the RFID card the most suitable sensor. The graphs on the next page give more information.

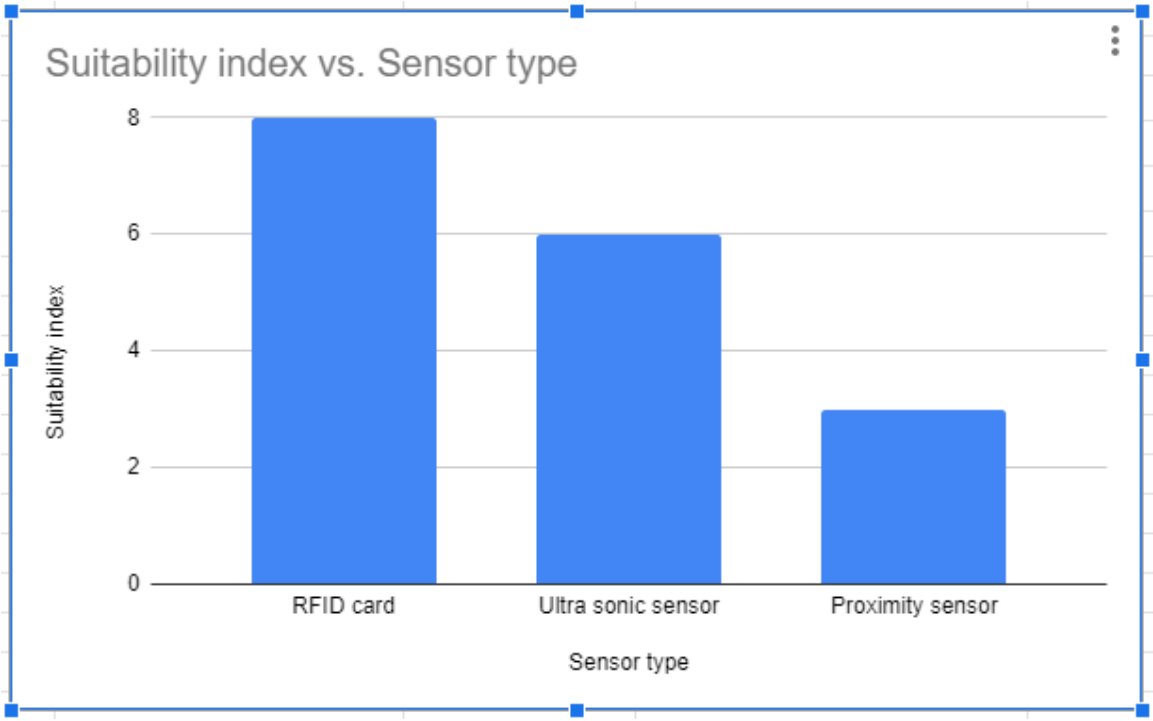


Fig 4.1 Suitability index vs Sensor type

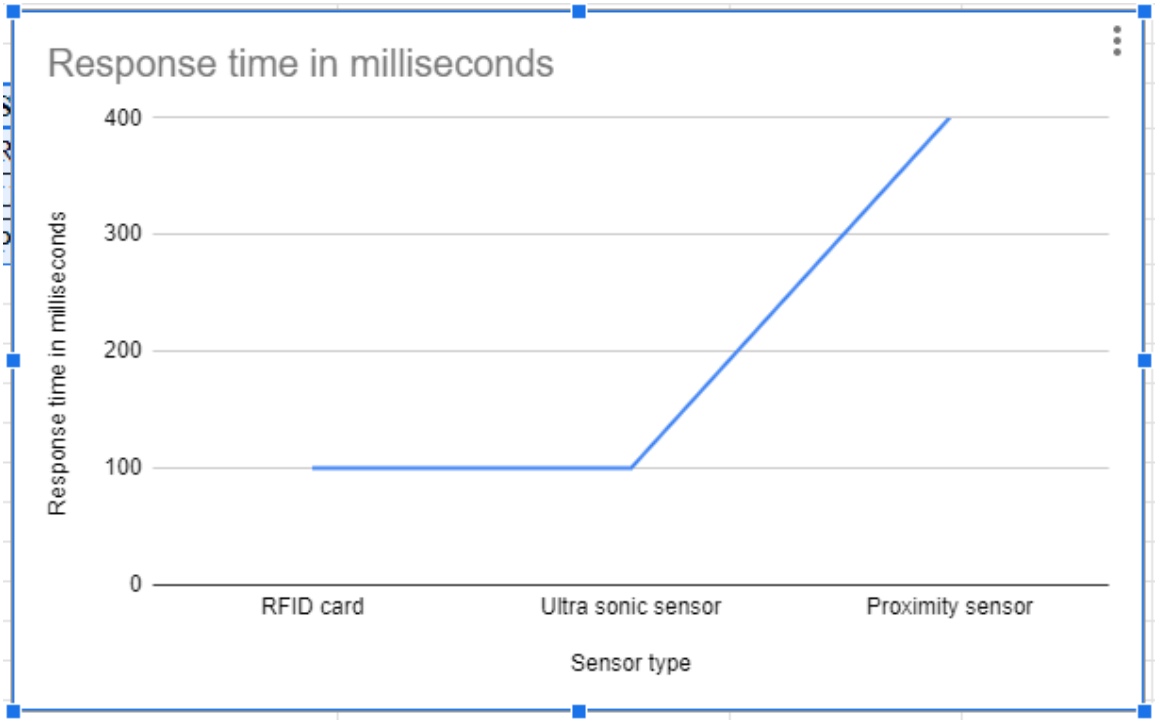
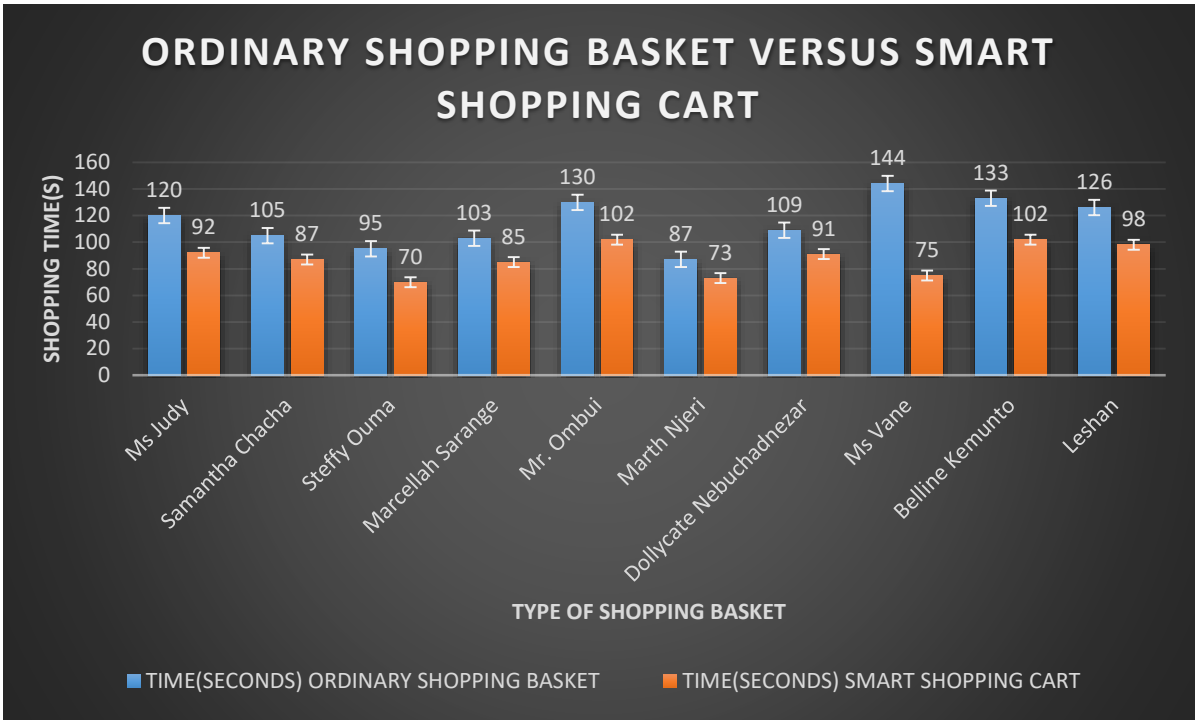


Fig 4.2 Response time (ms) versus sensor type

Table 4.2 Time taken to shop and pay for the same number of items

RESPONDENT	TIME(SECONDS) ORDINARY SHOPPING BASKET	TIME(SECONDS) SMART SHOPPING CART
Ms Judy	120	92
Samantha Chacha	105	87
Steffy Ouma	95	70
Marcellah Sarange	103	85
Mr. Ombui	130	102
Marth Njeri	87	73
Dollycate Nebuchadnezar	109	91
Ms Vane	144	75
Belline Kemunto	133	102
Leshan	126	98

Fig 4.3 ORDINARY SHOPPING BASKET VERSUS SMART SHOPPING CART



4.3 Data Discussion

From the results obtained in 4.2, the independent variable is the sensor type while the dependent variable is the suitability index. Note that the suitability index varies as a result of the sensor type making the sensor type the independent variable. The ultra-sonic sensor is very reliable just like the RFID card because it has the same response time as the RFID card but it cannot tell apart the different products. The motion sensor is much slower but can be triggered by any motion and counts even human movement as an item. All these factors make the RFID card the most suitable sensor. The time taken to shop using the smart shopping cart is lesser than the time taken to shop using the ordinary shopping basket. This is indicated by all the 10 respondents that shopped using the smart shopping cart. They did at a faster rate compared to when they shopped for the same number of items using the same size of ordinary shopping basket.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From the results observed in chapter IV above, it is faster and more convenient to shop using the smart shopping cart than the ordinary shopping basket. The ultra-sonic sensor is very reliable just like the RFID card because it has the same response time as the RFID card but it cannot tell apart the different products. The motion sensor is much slower but can be triggered by any motion and counts even human movement as an item. All these factors make the RFID card the most suitable sensor. This study will be significant in improving the economy of the country by ensuring everybody is able to trade and with minimal wastage of time, hence able to achieve the economic pillar of vision 2030. While billing on this smart shopping cart, if the customers have to remove some products because it exceeds their budget, the Light dependent resistor is blocked to ensure it receives no light and the RFID tag passed on the RFID reader and therefore the item is deducted from the bill. With this data, the study has proved the hypothesis, answered all the research questions and achieved all the specific objectives.

5.2 Recommendations

This study recommends that the more dominant RFID readers with the upgraded limits should be utilized if there should be a progressive increase in the number of items in the cart so as to achieve the Vision 2030 on the economic pillar

5.3 Future Directions

In future, Water delicate and all the more dominant labels with further developed highlights like a metal safe and temperature safe are under research which will be exceptionally valuable later on.

5.4 Link to emerging issues:

As we aim toward the achievement of Kenya's vision 2030 more specifically the economic pillar. We have to embrace technology in improving Kenya's GDP. This project aims at automating shopping and reducing congestion thereby curbing challenges and diseases like Covid 19 which has been an emerging issue up until recently and any other infectious diseases like flu outbreaks.

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APPENDICES

APPENDIX I: LETTER TO THE RESPONDENT

Dear Respondent,

I am currently a teacher at St Angela Sengera Girls' High School, Kenya. My Science club students are currently carrying out a research study on a project whose topic is:

"SMART SHOPPING CART".

I therefore request for your information and cooperation in this exercise. All information will be treated with confidentiality.

Yours with regard

DR. DENNIS OSORO MARANGA
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