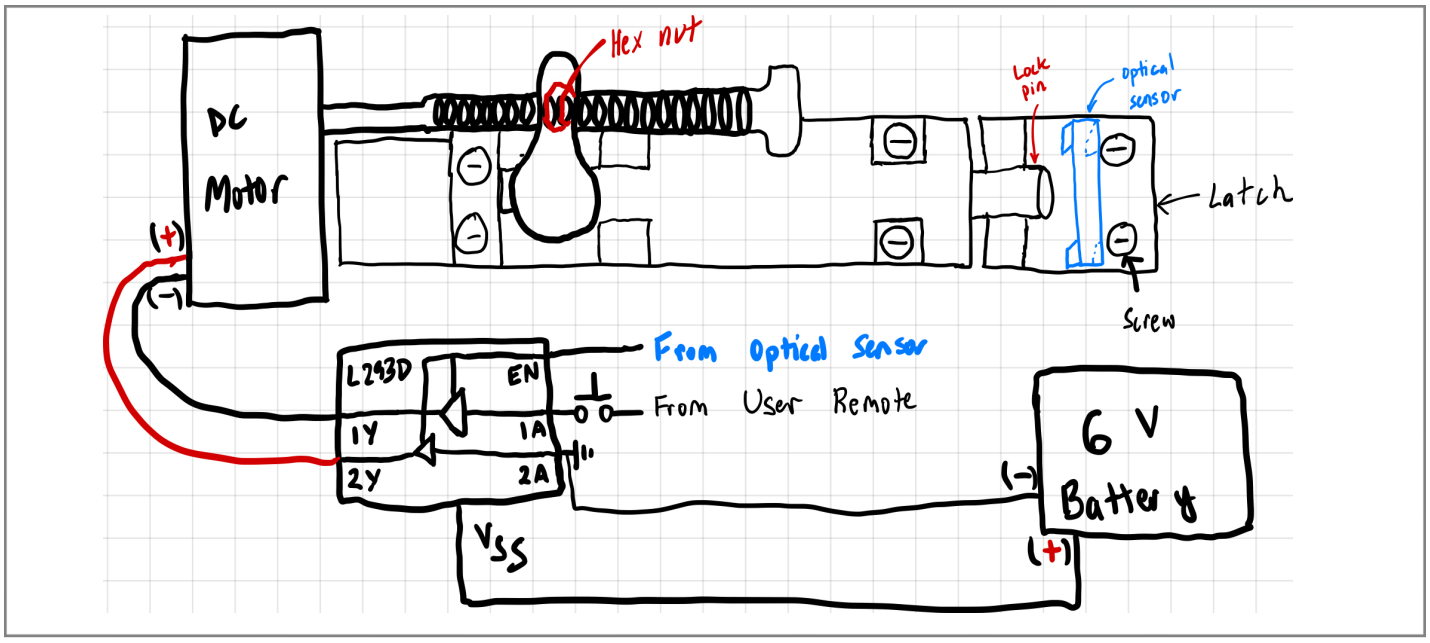
# A Remote Control Door Lock




Tanaykumar Murarka

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## Executive Description

A remote door lock is a system split into two: an encoder circuit and a decoder circuit. This allows for the remote control application while being able to securely maintain the connection. It receives data from user pushed buttons on whether they want to engage the lock or disengage. The system has conditions where the pin will not be able to slide further than the latch mechanism from a optical sensors output. The system will provide for an easy way for the user to open or close the lock of the door, assuming the door itself is already in the closed position. Additionally, it will cut off access to user input once it has reach its final state where the latch/optical sensor is. The user pushed buttons, encoder decoder data line, optical sensor, and battery level of the decoder circuit will all be monitored conditions that the user can control preferences for. The intended users of this product are lazy college students who are on a budget and need a lazy way of feeling secure in the densely populated areas of college towns. This could also be used inside of small businesses since the lock is inside the building, there is a less chance of it being tampered with.

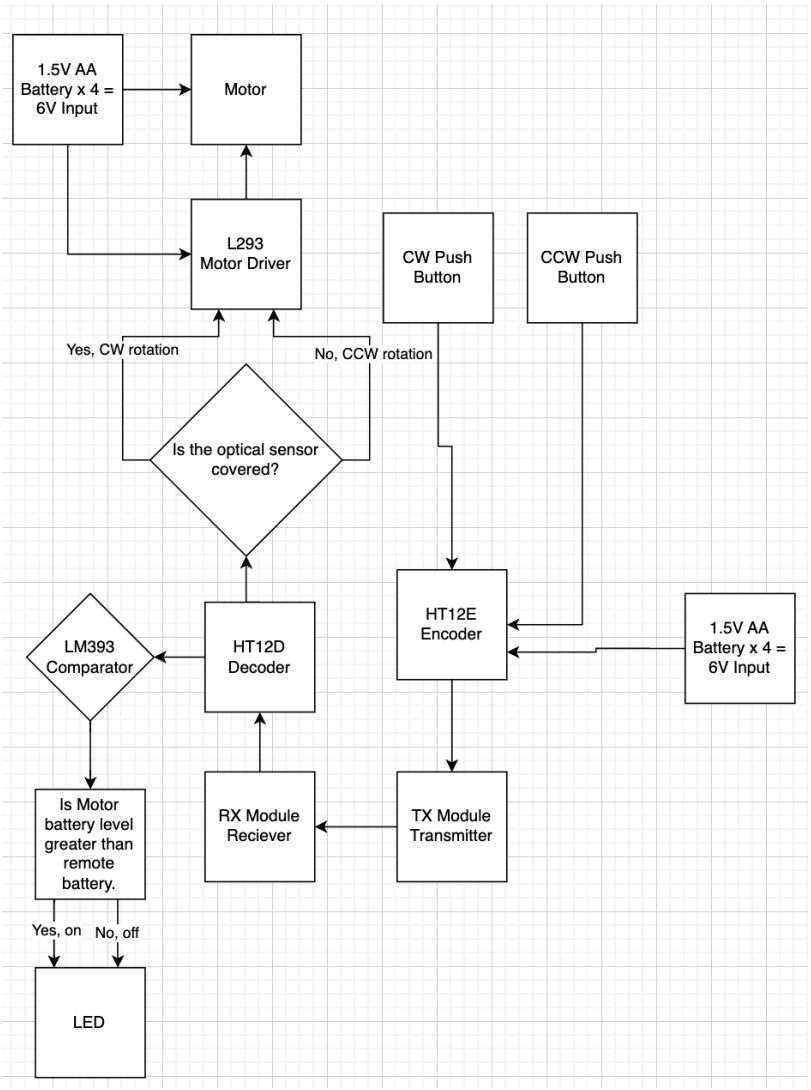
## User Story

Sarah the Slacker has decided “she can’t” with her roommates pranking her every night and it is getting on her mind. She keeps forgetting every night and morning to lock and unlock her door. She wants a device that can not only stop her roommates from coming into the room but do so remotely from the comfort of her bed. She would like it to have a secure connection so that the roommates cannot access the device without her access. In accordance with this, she does not want to worry about when to stop the lock so that she can do it in mid-sleep.

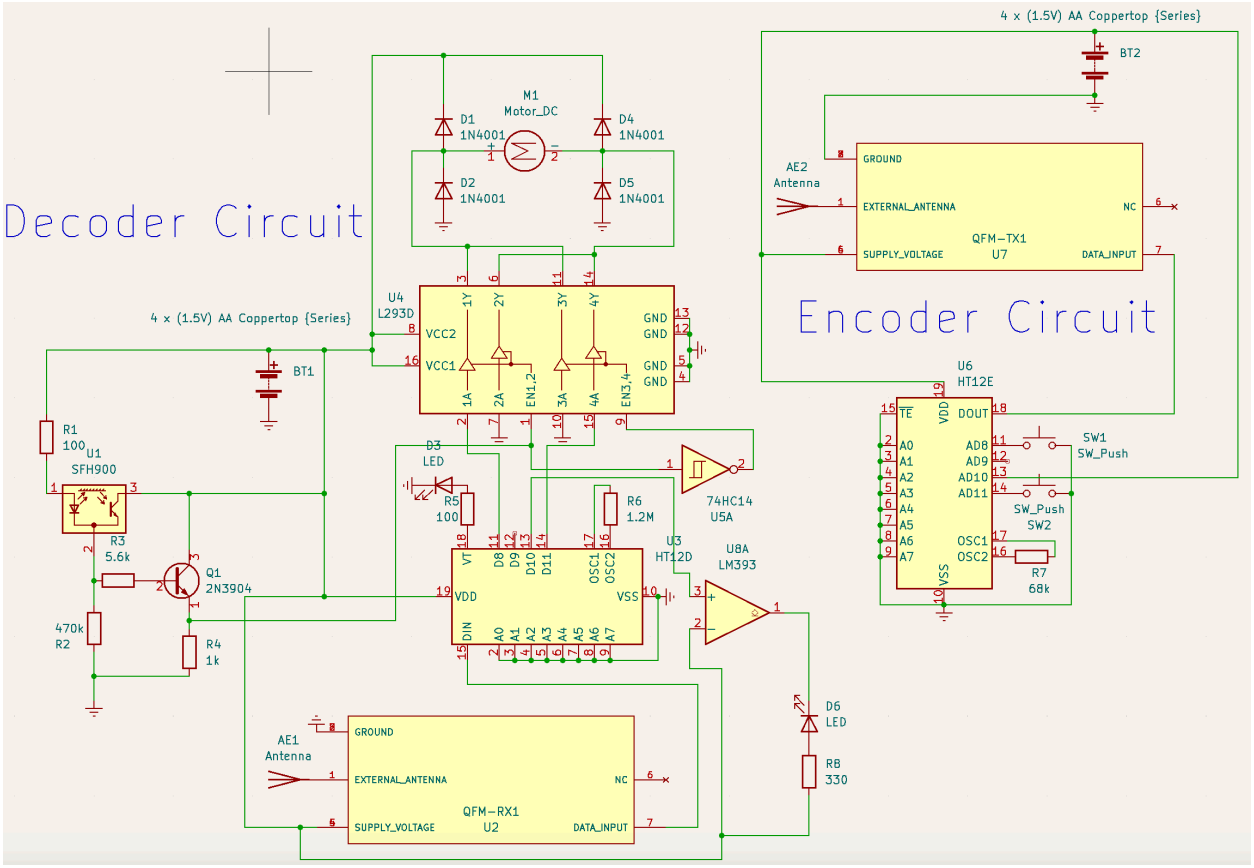
# Design Requirements

1. The door lock must be locked and unlocked only by the person with device access.
2. The lock mechanism must use the DC motor (link).
3. The circuit may be battery powered.
4. Protection circuits should be implemented.
5. Device must be protected from electrostatic charge.

# System Block Diagram



# Schematic


Decoder Circuit
Encoder Circuit
4 x (1.5V) AA Coppertop {Series}
4 x (1.5V) AA Coppertop {Series}
BT1
BT2
M1
Motor_DC
D1
1N4001
D2
1N4001
D4
1N4001
D5
1N4001
U4
L293D
VCC2
VCC1
1Y
2Y
3Y
4Y
GND
GND
GND
GND
1A
2A
EN1,2
3A
4A
EN3,4
R1
100
U1
SFH900
R3
5.6k
Q1
2N3904
470k
R2
R4
1k
D3
LED
R5
100
R6
1.2M
74HC14
U5A
U3
HT12D
U8A
LM393
VT
VDD
VSS
DIN
D8
D9
D10
D11
OSC1
OSC2
A0
A1
A2
A3
A4
A5
A6
A7
AE1
Antenna
GROUND
EXTERNAL_ANTENNA
NC
SUPPLY_VOLTAGE
QFM-RX1
U2
DATA_INPUT
D6
LED
R8
330
AE2
Antenna
GROUND
EXTERNAL_ANTENNA
NC
SUPPLY_VOLTAGE
QFM-TX1
U7
DATA_INPUT
U6
HT12E
TE
VDD
DOUT
A0
A1
A2
A3
A4
A5
A6
A7
AD8
AD9
AD10
AD11
OSC1
OSC2
VSS
SW1
SW_Push
SW_Push
SW2
R7
68k

# Integration Approach

Overall system integration was completed using the encoder decoder HT12D and HT12E respectively. Primary integration was approached by the connection of the wireless RX TX module to the encoder decoder chips. Each IC was powered with the 4 x 1.5V AA batteries in series. Each IC will have their purpose covered below however the encoder decoder chip was the primary means of the connections between all. All of the connections made below could have been improved upon the use of a microcontroller of some kind. Regardless, the system is functional and fulfills most of the requirements of the design.

Beginning with the remote control or encoder circuit, it received power from a separate 4 x 1.5V AA batteries in series in a user controller. The controller consists of the TX module, an antenna, two push buttons, and the HT12E encoder. The push buttons act as a switch to send data on that address pin. The transmission pin has been pulled to a logic low so that it is always recieving or sending data when power is attached. Additionally, all of A0-A7 address pins have been pulled low so it is resulted in 0x00 as being the address. This is where the security of our receiver and transmitter lies. The A0-A7 address pins control which receiver and transponder is needed to be responded to. Since all of the pins have been low for this case for ease of explanation, we can do so the same in the HT12D decoder chip. Finally the power supply of the remote control is also connected to one data pin on the encoder so it can be compared with the motor battery level.

Next, discussing the decoder circuit or the door lock circuit itself. The power is also received from a separate 4 x 1.5V AA batteries in series. The door lock consists of the RX module, an antenna, the HT12D decoder, the L293D motor driver, an optical sensor, and a hex inverter Schmitt trigger. Using the data sheet from the decoder and encoder, the selected resistors were 75k-ohms and 1.2M-ohms respectively. This set the frequency for the encoder to be 2.5khz and 125khz for the decoder. The data sheets are supplied below for correct resistor selection as this determines if the modules will be able to talk to each other or not. The RX module receives user pushed buttons from the remote controller and supplies this data to the HT12D decoder to be understood and decoded. The three outputs we have are when the CW rotation push button is being pressed, when the CCW

rotation push button is being pressed, and finally the output of the voltage level of the remote control. Two of the push button data lines from the decoder are connected to the L293D inputs. The optical sensor is connected to the enable 1,2 pin of the L293D motor driver through some protection circuitry. There is a Schmitt inverter connected to the enable pin 3,4 coming from enable pin 1,2. This is done so that the user cannot press two buttons at the same time. Even though it might be physically possible. The motor will not stall therefore. The isolation of the enable pins is key to the circuitry because as the lock slide into the pin, the optical sensor is covered and the user cannot spin the motor in that direction anymore. This is to protect the lock and motor itself. Once the lock is spun back and unlatched from the lock pin, we can spin it in that direction once more and it will be locked from going further back. The addition of the diodes near our motor is just simply for the basic induction equation. The voltage across an inductor is known as L* di/dt, therefore when the dt goes to very small, the outputted voltage spikes due to the immediate current loss. This voltage is needed to be dissipated somewhere, so the diodes are arranged in an H-bridge configuration so that SW1 and SW2 are never closed together and vice versa for SW3 and SW4.

Finally, discussing the comparator output that is connected to a LED to depict if the battery level of the motor is getting low. When the LED is on, that depicts the motor battery level is good, however if the LED is off then the motor battery should be kept on an eye as it is probably not dead however the voltage has dropped compared to the remote control.

## Design Improvements

This design was very limited in terms of it's smartness due to the lack of a use of a microcontroller. In today's day it is almost essential for a device to have a microcontroller so that it may have some smart functions such as timers, additional protection circuitry, boolean protection circuitry, and access from a smartphone or GUI. The microcontroller would add an easy means of access to the user while providing more security and reliability. A microcontroller could also be added as a diagnostics tool to see what is the best position for the optical sensor or if it can be removed entirely with its purpose being replaced. With the main use of the

microcontroller, we can add an incremental rotary encoder to the motor to keep track of a zero position. The number of encoder steps would be manipulated to find the rotor position and distance. This type of manipulation requires a type of control known as PID. PID - **P**roportional **I**ntegral **D**erivative is a type of control algorithm in which the control signal is the sum of the three terms. To construct the feedback algorithm, we must establish the position we need to get to, compute the error between current position and needed, and then generate a control signal based on this. The details of this method can be further explored to be implemented however in this procedure, it is only outlined. Furthermore discussing ESD protection, there are several ways to protect against an electrostatic discharge. The best way would be to isolate the motor circuit so that only when the user input is being pressed, then power is being sent to decoder circuit. There are many straps and mats that allow for charge to dissociate in the located area also. The easiest method to protect against ESD would be to mount a grounding screw and connect that to the PCB so any excess charge goes to earth.