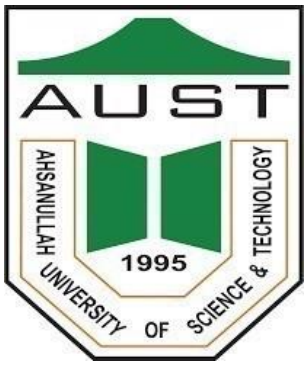

AHSANULLAH UNIVERSITY OF SCIENCE & TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Open Ended Lab Report

"Automated Toll Collection System Using RFID and Arduino"

Course Title: Microprocessor, Interfacing and System Design Lab

Course Number: EEE 3210

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Program: BSc in EEE
Section: D2
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Introduction

An automatic toll collection system transforms the way we navigate through transportation networks, offering a seamless and efficient solution for toll payment. As traffic congestion at toll plazas becomes an increasingly vital concern, this inventive system strives to mitigate gridlocks and preserve commuters' precious time. By utilizing advanced technologies such as RFID (Radio Frequency Identification), the system simplifies the toll-paying procedure, eliminating the need for manual transactions. In this introduction, we will delve into the key features, benefits, and functioning of the automatic toll collection system, highlighting its role in modernizing transportation systems and enhancing overall user experience.

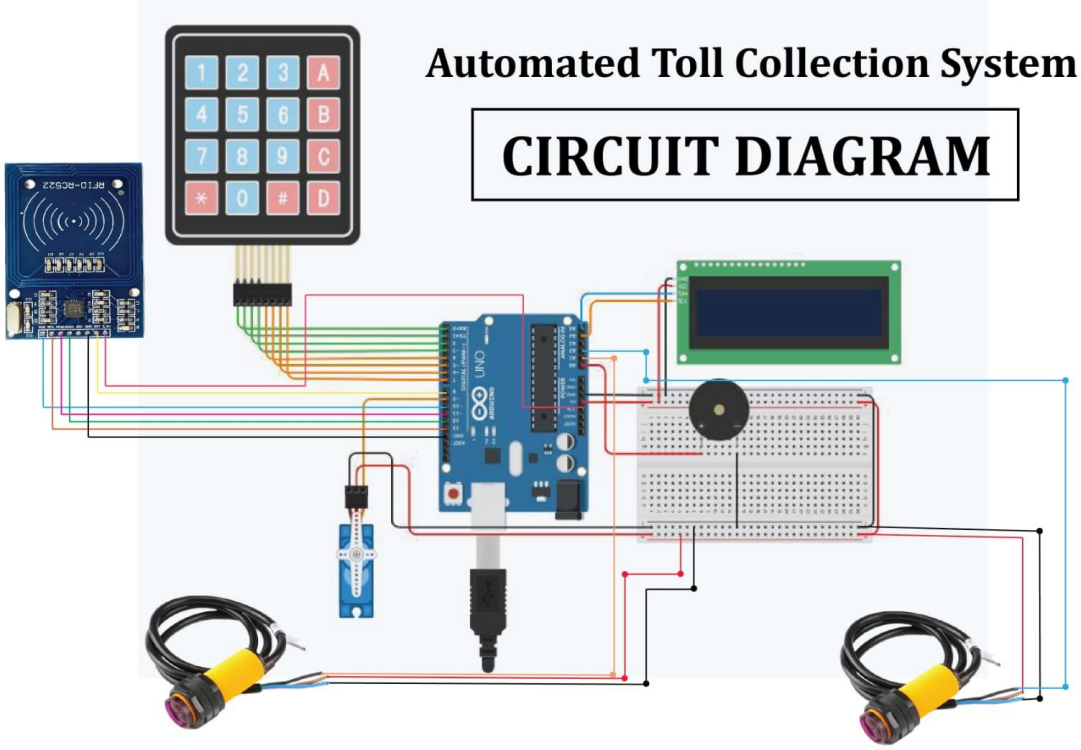
Objective

The project's objective is to automatically detect the RFID tag within a vehicle and present the corresponding toll fee that needs to be paid for toll passage. Upon successful payment, the vehicle can proceed through the gate; otherwise, access will be denied. This initiative aims to reduce traffic and save time for all commuters involved.

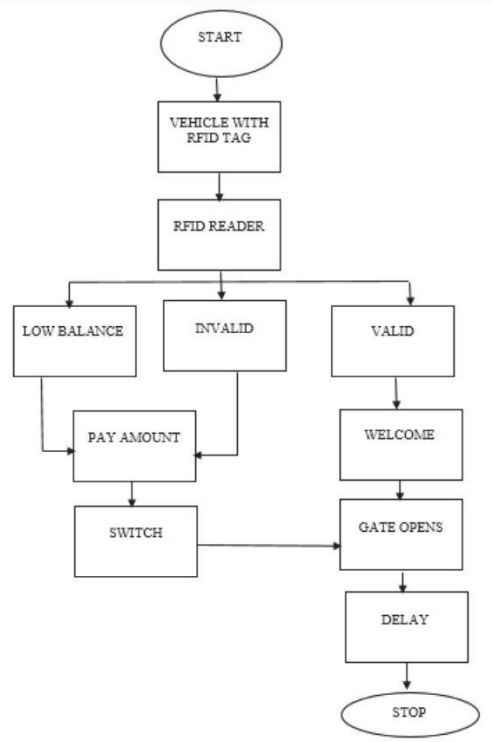
Apparatus employed

1	**Arduino UNO Board**
2	RC522 RFID Reader
3	13.56 MHz RFID Card
5	I2C LCD Display
6	4x4 Keypad Module
7	IR Sensor Module E18-D80NK
8	Servo Motor MG995
9	Resistor 1K
10	Resistor 4.7K
11	Zero PCB
12	9V DC Power Supply

Circuit diagram



Flow chart (System Overview)



Working procedure

- The IR sensors are strategically positioned at the entrance of the toll booth to detect the approach of any vehicle. On detecting an obstacle, the boom barrier of the toll plaza gets closed preventing any vehicle from passing through. This action is achieved using servo motor.
- Each vehicle is equipped with an RFID tag containing unique identification data. As the vehicle comes within range of the RFID reader, the reader wirelessly communicates with the RFID tag to extract its data. The Arduino microcontroller processes the data received from the RFID reader. It identifies the vehicle and accesses the corresponding toll fee information linked to that particular RFID tag.
- Based on the information retrieved, Arduino calculates the toll fee associated (Standard Tk.500 for this proposed project). The calculated toll fee is displayed on the LCD screen at the toll booth, visible to the driver. The driver has the option to proceed with payment. If the driver chooses to pay, they can do so using electronic payment methods. The payment is verified and confirmed by the system.
- Upon successful transaction, a buzzer installed within the system beeps aloud to indicate valid transaction.
- If the card has insufficient balance, the user is asked to recharge at least the minimum balance for the toll fee. By giving input of the money balance in a 4*4 keypad this action can be completed and the LCD shows up new balance information. In the event of non-payment, the system retains the barrier in a lowered position, preventing the vehicle from passing until the toll fee is settled.
- IR sensors that are positioned at the toll booth exit detect the passage of the vehicle and signal the system that the vehicle has successfully passed the toll plaza and opens the boom barrier.

Code

```
#include <SPI.h>
#include <MFRC522.h>
#include <Keypad.h>
#include <Servo.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd (0x27, 16, 2);
```

```
Servo servo;
int servoPos = 0;
#define sensorPin1 A2
#define sensorPin2 A3
const int buzzerPin = A0;
int senVal1 = 0;
int senVal2 = 0;
#define RST_PIN 9
#define SS_PIN 10
int card1Balance = 4000;
int card2Balance = 200;
#define num 7
char Data[num];
byte data_count = 0;
String num1, num2, card, card2;
int a, b;
char Key;
bool recharge = true;
MFRC522 mfrc522(SS_PIN, RST_PIN);
int state = 0;
const byte ROWS = 4; //four rows
const byte COLS = 4; //four columns
char keys [ROWS][COLS] = {
  {'1','2','3','A'},
  {'4','5','6','B'},
  {'7','8','9','C'},
  {'*','0','#','D'}
};
```

```
byte rowPins[ROWS] = {0, 1, 2, 3}; //connect to the row pinouts of the keypad
byte colPins[COLS] = {4, 5, 6, 7}; //connect to the column pinouts of the keypad
Keypad keypad = Keypad( makeKeymap(keys), rowPins, colPins, ROWS, COLS );
void setup() {
  lcd.begin(16, 2);
  lcd.init();
  lcd.backlight();
  Serial.begin(9600);
  servo.attach(9);
  servo.write(30);
  pinMode(sensorPin1, INPUT);
  pinMode(sensorPin2, INPUT);
  pinMode(buzzerPin, OUTPUT);
  SPI.begin();
  mfrc522.PCD_Init ();
  lcd.setCursor(0, 0);
  lcd.print(" Automatic Toll");
  lcd.setCursor(0, 1);
  lcd.print("Collection System");
  delay (3000);
  lcd.clear();
}
void loop () {
  if (recharge == 0) {
    reCharge();
  }
  else {
```

```
lcd.setCursor(0, 0);
lcd.print("    Welcome");
sensorRead();
rfid();
KeyPad();
if (senVal1 == 1) {
  servoDown();
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Vehicle Detected");
  delay(1000);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Put Your Card To");
  delay(1000);
  lcd.setCursor(0, 1);
  lcd.print("The Reader......");
  delay(2000);
  lcd.clear();
}
else if (senVal2 == 1 && state == 1) {
  servoUp();
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Have A Safe");
  lcd.setCursor(0, 1);
  lcd.print("Journey");
  delay(1000);
  lcd.clear();
```

```
      state = 0;
    }
  }
}
void servoDown()
{
  servo.attach(9);
  for (servoPos = 30; servoPos <= 120; servoPos += 1)
  {
    servo.write(servoPos);
    delay(5);
  }
}
void servoUp()
{
  servo.attach(9);
  for (servoPos = 120; servoPos >= 30; servoPos -= 1)
  {
    servo.write(servoPos);
    delay(5);
  }
}
void sensorRead()
{
  senVal1 = digitalRead(sensorPin1);
  senVal2 = digitalRead(sensorPin2);
}
void rfid()
{
```

```
  if ( ! mfrc522.PICC_IsNewCardPresent()) {
    return;
  }
  if ( ! mfrc522.PICC_ReadCardSerial()) {
    return;
  }
  // Play the buzzer for 1 second when an RFID card is scanned
  playBuzzer(1000);  // Duration: 1000 ms
  Serial.print("UID: ");
  for (byte i = 0; i < mfrc522.uid.size; i++)
  {
    Serial.print(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " ");
    Serial.print(mfrc522.uid.uidByte[i], HEX);
  }
  String content = "";
  for (byte i = 0; i < mfrc522.uid.size; i++)
  {
    content.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : "
"));
    content.concat(String(mfrc522.uid.uidByte[i], HEX));
  }
  content.toUpperCase();
  if (content.substring(1) == "63 A0 C6 0E")
  {
    if (card1Balance >= 500)
    {
      lcdPrint();
      card1Balance = card1Balance - 500;
      lcd.setCursor(9, 1);
```

```
    lcd.print(card1Balance);
    delay(2000);
    lcd.clear();
    state = 1;
  }
  else
  {
    card = content.substring(1);
    LcdPrint();
    lcd.setCursor(9, 1);
    lcd.print(card1Balance);
    lcd.print(" Tk");
    delay(2000);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Please Recharge");
    delay(1000);
    lcd.clear();
    state = 0;
  }
}
else if (content.substring(1) == "98 A6 E4 64")
{
  if (card2Balance >= 500)
  {
    lcdPrint();
    card2Balance = card2Balance - 500;
    lcd.setCursor(9, 1);
    lcd.print(card2Balance);
```

```
    delay(2000);
    lcd.clear();
    state =1;
  }
  else
  {
    card = content.substring(1);
    LcdPrint();
    lcd.setCursor(9, 1);
    lcd.print(card2Balance);
    lcd.print(" Tk");
    delay(2000);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Please Recharge");
    lcd.clear();
    delay(1000);
    state = 0;
  }
}
else  {
  lcd.setCursor(0, 0);
  lcd.print("Unknown Vehicle");
  lcd.setCursor(0, 1);
  lcd.print("Access denied");
  delay(1500);
  lcd.clear();

}
```

```
}
void KeyPad() {
  char key = keypad.getKey();
  if (key) {
    if (key == 'A') {

      lcd.clear();
      lcd.setCursor(0, 0);
      lcd.print("Recharging Mode.");
      lcd.setCursor(0, 1);
      lcd.print(".................");
      delay(1500);
      lcd.clear();
      recharge = 0;
    }
  }
}
void clearData()
{
  while (data_count != 0)
  {
    Data[data_count--] = 0;
  }
  return;
}
void reCharge() {
  lcd.setCursor(0, 0);
  lcd.print ("Enter the amount");
  char key = keypad.getKey();
```

```
if (key) {
  if (key == 'D') {
    if (card == "63 A0 C6 0") {
      num1 = Data;
      card1Balance = num1.toInt() + card1Balance;
      lcd.clear();
      lcd.setCursor(0, 0);
      lcd.print("Your current");
      lcd.setCursor(0, 1);
      lcd.print("balance: ");
      lcd.setCursor(9, 1);
      lcd.print(card1Balance);
      lcd.print(" Tk");
      delay(3000);
      clearData();
      lcd.clear();
      recharge = 1;
    }
    else if (card == "98 A6 E4 64") {
      num2 = Data;
      card2Balance = num2.toInt() + card2Balance;
      lcd.clear();
      lcd.setCursor(0, 0);
      lcd.print("Your current");
      lcd.setCursor(0, 1);
      lcd.print("balance: ");
      lcd.setCursor(9, 1);
      lcd.print(card2Balance);
      lcd.print(" Tk");
```

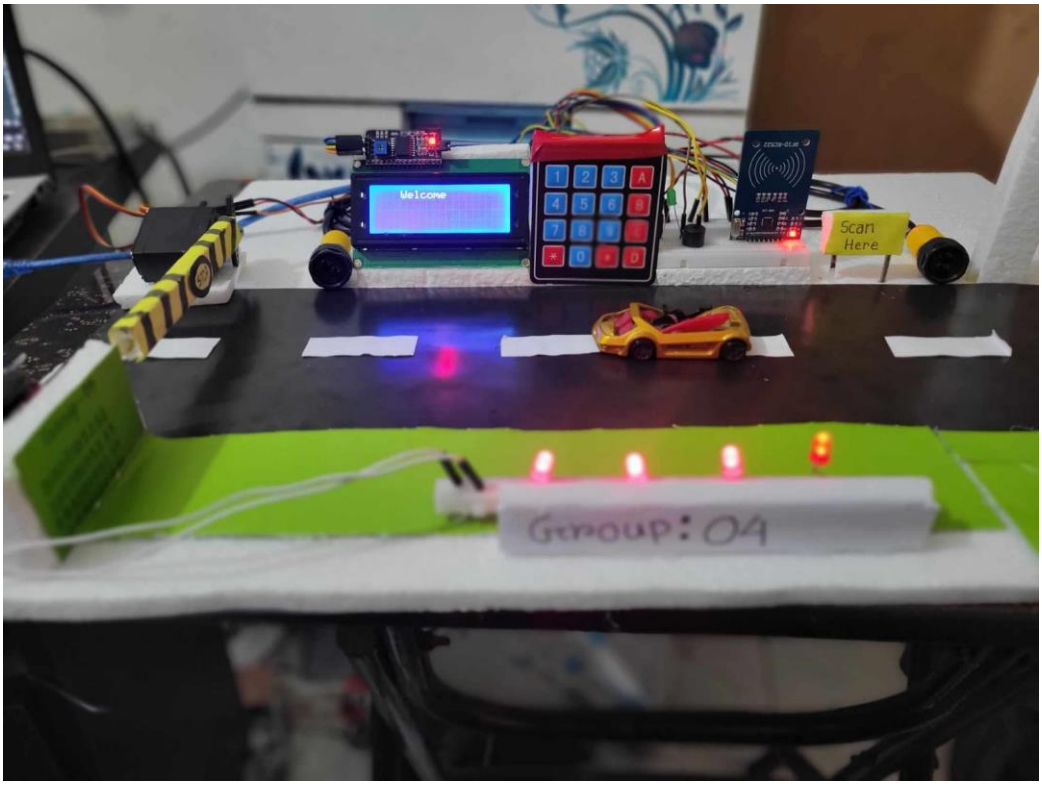
```
        delay(3000);
        clearData();
        lcd.clear();
        recharge = 1;
      }
    }
    else {
      Data[data_count] = key;
      lcd.setCursor(data_count, 1);
      lcd.print(Data[data_count]);
      data_count++;
    }
  }
}
void lcdPrint()
{
  delay(200);
  delay(100);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print(" Successfully");
  lcd.setCursor(0, 1);
  lcd.print(" paid your bill");
  delay(1500);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Your Remaining");
  lcd.setCursor(0, 1);
  lcd.print("balance: ");
```

```
}
void LcdPrint()
{
  delay(200);

  delay(100);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("  Your balance");
  lcd.setCursor(0, 1);
  lcd.print(" is insufficent");
  delay(1500);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Your Remaining");
  lcd.setCursor(0, 1);
  lcd.print("balance: ");
}
void playBuzzer(unsigned long duration) {
  analogWrite(buzzerPin, 128); // Set the buzzer intensity
  delay(duration); // Play the buzzer for the specified duration
  analogWrite(buzzerPin, 0); // Turn off the buzzer
}
```

Hardware implementation


NATIONAL HIGHWAY
TOLL PLAZA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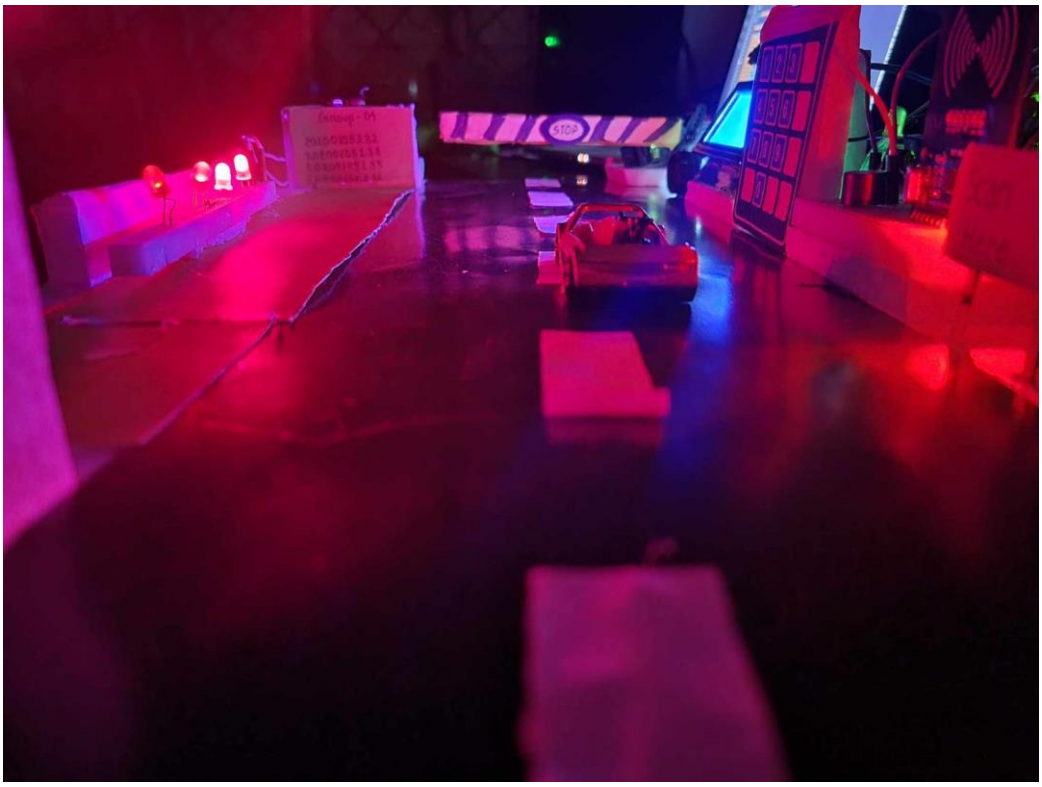

Advantages of ATC systems

- **Time Efficiency:** The system significantly reduces wait times at toll plazas by enabling seamless, non-stop passage for vehicles, leading to quicker journeys and reduced congestion.
- **Reduced Traffic Congestion:** With streamlined toll payment processes, traffic bottlenecks are minimized, improving overall traffic flow and reducing the likelihood of accidents.
- **Cost Savings:** The elimination of manual toll collection reduces the need for toll booth attendants and the associated operational costs, leading to potential cost savings for toll operators.
- **Accurate Billing:** Automated systems ensure accurate toll calculations based on predetermined rates and vehicle classifications, reducing the chances of errors or disputes.
- **Safety Improvements:** The elimination of sudden stops and starts at toll plazas decreases the risk of rear-end collisions and enhances overall road safety.

- **Data Collection:** Automated toll systems can gather valuable data on traffic patterns, vehicle types, and usage, which can aid in transportation planning and infrastructure development.
- **Economic Benefits:** The increased efficiency and reduced traffic congestion lead to improved economic productivity by saving time for individuals and businesses.
- **Modernization:** The adoption of cutting-edge technologies reflects a commitment to modernizing transportation infrastructure and improving the overall travel experience.

Disadvantages of ATC systems

- **Initial Setup Costs:** Implementing ATC systems requires significant upfront investments in infrastructure, equipment, and technology, which can be a financial burden for toll operators.
- **Technical Complexity:** The integration of various technologies, such as RFID, sensors, and electronic payment systems, can introduce technical challenges, requiring specialized expertise for maintenance and troubleshooting.
- **Maintenance Costs:** Ongoing maintenance and updates are necessary to ensure the reliable functioning of the technology, adding to operational costs over time.
- **Privacy Concerns:** ATC systems involve the collection and storage of personal and vehicle data, raising privacy concerns among users about potential misuse or unauthorized access to their information.
- **Dependency on Technology:** ATC systems are reliant on functioning technology components. Technical glitches, power outages, or system failures can disrupt toll operations and cause inconvenience.
- **Exclusion of Cash Transactions:** ATC systems eliminate the option for cash payments, potentially excluding individuals who prefer or rely on cash transactions.
- **Complex Pricing Structures:** Automated systems may implement intricate pricing models based on factors such as distance, time of day, or vehicle type, which can be confusing for users to understand.

Discussion and conclusion

The future of automatic toll collection is brimming with innovation. With technology and transportation trends advancing, ATC could evolve into an interconnected system that integrates various modes of transport, potentially including biometric identifiers, cryptocurrencies, and

dynamic pricing. The synergy between ATC and smart city initiatives could pave the way for efficient urban mobility and predictive traffic management, while augmented reality interfaces and remote payment integration promise enhanced user experiences and reduced congestion. Moreover, automatic toll collection's potential to incentivize eco-friendly vehicles and its role in cross-border travel solutions underline its transformative impact on transportation networks.

In this vision of the future, ATC systems could also leverage blockchain technology for secure and transparent payment mechanisms, while connected vehicles and real-time data enable adaptive toll pricing based on traffic conditions. Subscription models reminiscent of streaming services might offer unlimited toll access, and cloud-based solutions could centralize management for efficiency. As data-driven insights shape infrastructure improvements, ATC is poised to be an essential component of sustainable and streamlined transportation ecosystems, contributing to smoother mobility, reduced environmental impact, and enhanced urban planning.

Executed by: Group 04

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