



Prince Mohammed University

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Learning Outcome Assessment III

Product Proposal

Parking Monitoring and Control System

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Definition:

Design a project of parking monitoring and control system to count the number of automobiles entering and leaving a parking and provide information about free parking spaces. It will have the ability to reject specific car for security reason and provide statistics.

1. Objectives:

- (i) Learn about sensors, controllers, displays, and communication techniques as it would be great experience and chance for the group to practice real engineering and design.
- (ii) Provide statistical information for future planning and improvement to the parking system.
- (iii) Saving people's time in finding parking lots.
- (iv) Saving energy of automobiles which in turns reduces CO₂ emissions and other harmful gases; hence better green environment.
- (v) Providing an authentication system that help security.
- (vi) Providing a good mean of paying for reserving a parking

2. Target customers:

- (i) Malls.
- (ii) Hospitals.
- (iii) Universities.
- (iv) Hotels.

3. Product assumptions:

- (i) Use reliable sensors in detecting automobiles with minimum error.
- (ii) Use data processing for providing statistical information and other information to be used by authority.
- (iii) Use up-down counter that is fast and reliable which in this case will be an embedded software that will count
- (iv) Use high quality displays to get readable information.
- (v) Using a closing drop gate as an output action from control system to isolate areas of full parking and to authenticate the access for customers
- (vi) Use RFID technology for reserved parking lots for identification and security matters.
- (vii) The capability of handling large parking lots.
- (viii) The availability of all resources needed to implement the project in the field.

4. Customer Needs:

The need for such a product is in fact interests several customers. So, contacting the target customers is really an essential step to study the needs and specifications required by customers. Therefore, this can be done by collecting data from field through

conducting surveys on the targeted parking to have a clear idea of what the customers need. Meet or interview the targeted managers of the targeted location to emphasize the advantages of the product and how that product will increase their income by gaining more satisfaction from their customers. A security officer of Prince Mohamed University was asked for the need of such monitoring system and how it would be beneficial to them. He said that it would be very beneficial since in the morning there are 3 security officers work in the parking area trying to guide students and close the entrances of those filled parking spaces. In fact, they highly appreciate such a system to be implemented in Prince Mohamed University. Also, ordinary people were asked about parking lots in malls and in airports and received similar responses. Another step is to analyze such data to know how it can be implemented cost effectively and efficiently in line with the features preferred by customers. Then, the gathered information will be analyzed to define the product specifications that match their needs and requirements taking into consideration any safety issues or standards. Moreover, the designed product will have more flexible features that can be added which make it more interesting to different customers with different needs and desires.

5. **Target Specifications:**

There is a need to see the comparable available products and select a benchmark and see how it can be improved to satisfy the need of the customer. Also, the product of the targeted customers shall be developed by using surveys, interviews and observations in the targeted field. However, there are some main specifications to be followed which are:

- (i) Low power consumption.
- (ii) High quality sensor and long life LED.
- (iii) Very clear display and high efficient counter.
- (iv) Easy to install and maintain.
- (v) Easily designed system to minimize the cost of the product.
- (vi) Can function efficiently to guide people, without confusion, to free parking lots.

6. **Product concept generation, selection, and testing**

a. Generation

Many ideas can be generated by considering the different ways and technologies to implement each subsystem. The below ideas are generated from all group members.

Energy: (1) normal grid, (2) solar (3) battery banks (4) multiple DC output supply to accommodate the different rating for devices used in the control system.

Counting elements: (1) ultrasonic sensor, (2) motion sensors, and (3) IR sensors (4) Optical sensors. (5) Magnetic sensor (6) RFID.

Processing: : (1) controller, (2) digital gates.

Communication and connection: (1) wireless, (2) all units interconnected using wires and cable tray systems.

Display and Action: (1) indoor/outdoor LED display, (2) Mech. Closing bar, (3) LED indicator with arrow directions.

The alternatives will result in different ideas for the design implementation. Therefore, the selection

b. Selection and testing

Selecting the best alternative among several options is mainly dependent on cost and reliability. Therefore, studying the alternatives, in terms of all essential design steps in order to select the best one, requires right decision making. Then testing the selected option against several factors such as customer preferences and needs, national standards if it shall be recommended by government law, availability of material, estimated material costs, financial budget, feasibility as well as efficiency of which all will determine the final selection of the design. Since there was work conducted by the group previously and according to the results obtained from the previous testing, the group decided to not to use the ultrasonic sensors as to sense the presence of a car since it was very noisy, sensitive and prone to errors. Instead, RFID technology will be used along with IR distance measurement together which make the sensor subsystem. Also, the PIC microcontroller was also changed into Arduino since the PIC would take much time for setting it up and was difficult also to learn its behavior. However, Arduino is more stable, easier to connect with PC and has more flexibility in addition to features.

Our first meeting after defining the project features is to define the sources that we can use to complete our project. We actually found to good sources:

- 1- The Arduino (<http://arduino.cc/en/Tutorial/HomePage>) & <http://arduino.cc/en/Reference/HomePage>) official website that contains a lot of tutorials that can help us to do our job.
- 2- Jeremy Blum website (<http://www.jeremyblum.com/category/arduino-tutorials/>) that provides some good tutorials.
- 3- Adafruit website that buy most of Arduino material, have forum for Arduino and provides good tutorials (<http://www.adafruit.com/tutorials>).

We have order all the material needed in two stages. We have received the first material and we found that we need more material so we ordered them and they have been received

Second meeting was after receiving the materials was to put stages to implements our project and we have decided on these three stages:

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1- Testing stage: which is to test all the material separately and we have done two in different days and we still working in this stage:

a. The first project was about turn led on and off every 1 second (<http://youtu.be/Gthc749qqjw>) code is

```
int ledPin = 3;

void setup()
{
  pinMode(ledPin, OUTPUT);
}

void loop()
{
  digitalWrite(ledPin, HIGH); // sets the LED on
  delay(1000);                // waits for a second
  digitalWrite(ledPin, LOW);  // sets the LED off
  delay(1000);                // waits for a second
}
```

b. The second is to test the IR (<http://youtu.be/-Pzj6BKzeq8>). The Code is

```
int ir=1;

void setup() {
  Serial.begin(9600);
}

void loop() {
  float v = analogRead(ir) * 0.0048828125;
  float d = 65*pow(v, -1.10);
  Serial.println(d);
  Serial.println( d );
  delay(300);
}
```

- 2- Gradually connect all the material together.
- 3- Make the final prototype.

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Therefore the below is providing an overall description of the product along with its features and they might also be changed as needed to meet the customer needs as applicable:

Power Supply Subsystem:

Power consumption for the project (prototype):

S/N	Component	Wattage consumption
1	RFID readers (spark fun ID 12):	$2 * 5V * 30mA = 0.3W$
2	IR distance sensor (Sharp-GP2Y0A21YK0F):	$2 * 30mA * 5V = 0.3W$
3	Stepper motors	$2 * 12V * .35mA = 8.4W$
4	LED matrix display	$2 * 5V * .6mA = .06W$
5	Cellular shield with SM5100B	$5V * 35mA = .175W$
6	Arduino microcontroller	14 digital pin * $5V * 40mA = 2.8W$ + In addition to 3.3V pin which is 0.165W
7	Laptop computer (ASUS)	90W
Total estimated power consumption		102.17W

The main power supply block diagram that will supply the laptop and microcontroller:

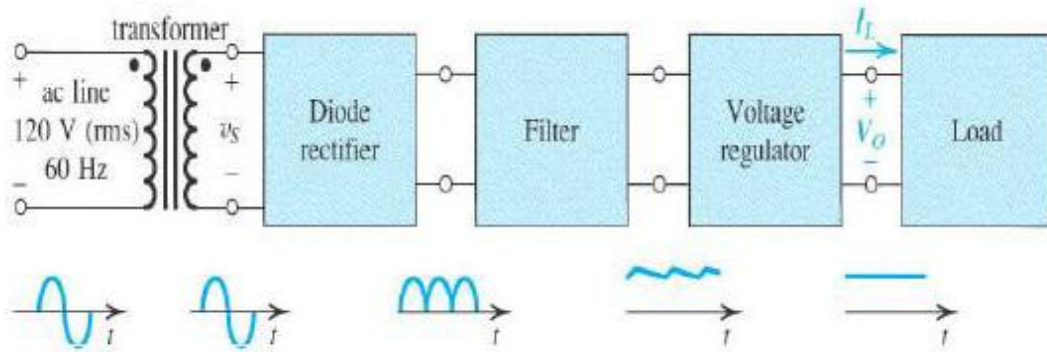


Figure 1: Power supply components

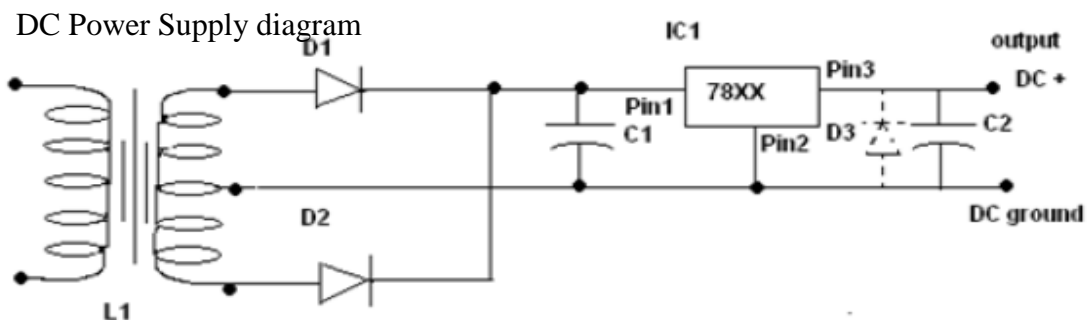


Figure 2: Power supply diagram

Components of Power Supply

1. D1, D2 = Diodes 1N4003
2. L1 = center tap Step down transformer with input of 120 V AC 60 Hz and output of (13.8V AC 60Hz)
3. C1 = 1000 Micro Farad aluminum electrolytic capacitor
4. C2 = 10 Micro Farad aluminum electrolytic capacitor
5. IC1 : =LM7812 for +12V DC output (for sensor circuit) and LM7805 (for controller and sensor circuit).

Components Selection:

1. **Diode 1N4003**, PIV (peak inverse Voltage)<BV

$$V_S \text{ Max} = V_O \text{ Max} + V_D = 13V + 0.7V = 13.7$$

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$$PIV=2V_s (\text{Max})-V_D=2*13.8-.7=20.6V < 200 \text{ (140 RMS reverse V)}$$

2. Capacitor V min;

$$V_P \text{ secondary}-V_D-V_r (\text{ripple})=13.8V-0.7-.5=12.6 \text{ DCV}$$

3. **Capacitance 1** ; $C= V_m/(2fRV_r)=23 \text{ microfarad}$

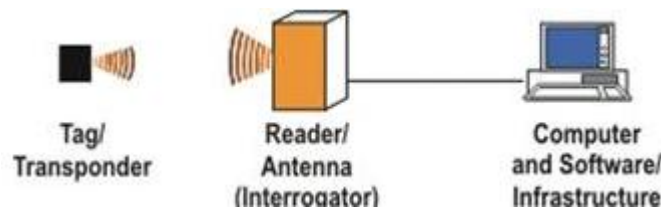
Arduino:

Arduino is an open source electronics prototyping platform based on flexible, easy to use hardware and software. It's intended for artists, designers, hobbyist and engineers. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motor and other actuators. The microcontroller on the board is programmed using the Arduino programming language.

Sensor Subsystem (RFID):

RFID is a form of automatic identification that uses electric or magnetic fields at radio frequencies to transmit information. Every RFID system includes a radio frequency (RF) subsystem, which is composed of tags and readers. This technology has been described as a major enabling technology for automated, contactless, and wireless data collection.

We are planning to use RFID technology for many reasons. By using this technology, we can have a database to store information and create historical data for security and statistics. Both the tag and the reader are two-way radios. Each has an antenna and is capable of modulating and demodulating radio signals. Such system requires using communication techniques, latest IT technologies, complicated software, and programming to link the RFID system with the controller and the main server.



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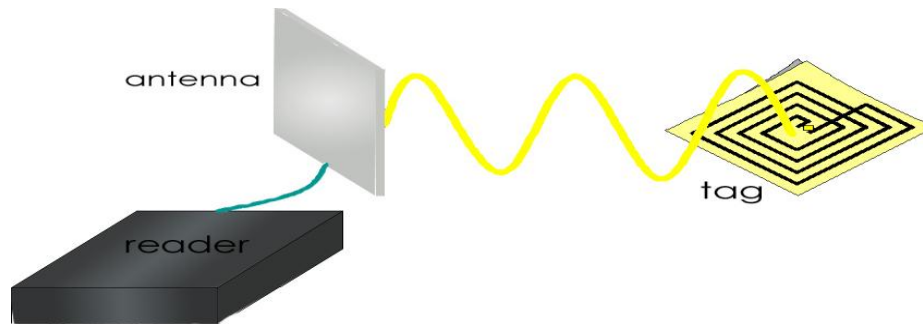


Figure 3: RFID Tag and Reader

This important technology has many applications:

- Payment Systems.
- Security and Access Control.
- Tracking.
- Process Control.

We used this technology because it has the following advantages over the other used technologies in this field:

- Unlike a bar code, RFID technology does not require a line of sight.
- RFID tags can hold more data than bar codes.
- RFID tags can stand in a harsh environment.
- It has a long read range and portable database.

In our project, we are planning to use RFID systems for controlling, monitoring, collecting data, and managing vehicle access into sensitive areas.

RFID subsystem consists of two components:

1. RFID Tags (sometimes referred to as transponders): They are small electronic devices which has a unique identifier and may also have other features such as memory to store additional data.



Figure 4: RFID Tag

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Tags are categorized into two main types based on the power source for communication and other functionality:

- a. Passive: uses the electromagnetic energy it receives from a reader's transmission to reply to the reader.
- b. Active: relies on an internal battery for power.

We are planning to use the passive tag since it is cheaper, smaller, and it has no battery. Instead, the tag uses the radio energy transmitted by the reader as its energy source.

2. RFID readers: They are devices that wirelessly communicate with tags to identify the item connected to each tag and possibly associate the tagged item with related data. In other words, readers send electromagnetic signal to the tag and read its response. They generally transmit their observations to a controller and a computer system running RFID software.

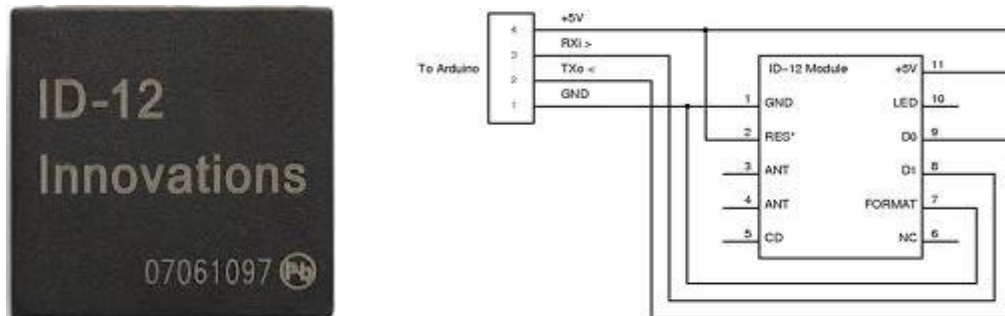


Figure 5: RFID ID-12 Reader

Features of the product:

- 1- One parking zone for employee and others (students or visitors). They will be provided with [RFID tag](#) to allow them passing from the gate.
- 2- All the customers' mobile numbers will be attached with the serial number of their tags to be used for send and receiving SMS from the system and send the violation to their mobile number with the number of days that will not be authorized to use the parking lot.
- 3- Arduino [Uno](#) and [Mega 2560](#) instead of microcontroller because it is more stable and easier to deal with and it will be used as the brain to control our system by sending and receiving instructions from inputs and output devices as follows:
 - a. Input devices:

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- i. [RFID reader ID-12](#) with built in antenna one in the entrance and one in the exit which will detect the unique serial number of the [tag](#) and send to Arduino to take the appropriate action (allow or denied).
 - ii. [IR distance sensor](#) in the entrance and exit to make sure that the car has passed the gate and it will send a signal to allow closing the gate.
 - iii. Push button to open and close the gates incase of RFID reader failure.
 - b. Output devices:
 - i. Open and close gate by using [stepper motor](#) one in the entrance and exit.
 - ii. [16x24 Red LED Matrix Panel](#) to display the number of available parks and it will display the word “Full” when no parking available.
 - c. Input and output device:
 - i. Laptop will be used to add new customer or delete unwanted one and it will be used to display the customer’s information.
 - ii. [Cellular Shield with SM5100B](#) will be used to send the number of available park by SMS and it will receive an SMS to reserve park.
- 4- The system will have the ability to reject specific cars that has violation or security issue.
- 5- The system will use Microsoft Office Access as logging Data for security in a database and showing:
 - a. Name, ID and Plate number.
 - b. Time in and time out.
- 6- Monthly statistics showing how many visitors and violations per month.
- 7- The power will be feed the Arduino and all the other devices will be taking their power from Arduino.

7. Product architecture

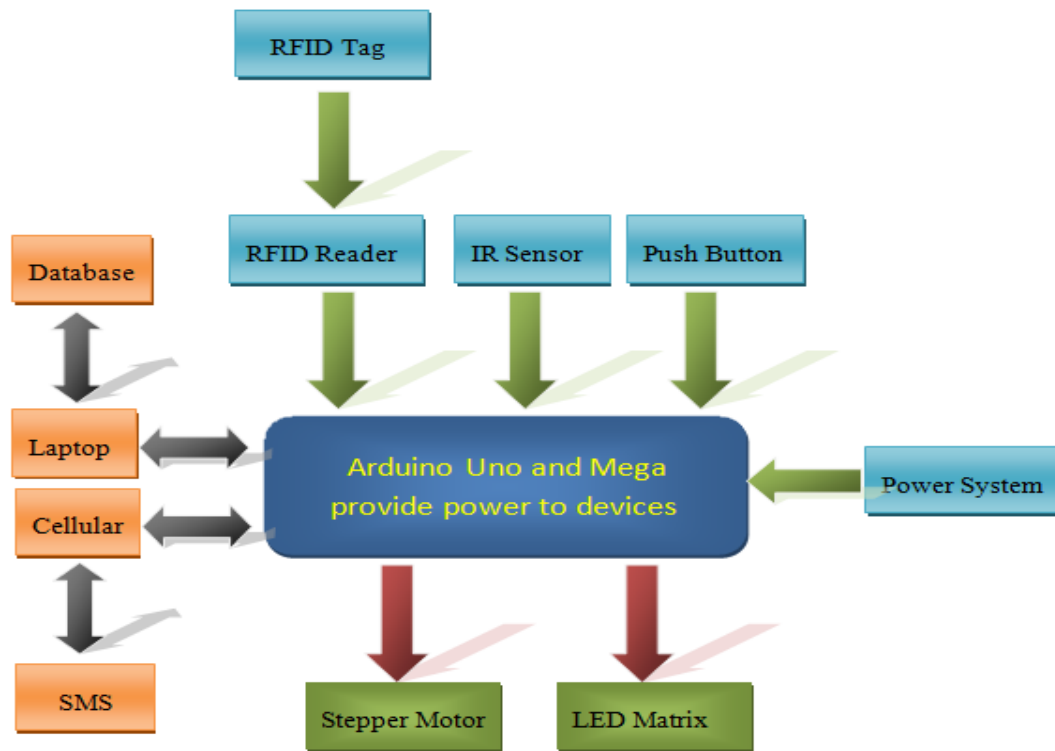


Figure 6: Functional Diagram