ECE 414 Senior Design Project Proposal

Team number: 33

Project Title: Intelligent Door System (IDS)

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Abstract

Our project consists of designing an intelligent security door system. The idea behind our project is to create a system that uses an electronic door lock with wireless communication module so that a person in the possession of an NFC device can get access to a secured area. Our project will be designed to provide security to the customer that will buy our product. This security is going to be in the form of a backend server that will make sure that you are authorized to be in a specific area. A mobile phone application or computer software will be used to display any important information and configure the system.

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Introduction

The ongoing evolution of the network of computing devices embedded in everyday objects to transmit and receive data better known as the Internet of Things (IoT) has enabled devices to become smart objects. New communication interfaces, like Near Field Communication (NFC), have been integrated in different devices. This technology is a type of Radio Frequency Identification (RFID) that could have a great impact on the usability for security systems by enabling the integration of NFC enabled devices to a network and using them as a medium to grant authorization to specific areas. In this context, an emerging trend is the integration of NFC devices like smartphones or just simple tags into modern security systems such as access control lock, unlock and configure the system. In specific, NFC is suitable for this application due to its close-range communication requirement.

In this paper, we propose a simpler way to go in and out into authorized areas by using an Intelligent Door System (IDS). An IDS consist of an electronic door lock that prevents an unknown or restricted person from entering a specific area unless the corresponding tag or token is physically present or authenticated. Access rights can be given to multiple users, cancelled or bound specific levels of security. All this organization and distributions of keys will be done though a software application. Despite of all the advantages of this innovating system, there are certain challenges like security aspects that will have to be target during the designing process.

Technical Goal

1. Select appropriate controller and compatible RFID hardware.
2. Design a friendly user interface (tablet, phone, computer)
3. Stablish communication protocols for the systems mentioned above

   Roles

   - Shawn Carnevale: Hardware implementation and assembly process.
   - Stephen Benavides: Network and Communication implementation.
   - Gregory Escobar: Software implementation.
   - Geomar Reyes: Security (Hardware and Software) implementation.

Projected Community Impact

- It will help people with disabilities access the facilities that have been implemented with our device easily as it does not require an external force to open the door.
- Increased security standards at home and businesses by 20% as the device is provided with an automatic closing mechanism.
- Improved response time during emergency situations.
- Allowing quick access to the facilities could increase productivity by 5%.

Relevant ethical issues

In our project we face some ethical concern with the security of our product. The main ethical concern is people's privacy. Privacy can be described as a person right to keep their information from being public. The main ethical impact is going to occur on the gathering, storage, retrieval and dissemination and the impact relate to accessibility/inaccessibility and the manipulation of information. Because a lot of different people have access to this system the risk of information getting stolen or use for the wrong purpose increase. We can prevent this from happening by implementing security measure like password and other security measure we can implement to make sure that just the right people have access to sensitive information.

Engineering standards

The project consists of electrical hardware that will use wireless communication to receive and send data between different devices. The project must comply with the IEEE, NFC Forum and FCC signal and frequency standards.

- IEEE 802.11: This standard deals with wireless communication between devices. There are a set of Media Access Control (MAC) and Physical layer used for implementing wireless local area network. This apply to this project because there is an electronic door lock that will communicate wirelessly to a computer and to a NFC enable device or tag. The FCC 1934 act "title" deals with the regulation of all wireless communication from

telecommunication to microwave and many other types of wireless communication. This will be critical because things like wireless communication and RF signal are regulate by this industry for safety of and public.

- ISO/IEC 14443: This standard defines proximity cards used for identification, and the transmission protocols for communicating with it.
- ISO/IEC 18092:2013: This standard defines communication modes for Near Field Communication Interface and Protocol (NFCIP 1) using inductive coupled devices operating at the center frequency of 13,56 MHz for interconnection of computer peripherals. It also requires conditions to control data collisions when transmitting data.
- Unfortunately, there are no standards regarding data management. The project will be handling sensitive information about a person or a company. The system will be designed to prevent any alteration or any unauthorized access to this information.

Constrains:

Legal:

- The components use for our device are open source, they can be acquired from the company and be use freely in the implementation of our device, thus avoiding legal problems when the project is released to the market.
- Whenever we are talking about someone's personal information, legal issues are always important to address.
- When working with people's personal information we must provide confidentiality and protection, otherwise we might get some legal issues and more importantly we will lose people's trust in our device.

Confidentiality Agreement: The information provided by the user will be encrypted and their personal information such as names won't be listed in our database giving the user the anonymity status.

Protection Policy: The information provided by the user won't be share to a third party unless requested by a higher authority. The information won't be made public by the company under

any circumstances. By disclosing legal issues, we will avoid any legal action towards the company and its associates.

Budget:

One of our biggest challenges is going to be to create our project for the least amount of money but also work efficiently. This is always an important question whenever an engineer works in the industry because time is money. We have determined that the programming and the Arduino chip will not cost that much money but, the linear actuator and the bracelet could be big factors in the price. The following table shows the equipment that will have to be purchased to start developing the project.

Item	**Price**
Linear Actuator L16	$79.99
Rutherford Electric Strike Electronic Lock	$59.68
Adafruit PN532 NFC/RFID	$39.95
DC Power Supply	$10.00
Door Hinges	$7.98
NTAG213 by Tagstand NFC tags	$9.99
1740 Adafruit Speaker	$0.95
Total Price	**$208.54**

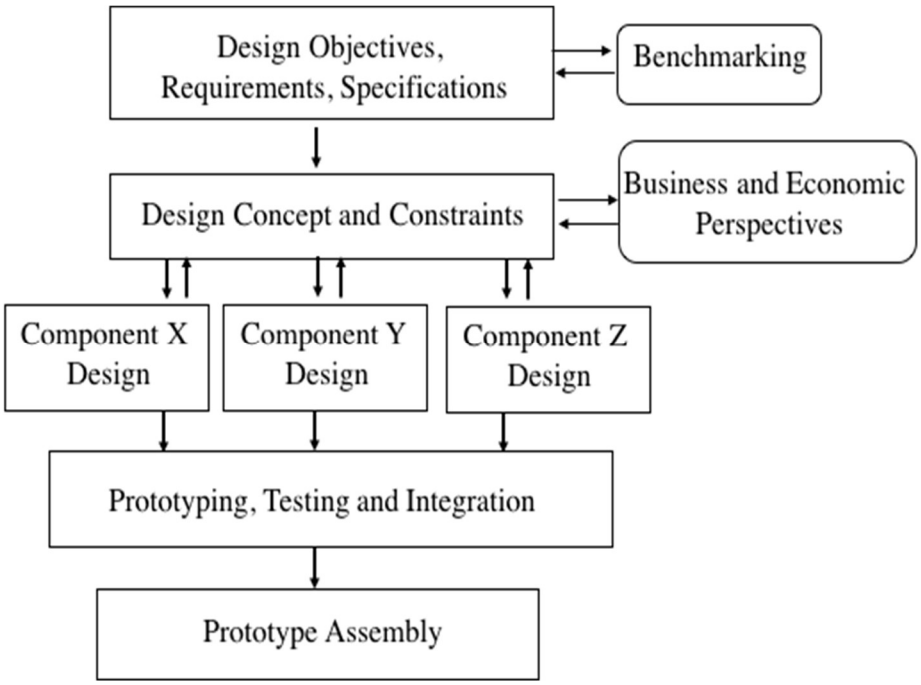
Technical Constraints:

- Since we are using NFC technology which is a branch of HF RFID (13.56MHz) the maximum range will be 10cm (4 inches). The NFC shield should be placed close enough

to the door knob and make sure that there isn't a metal barrier that will attenuate the radio wave.

- Providing enough power to trigger the linear actuator in order to open the door.

Design methodology, analysis, prototyping and validation.



Design Objectives, Requirement, Specification

The design objective is to create an intelligent door system that will use a wireless communication module so that a person in the possession of an NFC (Near Field Communication) device can get access to a secured area.

Benchmarking

This device will provide a quicker, cheaper and more reliable way to protect and access facilities in comparison with other similar systems. For instance ID card for doors requires of expert installation and electrical wiring to control the locking mechanism of the door, the cards itself can be lost or stolen easily and the mass production of this card can cause serious harm to the environment in the long term, in comparison our system is easy to install by the end user, the NFC transmitter can be implemented in any personal belonging of the user, as well as a virtual key

for your phone thus making it harder to lose or forget and easier to access, because the “key” for the NFC transmitter can be implement to the phone through software it will leave a leaser carbon foot print thus helping the environment.

Design Concept and Constraints

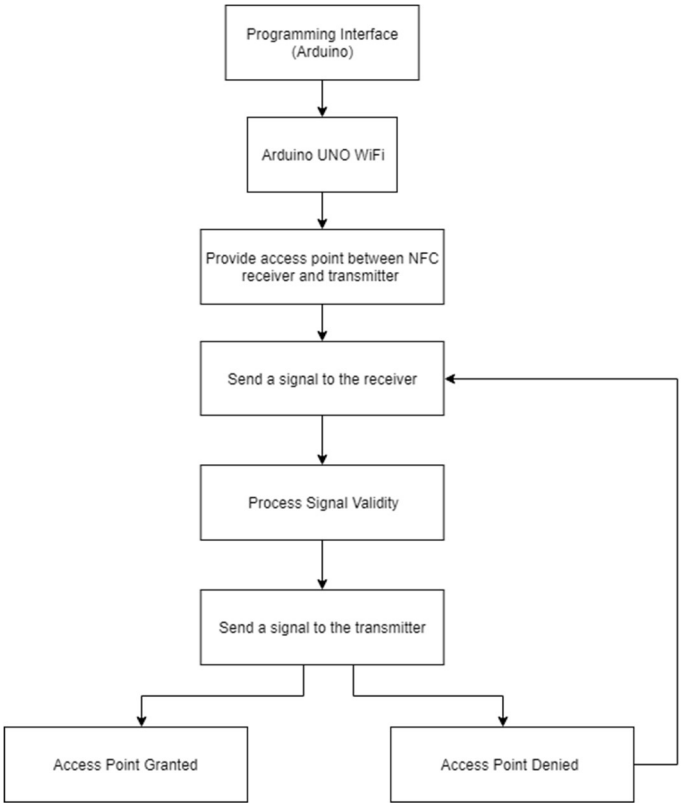
It’s a dispositive that will open the door after receiving a signal from the NFC transmitter, this will in return send a signal back to the servers to prove its validity. Since we are using NFC technology which is a branch of HF RFID (13.56MHz) the maximum range will be 10cm (4 inches). The NFC shield should be placed close enough to the door knob and make sure that there isn’t a metal barrier that will attenuate the radio wave. We will also have to make sure that enough power is provided to trigger the linear actuator to open the door.

Business and Economic Perspectives

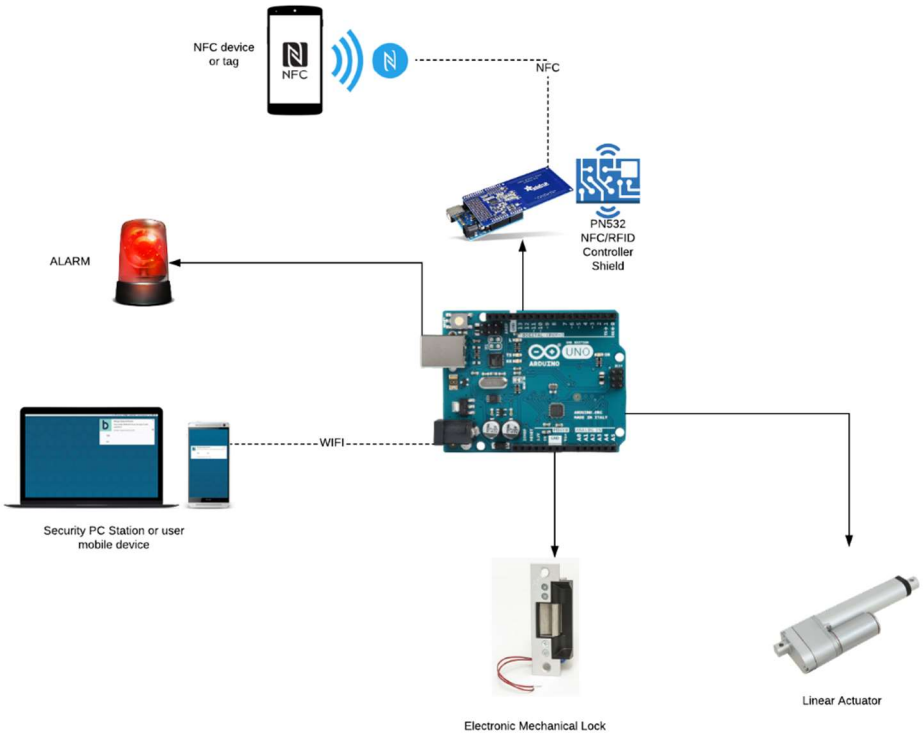
Our design is of cheap production, we use open source software and hardware, thus making it viable for mass production, this in exchange will allow us to sell it for a significant profit. The easy installation will provide a better response from the community making it accessible not only to companies but also regular homes.

Software Design

The Arduino program interface will provide an access point between the NFC receiver and transmitter, when the user attempts to access the facility though the IDS (Intelligent Door System) this will send a signal to the door, the door will access the database to confirm the user identity, if the user is authenticated the door will open and the user will be able to access the facility. If the user information is not in the database, then access will be denied. In both cases the main user will be notified in the correspondent software.



Hardware Design



Prototyping, Testing and Integration

For our project we are going to build a small model that can be used on a bigger scale. The block diagram shows how our project works and how the components interact with one another. The model we are going to build is quite simple with only a few components. First, we are going to attach the linear actuator, the Arduino, the power source and the alarm to a plank of wood. Then we are going to build a 12x8 box made of wood with one end open with a piece of wood attached to hinges. Since the linear actuator can extend a total of seventeen inches we want to make the box smaller so the movable end of the box can open. Our prototype can be thought of as a security box. When the RFID/NFC comes close to the box if they are authorized the actuator will extend and open. If the person is not authorized an alarm will go off.

Prototype Assembly

To build our project we are first going to use a table saw to cut precise planks of wood for our box. Next, we are going to drill screws into the planks of wood, so they don't come apart. The next thing we must do is cut a hole in the back, so we can run the power supply cable to the linear actuator and Arduino. After we cut the hole in the back and run the power cables, we are going to drill hinges to the front of the box and attach a piece of wood to them, so the box can open and close. When we start to build the project there still are some questions. One of the questions is how thick each plank of wood should be. We want our model to be as compact as possible but also sturdy. Another question is do we attach the actuator on top or the bottom of the box. The last question is if we are going to use an extension cord for our power supply. Depending on how far the box is from the wall will it be necessary. These are questions that will be answered when we start to physically build our project.

Project Originality

The Intelligent Door System (IDS) has a lot of competition in the current security market. The Smart lock systems and methods (patent number: US8947530B1) is a lock that can receive electricity from a transformer of a doorbell chime while the lock is mounted on a door. This system uses facial recognition feature that can be expensive to implement and can have a high probability of error because it is an emerging technology. This smart lock is selling for a very high price in amazon. This patent was invented by Joseph Frank Scalisi. In contrast, our system

takes advantage of Near Field Communication (NFC) which is less expensive and easier to implement. In our project we will have a phone that is NFC enabled, which will allow us to open the door without touching the lock or without having a key. This patent just uses a mobile app in contrast with the IDS which also has a PC application that will allow companies to install it in different computers for a better security protocol throughout all the company.

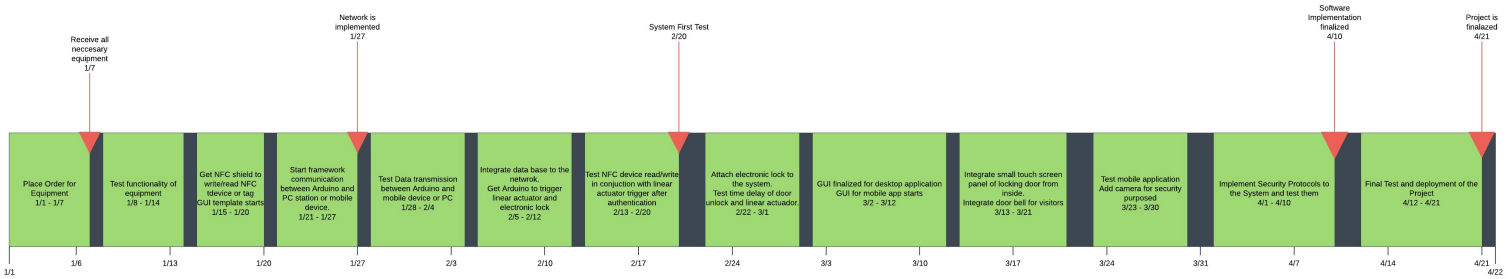
The Gate Smart Lock is also another smart lock (patent number is US20140265359A1). The Gate smart lock is a smart Wi-Fi door lock with a built-in camera that records video when somebody approaches it. This lock is using motion detection which is very expensive to implement compared to an NFC module. In addition, it will end up consuming more cache memory because it will be recording video thus restricting the functionality of the lock. In comparison the Intelligent Door System (IDS) will only use signals when the knob is used, and because we are not using video but logs data instead, our system will be more reliable and faster, and will consume less energy thus making it energy efficient. The Gate Smart Lock doesn't have an integrated software that will allow you to have different levels of security within a facility in comparison the Intelligent Door System (IDS) has an interface that will provide the user to program different levels of security for different access points. Our system has an automatic linear actuator which will automate the opening of the door. In conclusion, the Intelligent Door System (IDS) provides a better interface, versatility and reliability when accessing the different facilities.

In the paper, 'Near Field Communication' by Tomi Aarnio the author explains how Near field communication (NFC) has many applications when it comes to security systems. The reason being is because for the sensor to read the person's information he/she has to be close. When reading an article where about NFC communication more in depth we realized that NFC sensors typically consume little power and tend to be cheaper as well. For our project NFC sensors was the best for us to use because of its wide use in any type of security system. Because of it low power consumptions the components don't have to be that big either which greatly simplified our project.

Marketability:

This product targets companies and home owners. It will serve the consumer as an automated security system. This will be achieved by taking advantage of the internet of things. This will allow users to have more control over a specific area. There are several smart lock systems in the market that provide similar services to this product, but the difference is that we are taking the advantage of NFC technology in conjunction with IoT network of devices that allow the user to have a better perspective of the flow of people to specific areas. The competition for our product is the Kitwest Kevo smart door lock. This lock has a lot of the same feature that we want to implement into our project, but our product will have the latest innovation when it come wireless communication. Also, another competitor that we have is Gate Smart Lock which have a camera integrate to it and can be control though an app. Our competitor price is $500, but our product will be market between $350 to $400. Intelligent Door System is a system that will be relevant in the current market.

Proposed 414-416/417 timeline and milestones



Time Range	Task
1/1 – 1/7	Place order of Equipment
1/8 – 1/14	Test Functionality of Equipment
1/15 - 1/20	Get the NFC Shield to write/read NFC device or tag GUI template starts
1/21 – 1/27	Start framework communication between Arduino and PC station or mobile Device

1/28 – 2/4	Test data transmission between Arduino and mobile or PC
2/5 – 2/12	Integrate database to the network. Get Arduino to trigger linear actuator and electronic lock
2/13 – 2/20	Test NFC device read/write in conjunction with linear actuator trigger after authentication
2/22 – 3/1	Attach electronic lock to the system. Test time delay of door unlock and linear actuator
3/2 – 3/12	GUI finalized for desktop application GUI for mobile app starts
3/13 – 3/21	Integrate small touch screen panel of locking door from inside. Integrate door bell for visitors
3/23 – 3/30	Test mobile application add camera for security purpose
4/1 – 4/10	Implement security protocols to the system and test them
4/12 – 4/21	Final test deployment of project

Conclusion

In the proposed project, we designed a system comprised of an electronic door lock with wireless communication module so that a person in the possession of an NFC device can get access to a secured area.

We performed a research making emphasis on how to improve the life of the user while making it easy to use and buy. After a long research and spending time deliberating, we decided to design the Intelligent Door System (IDS). The IDS will give the user an improved accessibility and security that until now was reserved for extremely important facilities that needed to protect sensible places. But now the same level of security and accessibility can be given to anyone by a fraction of the price.

We concluded that the proposed system will vastly improve security and accessibility thus having a high probability of replacing current security measures such as ID cards readers for doors.

Because our system is going to be of easy installation and lower cost in comparison to the competition. It's more likely to not only succeed in places that requires high security systems such as governmental offices but also in the common households that seeks an improved and cheaper security measure.

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Appendix

Read and Write on NFC tags code:

```
void setup(void) {
  Serial.begin(9600);
  Serial.println("NFC TAG READER"); // Header used when using the serial monitor
  nfc.begin();
}

void loop(void) {
  Serial.println("\nScan your NFC tag on the NFC Shield\n");  // Command so that you an others will know what to do

  if (nfc.tagPresent())
  {
    NfcTag tag = nfc.read();
    Serial.println(tag.getTagType());
    Serial.print("UID: ");Serial.println(tag.getUidString()); // Retrieves the Unique Identification from your tag

    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(".");

      // If you have more than 1 Message then it wil cycle through them
      int recordCount = message.getRecordCount();
      for (int i = 0; i < recordCount; i++)
      {
        Serial.print("\nNDEF Record ");Serial.println(i+1);
        NdefRecord record = message.getRecord(i);

        int payloadLength = record.getPayloadLength();
        byte payload[payloadLength];
        record.getPayload(payload);


        String payloadAsString = ""; // Processes the message as a string vs as a HEX value
        for (int c = 0; c < payloadLength; c++) {
          payloadAsString += (char)payload[c];
        }
        Serial.print("  Information (as String): ");
        Serial.println(payloadAsString);


        String uid = record.getId();
        if (uid != "") {
          Serial.print("  ID: ");Serial.println(uid); // Prints the Unique Identification of the NFC Tag
        }
      }
    }
  }
  delay(10000);
}
```