RFID BASED BICYCLE SHARING AND RENTING SYSTEM

Submitted in partial fulfilment of the requirements for the degree of
BACHELOR OF TECHNOLOGY in

ELECTRICAL AND ELECTRONICS ENGINEERING

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NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

DECLARATION

by the B.Tech. Student

I/We hereby *declare* that the Project Work Report entitled

RFID BASED BICYCLE SHARING AND RENTING SYSTEM

which is being submitted to the **National Institute of Technology Karnataka, Surathkal** for the award of the Degree of Bachelor of Technology in

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is a *bonafide report of the work carried out by me/us*. The material contained in this Project Work Report has not been submitted to any University or Institution for the award of any degree.

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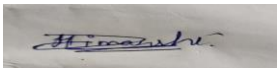
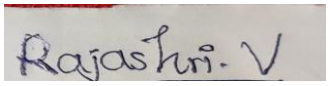
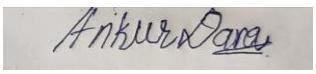
(1) HIMANSHI DEKATE (211EE120) 

(2) RAJASHRI VARADARAJ (211EE137) 

(3) ANKUR DARA (211EE107) 

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Place: NITK, SURATHKAL

Date: 5TH DECEMBER 2022

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CERTIFICATE

This is to *certify* that the B.Tech. Project Work Report entitled

.....

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Guide(s)
(Name and
Signature with Date)

Chairman - DUGC
(Signature with Date and Sea

ACKNOWLDGEMENTS

Working on this project was really interesting and gave us a deeper insight towards the application of electromagnetic theory in many of the modern-day appliances and technology that we use. Our understanding of EM waves improved and became more clear and compact. The process of building a working model was a fruitful learning experience for us, not just academically, but it also helped us in improving our teamwork, co-ordination and practical skills.

We would like to sincerely thank our professor Dr. Dastagiri Reddy Bonthapalle for providing us with this opportunity and guiding us throughout the project.

Therefore, we are grateful to the Electrical and Electronics department of NITK, for providing us with this course, EE207: Electromagnetic theory as a part of our curriculum.

Further on, we would like to thank our team members for showing remarkable interest and enthusiasm while working on this project and making it a successful one.

CONTENTS:

1.INTRODUCTION:

Electromagnetism is a phenomenon which deals with the interaction between an electric field and a magnetic Field. The Electromagnetic theory, which describes electromagnetism in great detail, has various applications- ranging from devices used in our daily lives to military, industrial and research applications.

Radio-frequency identification (RFID) is one such important application of electromagnetic theory that uses electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum for the purpose of identification and tracking using radio waves. Some tags can be read from several meters away and beyond the line of sight of the reader. In short, RFID can be seen as a combination of tag, reader and antenna that is able to distinguish IDs of different objects.

An IR sensor is another application of electromagnetism. It is electronic device, that emits the light in order to sense some object of the surroundings. An IR sensor can detects the motion of an object by their thermal radiations in the infrared region of the electromagnetic spectrum.
This project aims to demonstrate the usage of RFID cards for the facilitation of a bicycle renting and sharing system, broadly, as an application of the subject of electromagnetic theory. The working model also makes use of two IR sensors to detect the presence of a card and enable access to a bicycle.

Public Bicycle Sharing (PBS) systems have gained popularity over the years and an increasing number of cities have been adopting and implementing these systems. With being environmentally friendly, the concept of public bicycle sharing provides increased transport flexibility and health benefits, also saving the time and financial effort for the maintenance of the bicycle.

2.PROJECT REQUIREMENTS:

The following components have been used to build a fully working model for the demonstration of the bicycle renting and sharing system. The below section includes a short description of each of the components:

-Hardware:

- Arduino Uno
-MFRC522 RFID Module and RFID cards
-LCD 16X2 with I2C Module
-MG 995 Servo Motor
-IR Obstacle sensor module
-4x4 Matrix Keypad
-1k ohm resistors (4)
-4.7kohm resistor (3)
-Breadboard
-Jumper Wires

-Software:

-Arduino Application

Arduino Uno:

Arduino Uno is a microcontroller board based on the ATmega328P. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable

MFRC522 RFID Module :

MFRC522 RFID Module is the card reader module used to detect, read and write on the RFID cards, the cards each having a unique identification number (UID)

LCD 16X2 display with I2C module:

The I2C 16×2 Arduino LCD Screen is using an I2C communication interface. It is able to display 16×2 characters on 2 lines, white characters on blue background. The I2C adapter is directly soldered right onto the pins of the display.

MG 995 Servo Motor:

MG995 is a servo motor that is popular for its performance and low price. It provides a precise rotation over 180º range.

IR Obstacle sensor module:

An infrared (IR) sensor is an electronic device that measures and detects infrared radiation in its surrounding environment. Two IR sensors are used in this project.

4x4 Matrix Keypad:

The keypad is used to provide input- specifically to recharge the RFID card balance in this project. It has 16 keys in total, which means it can provide 16 input values.

3. COMPONENTS AS AN APPLICATION OF ELECTROMAGNETIC THEORY:

3.1. RFID Card reader module and Cards

Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects. An RFID system consists of a tiny radio transponder, a radio receiver and transmitter. When the scanning antenna and transceiver are combined, they are referred to as an RFID reader or interrogator. When triggered by an electromagnetic interrogation pulse from a nearby RFID reader device, the tag transmits digital data, usually an identifying inventory number, back to the reader.

The RFID reader is a network-connected device that can be portable or permanently attached. It uses radio waves to transmit signals that activate the tag. Once activated, the tag sends a wave back to the antenna, where it is translated into data.

RFID tags are made up of an integrated circuit (IC), an antenna and a substrate. The part of an RFID tag that encodes identifying information is called the RFID inlay.

There are two main types of RFID tags:

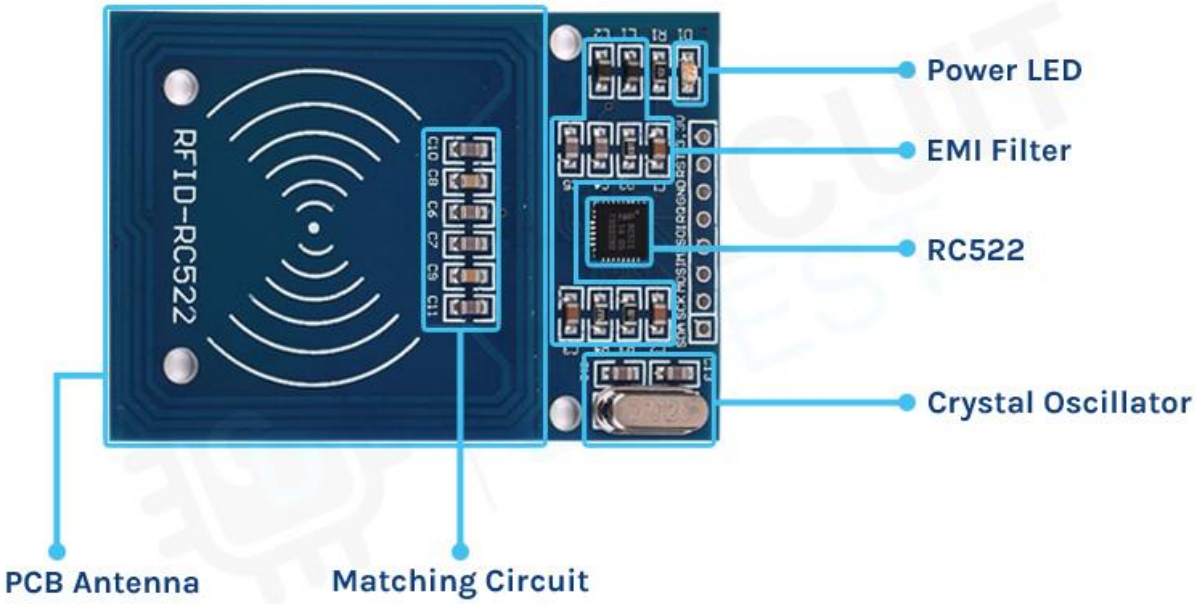
- Active RFID**:** An active RFID tag has its own power source, often a battery.
- Passive RFID: A passive RFID tag receives its power from the reading antenna, whose electromagnetic wave induces a current in the RFID tag's antenna.

There are also semi-passive RFID tags, meaning a battery runs the circuitry while communication is powered by the RFID reader.

Low-power, embedded non-volatile memory plays an important role in every RFID system. RFID tags typically hold less than 2,000 KB of data, including a unique identifier/serial number. Active RFID tags have a longer read range than passive RFID tags due to the stronger power source.

MFRC 522 RFID Module:

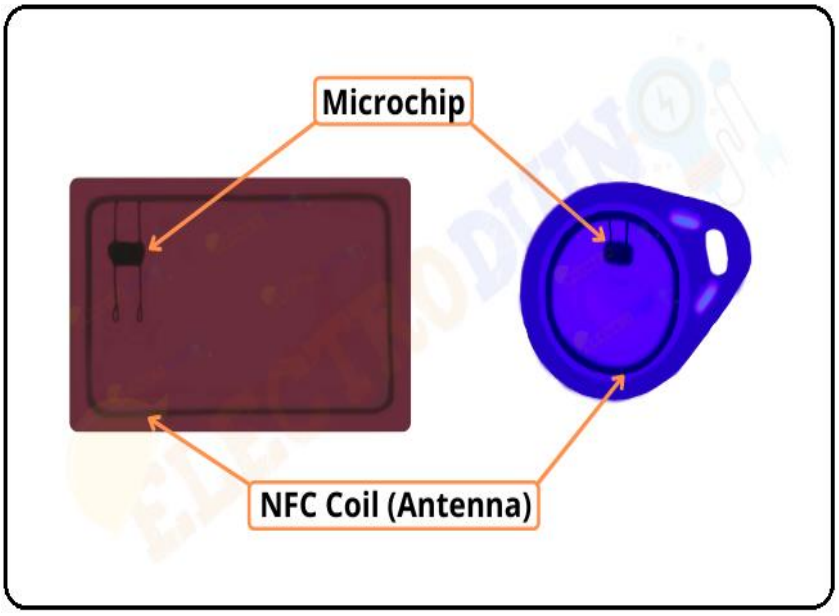
The RC522 RFID Reader/Writer Module (Transceiver) is based on a highly integrated reader/writer IC MFRC522 from NXP Company. It is used for contactless multi-communication at 13.56 MHz. This module uses electromagnetic waves in radio frequency to transfer data It can read/write all types of Transponders (RFID card tags and key fob tags) which having 1KB memory and compatible with 13.56 MHz frequency. It comes with SPI protocol which enables it to easily interface with almost any microcontroller. The reader module consists of three key components: the MFRC522 IC, a 27.12 MHz Crystal Oscillator, and Antenna.



MFRC522 IC/Chip: The RC522 RFID Reader Module is based on MFRC522 IC/Chip. It supports various types of RFID Tags like MIFARE 1K, MIFARE 4K, MIFARE Mini, and other ISO / IEC 14443 standard protocol-based cards and tags. Also, it supports MIFARE series higher speed contactless communication, duplex communication speed up to 424 kb/s and I2C serial communication with the host (Microcontroller like Arduino).

27.12 MHz Crystal Oscillator: A 27.12 MHz quartz crystal is connected to the OSCIN and OSCOUT pin of the chip for the Internal oscillator. 13.56 MHz clock pulse derived from the 27.12MHz clock pulse of the 27.12 MHz quartz crystal oscillator divided by 2.

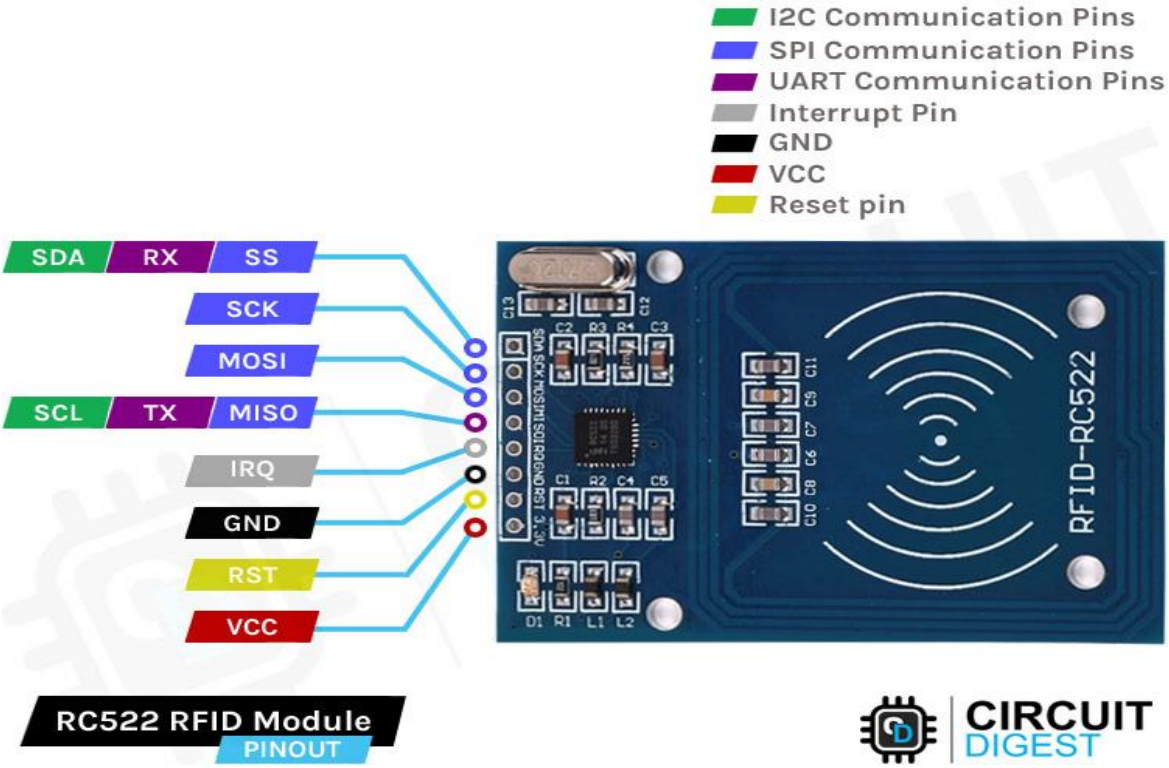
Antenna: An NFC Coil is embedded in the PCB of the module. This is an antenna that emits a 13.56 MHz high-frequency electromagnetic field. It supports 13.56 MHz passive components.



RFID Card And Key Fob Tags:

The RFID Card tag and Key fob tags (transponder) are passive devices, they don't contain a power source (battery). These consist of a microchip and an NFC Coil (Antenna). The microchip is for the storage of the data, and the NFC Coil (Antenna) is for transmitting the data to the RFID reader module.

Pinout:



- SDA SCL: I2C Communication pins. DATA and CLOCK.
- SS SCK MOSI MISO: SPI communication pins. Slave Select, Clock, MOSI, and MISO.

- RX TX: UART Communication pins.
- IRQ: Interrupt signal from the module to indicate RFID tag detection.
- GND: Ground pin that needs to be connected to the GND pin on the Arduino.
- RST: Reset pin for the module
- VCC: Supply pin for the module. The supply voltage can be anywhere from 2.5V to 3.3V and must be connected to the 3.3V pin on the Arduino.

Working:

The RFID reader module or Transceiver uses electromagnetic waves in radio frequency to transfer data. The control unit and an antenna coil of the reader module generate a high-frequency electromagnetic field.

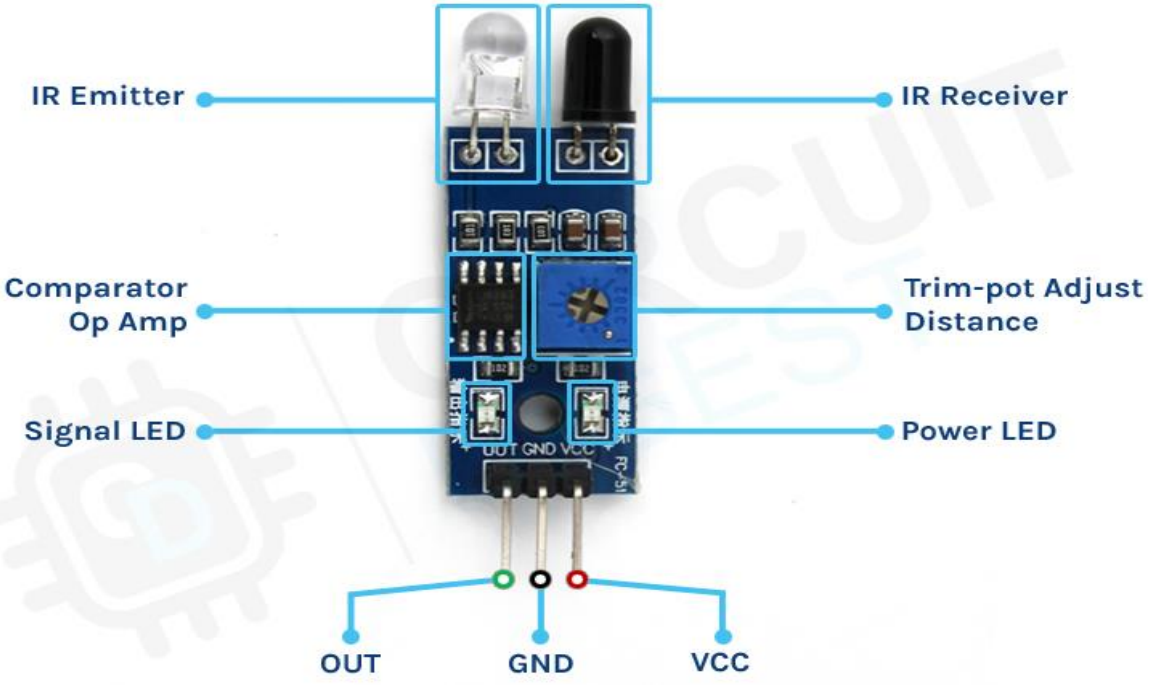
When an RFID tag or Transponder comes in the range of the electromagnetic field (detection range) of an RFID reader module (Transceiver). Due to mutual induction, a voltage is generated in the antenna coil of the tag, and this voltage work as a power supply for the microchip.

Now, the tag starts transmitting data serially and the reader read the tag information. This technique is known as load manipulation.

3.2 IR SENSORS:

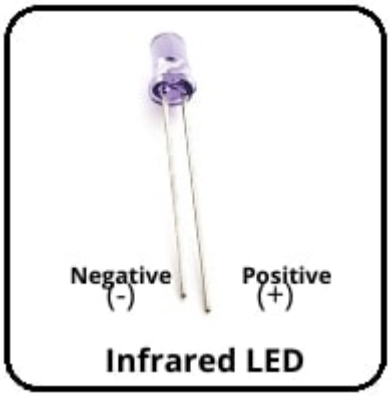
IR sensors mainly consist of an Infrared (IR) LED and a Photodiode, this pair is generally called IR pair. An IR LED is a special purpose LED, it is can emitting infrared rays ranging from 700 nm to 1 mm wavelength. These types of rays are invisible to our eyes. In contrast, a photodiode or IR Receiver LED detects the infrared rays.

Pin diagram:



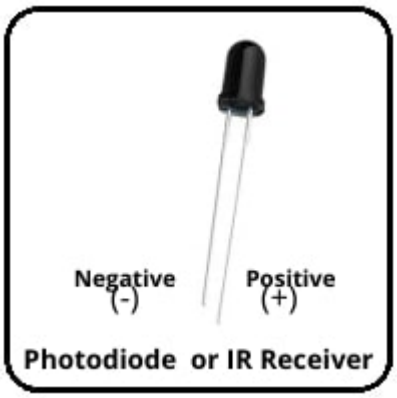
1.Infrared LED or IR transmitter:

An IR LED is a specially designed light-emitting diode (LED), it's emitting **infrared rays**. Infrared rays wavelength ranging is from 700 nm to 1 mm. Normally an IR LED looks like a normal LED. It has two terminals, the longer one is Positive and the smaller one is negative. When IR LED operated at a power supply, it starts emitting infrared rays.



2.Photodiode receiver or IR receiver:

Normally IR receivers are photodiode. It is a semiconductor which has a P-N junction. A photodiode is capable to detect infrared rays. It's operated in Reverse Bias. The photodiode has very High resistance in the absence of infrared rays and becomes low when infrared rays fall on it. Also, It has two terminals, the longer one is Positive and the smaller one is negative.



3.Variable Resistor/Trim Pot:

IR sensor has an onboard variable resistor(potentiometer). This variable resistor is a 10k preset. It is used to set the range of operation. Rotate the preset knob to adjust the detection distance, the effective operation range 2-

10 cm. If the preset knob is rotated clockwise, the detection range will be increased. If it is rotated counterclockwise, the detection range will be decreased.

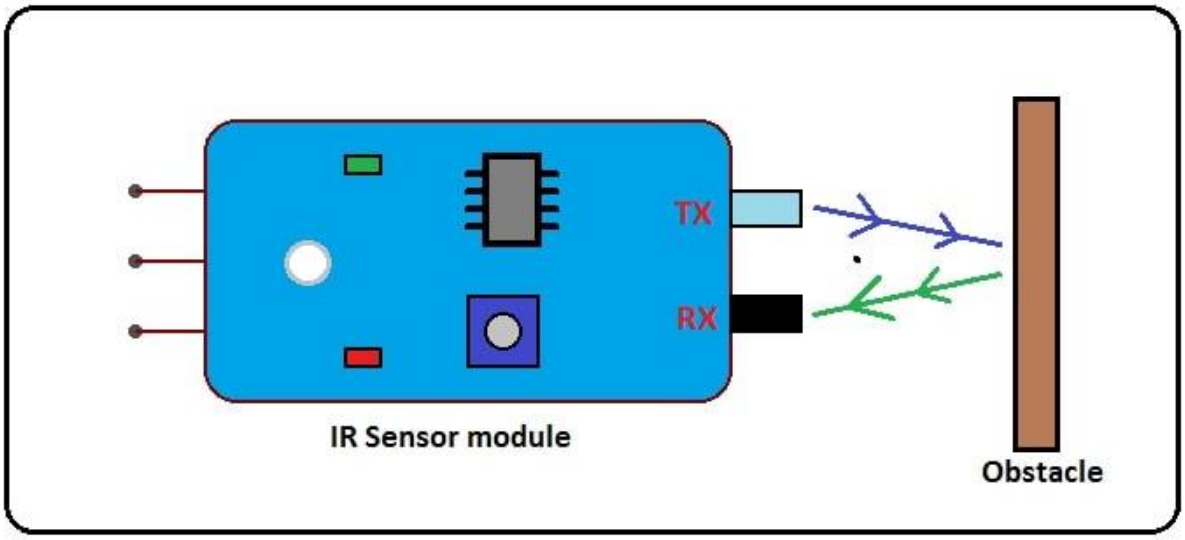
4.Power LED:

This onboard LED indicates the IR Sensor power supply is ON or OFF. When we turn on the IR Sensor power supply this RED LED is also turn on.

5.Output LED:

When infrared reflected back to the IR receiver and the sensor detects an obstacle, the green LED lights up. So, the Green LED use to indicate the sensor senses an obstacle.

Working:



When we connect the IR sensor module to 5v power supply. At the same time, Infrared LED (IR-TX) starts emitting infrared rays. If infrared rays reach to object's surface and some of the radiation reflected back to the IR receiver (IR-RX). The Photodiode or IR receiver (IR-RX) detects the infrared light.
When reflected infrared light Falls on the Photodiode, the resistance of the photodiode falls down from a huge value and the voltage across the photodiode drops. So, a **High** amount of voltage from the photodiode is given to the **Inverting input (2)** of the IC. Then the IC compares this voltage with the threshold voltage. In this condition, the Inverting input voltage is **greater than** the non-inverting input voltage so the IC output is **Low (0)**. So, the **sensor output is Low (0)**.

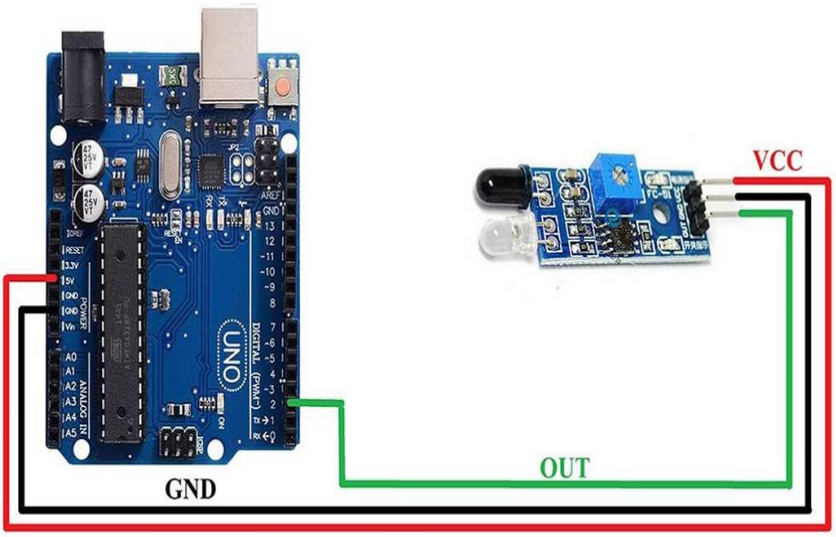
When the Photodiode or IR receiver (IR-RX) **does not detect** the infrared light, then the resistance of the photodiode will very high. So, a **Low** amount of voltage from the photodiode is given to the **Inverting input (2)** of the IC. Then the LM393/LM358 IC compares this voltage with the threshold voltage. In this condition, the Inverting input voltage is **less than** the Non-Inverting input voltage so the IC output is **High (1)**. So, the **sensor output is High (1)**.

4. IMPLEMENTATION:

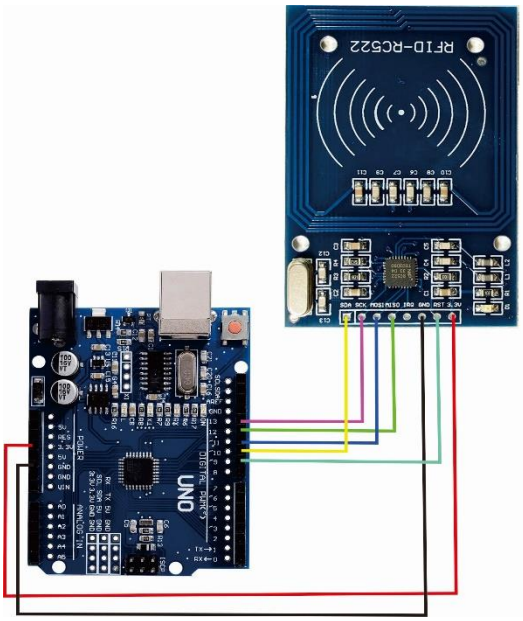
4.1 CONNECTIONS:

The connections to each component in the circuit are shown below:

IR sensor to the Arduino:

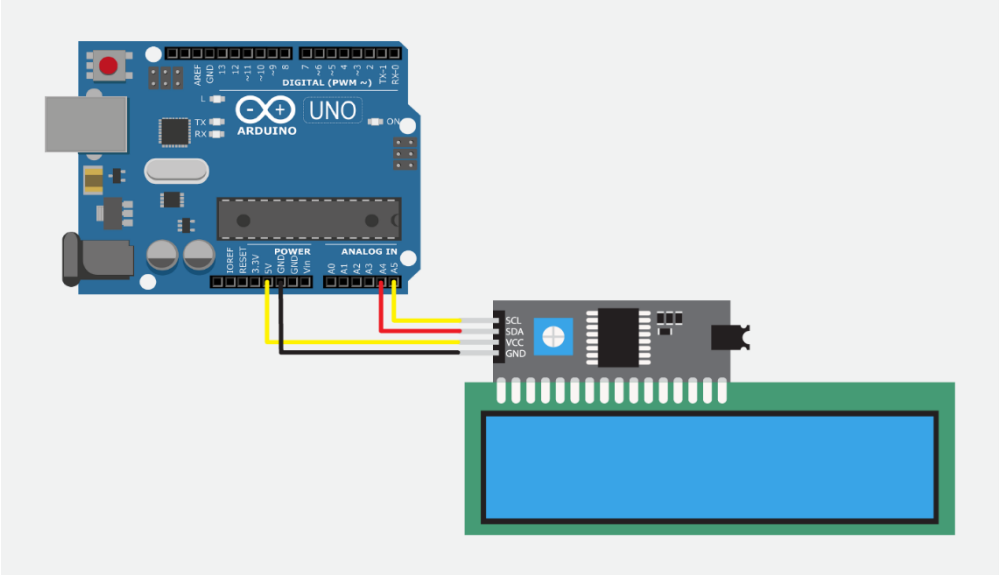


MFRC 522 Card reader to the Arduino (via breadboard in model):

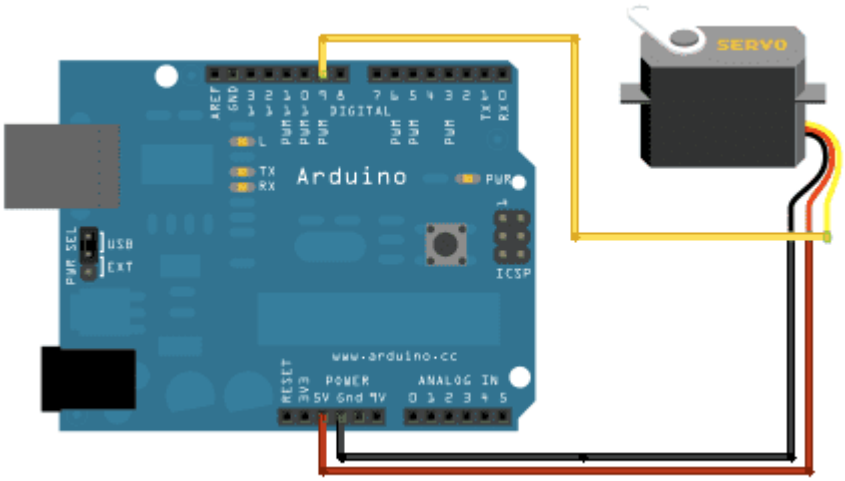


Arduino	RFID-RC522
SDA	10
SCK	13
MOSI	11
MISO	12
GND	GND
RST	9
3.3V	3.3V

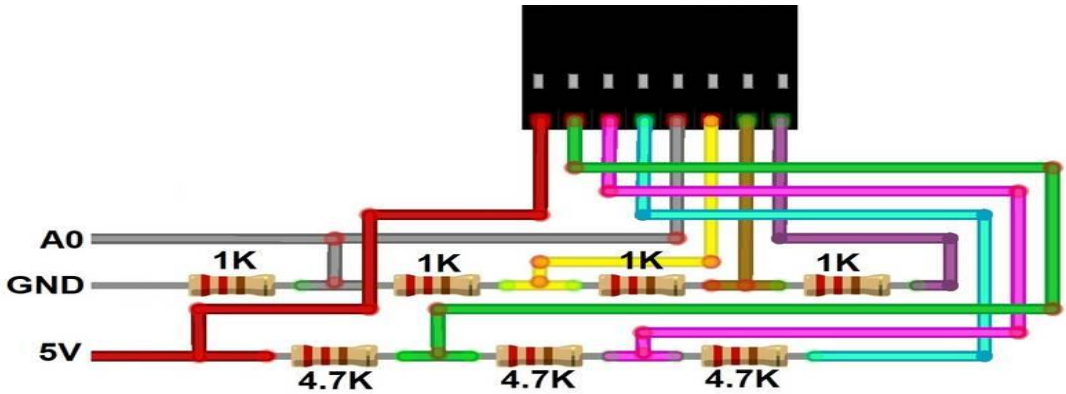
16x2 LCD display to the Arduino via I2C module:



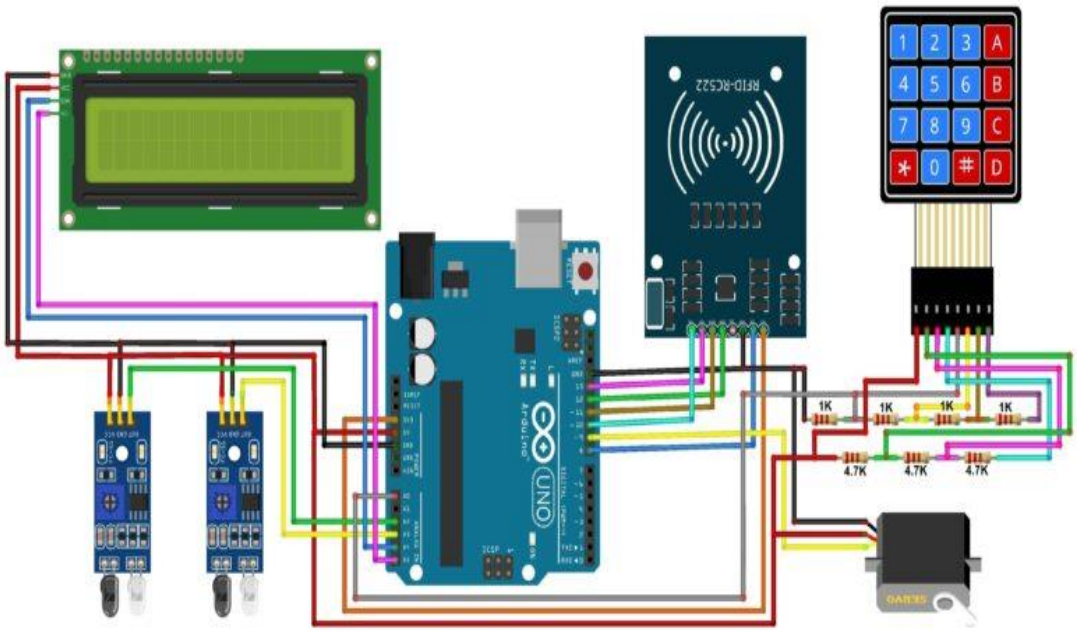
Servo motor to the Arduino:



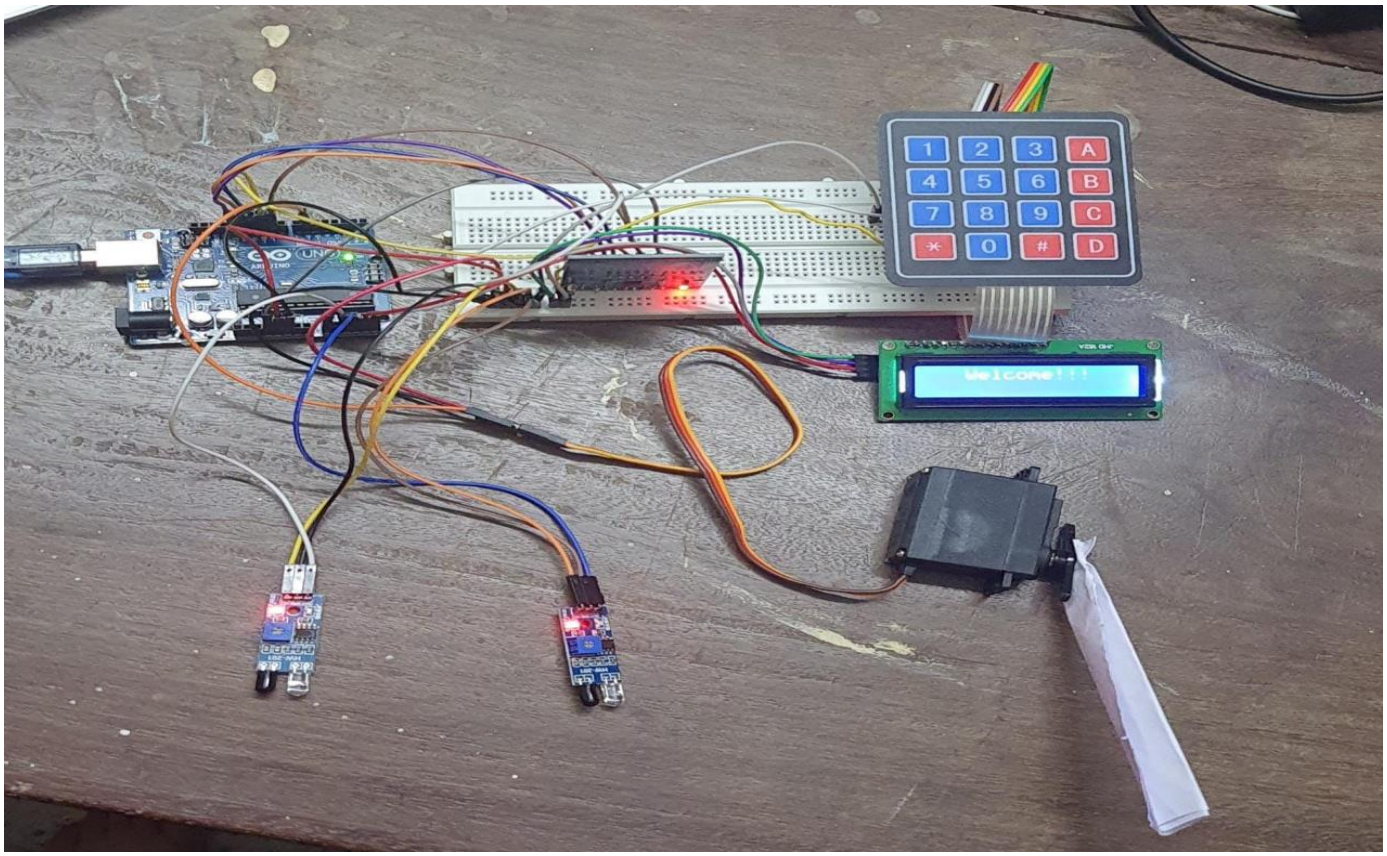
4x4 Keypad Matrix to the Arduino using resistors:



Overall Circuit Connection:



Working model Connection:



4.2 WORKING:

The RFID bicycle renting and sharing system comprises of different locations from where cycles can be borrowed and returned (referred to as stations here onwards). Every station has booths to which an RFID card reader is affixed and each booth holds one bicycle.

When a card is shown at the entrance of the booth, the IR sensor detects the presence of a user, changing the display from the initial ‘Welcome’ to ‘Card Detected’. Upon showing a valid RFID card to the reader (affixed to the breadboard in the model), the user is allowed access to the cycle. Provided that the card has sufficient balance, the LCD display indicates the success of the payment while displaying the balance in the account. The user is granted access to the cycle through opening of the exit gate depicted by the movement of the servo motor functioning like a gate.

The RFID card is rechargeable and the account is stored on the records. If the user produces a card with insufficient balance, the LCD display notifies the user that the access has been denied and states the current balance. It also prompts the user to recharge the card using the external keypad. Once recharged above the rent fee, the RFID card, upon reading, deducts the designated amount and allows the user to access the cycle.

If an invalid card is shown to the reader, it denies access and displays that the card is invalid on the LCD display.

5. CONCLUSION:

The concept of electromagnetic theory and it's application to devices such as RFID and IR sensors have caused major advancements in the industry and more widely, human lifestyle. The usage of RFID in systems such as public bicycle sharing(PBS) and other bicycle sharing and renting systems is extremely advantageous to the user. Firstly, the users will not wait to give the money because they just have to just show the valid RFID card in front of the card reader, and the automatic gate control system will open the gate to pass through. Secondly, user doesn't have to carry the money each time. He/she will just recharge the RFID card by a certain amount and will use this card each time he travels. The same card can be used to borrow the cycle from a different booth in a different location belonging to the same card managing system.

Current usage and future scope:

An RFID based bicycle sharing system is already in place in many cities. One such example is that of the successful 'Trin-Trin' public bicycle sharing in the city of Mysuru (Karnataka), India. Mysuru's 'Trin Trin' is a government of Karnataka project, partially funded by the World Bank under the Global Environment Facility (GEF) grant. This was one of the first bicycle sharing initiatives in the country. Last year Madhya Pradesh's capital Bhopal also saw the country's first fully-automated bicycle sharing system. As part of this completely automated system, users can pick up a cycle from any of the stations and deposit it at another station after use, without worrying about depositing it at the original location. Currently the bikes have RFID tags but gradually in the next phase all the bicycles will also have an in-built GPS system.

Future scope of the model:

The working model that has been built can be further integrated to a website or an application that will enable the user to register, recharge, view account balance, check for availability and wait time (making additional use of a possible GPS based system), request support and access other services. Further, the renting system can be improvised to accommodate a fixed charge, a variable hourly rent and bicycle procurement from the user after usage in case of a renting system incorporated with the sharing system. For a purely sharing (free bicycle sharing) system, the renting process can be done away with and the focus can be on secure access and return of the cycles.

Therefore, it would be safe to say that few key features of the project have been implemented in the real world and there is a good scope to improvise the existing systems in the future. The working model has successfully demonstrated the highlighting usage of RFID in these systems and certain additional functionalities that can be imparted using just few other components in the circuit.

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