SMART PET DOOR

Final Project Report

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OUTLINE

- Introduction
- Executive Summary
- System Hardware Design
- System Software Design
- Time Management
- Cost Management
- Testing/Validation
- Lessons Learned

INTRODUCTION

Problem Statement:
- Busy schedule
- 2 dogs that want outside often
- Neighbor dog, no fence

Solution Statement:
-Smart Pet Door that will unlock after reading an RFID tag on a pet's collar and lock after the pet passes through the door.

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EXECUTIVE SUMMARY

Scope
The Smart Pet Door Will:
- Have a user interface
- Recognize allowable RFID tags
- Unlock pet door upon reading allowable tag
- Re-lock pet door once pet goes through
- Will let your pet go in and out freely while blocking unwanted animals from getting in your house

OV-1 Diagram

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SYSTEM HARDWARE

- RFID System
- Arduino Uno Microcontroller
- IR Proximity Sensor
- Solenoid Locks
- User Interface

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RFID SYSTEM

Requirements:
- Read RFID tags from outside of door
- Read distance >= 6inch
- RFID tags must be collar mountable

- Passive RFID Tags
- Mifare RC522 (MFRC522) RFID Module
  - 13.56MHz (High Frequency Range)
- Antenna needs 3.3v power supply

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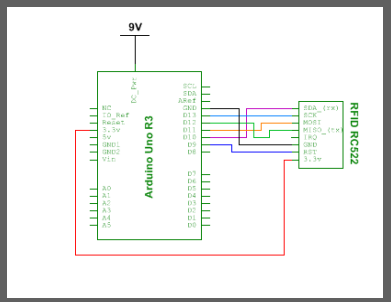
RFID SYSTEM

- MFRC522 RFID Module takes up 5 digital IO pins
- Arduino Library for this specific part
- Could not achieve 6inch read distance

- Second RFID reader
  - 2 IO connections, RX & TX
  - Could not read tags

- Continued design with MFRC522



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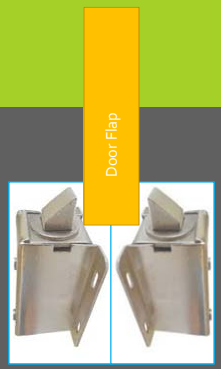
SOLENOID LOCKS

-Locks pet door from swinging either direction.

- When energized, a magnetic field pulls the plunger down, allowing the door flap to swing.

- Sloped edge on one side
  - Door able to close after solenoids lock
  - Hall Effect Sensor removed from design



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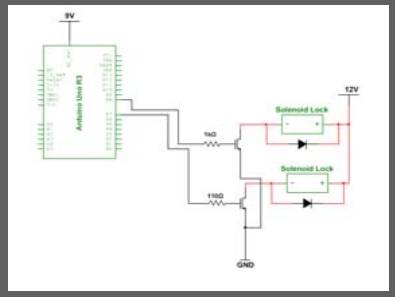
SOLENOID LOCKS

- 12V DC to power solenoids
  - External Power Supply
  - NPN Transistors (TIP120) used to control solenoid with Arduino.
  - Current limiting resistors
  - Diode to prevent kickback voltage



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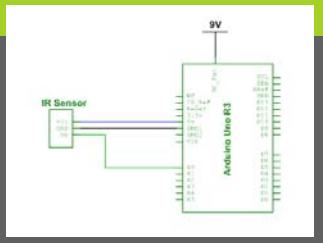
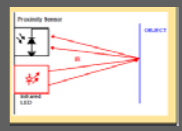
INFRARED PROXIMITY SENSOR

Requirements:
- Detect an object from at *least* 6inch away from the door

- Used to unlock door to let pet out
- 30cm (11.8") used instead of 6"
- 5v power, ground from Micro
- Output voltage measured 0.43V at 30cm





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USER INTERFACE

Planned User Interface:
- LCD and Keypad
- Lock/Unlock buttons
- Ability to add and remove programmed tags
- Not enough IO Ports available for this design.
  - Tried port expander IC
  - Did not work, code did not compile

Alternate User Interface:
- Red-Green-Blue (RGB) LED
- Push Button
- Locks/Unlocks door
- Shows Locked/Unlocked State
- Pre-programmed tags

Planned User Interface

Alternate User Interface

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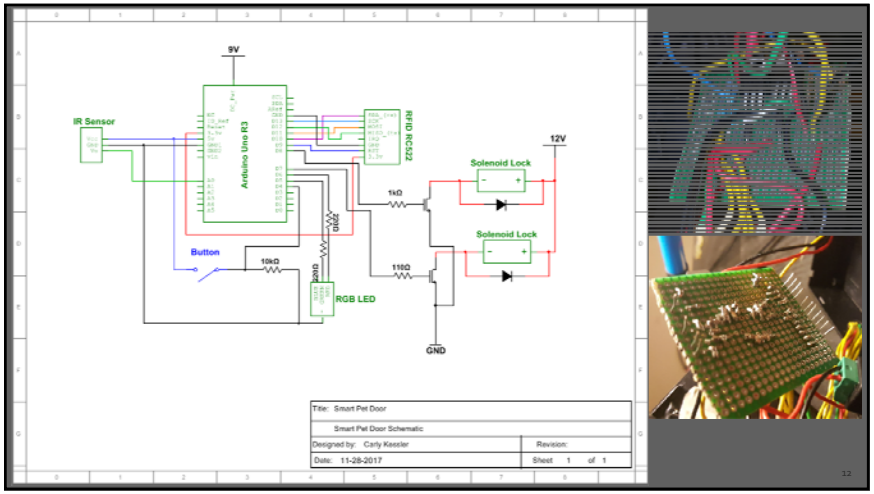

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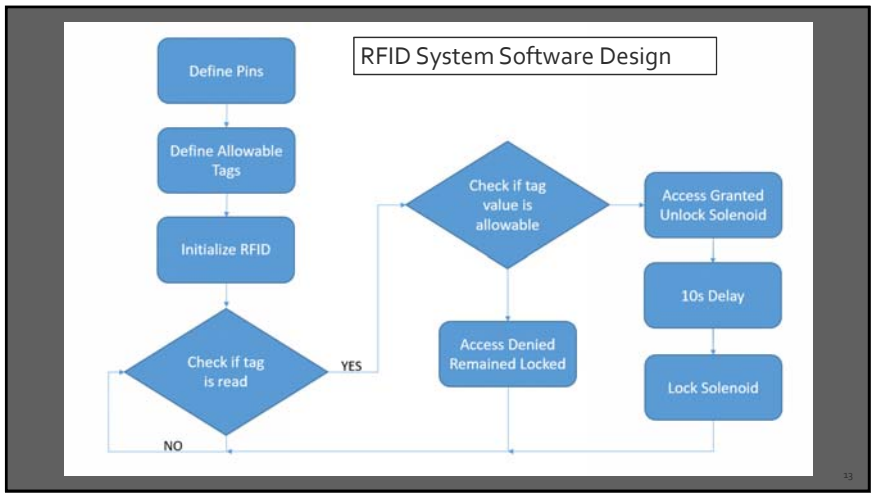
RFID System Software Design
Define Pins
Define Allowable Tags
Initialize RFID
Check if tag is read
YES
NO
Check if tag value is allowable
Access Granted Unlock Solenoid
Access Denied Remained Locked
10s Delay
Lock Solenoid
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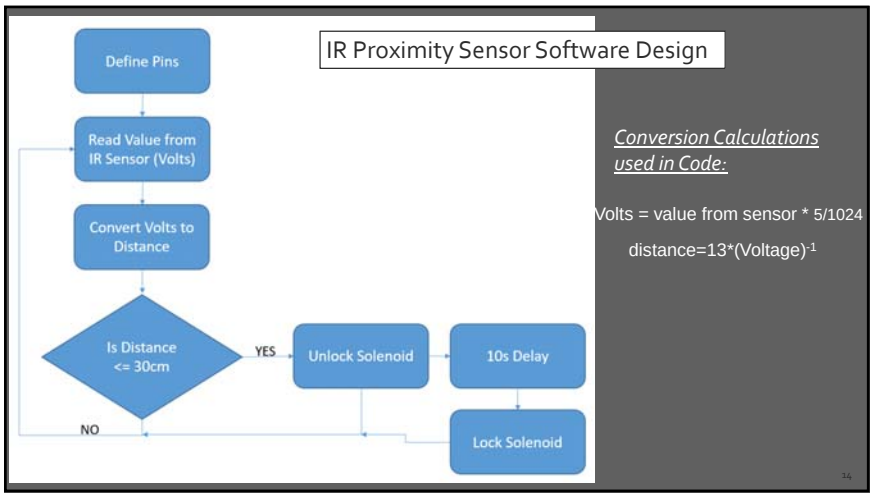
IR Proximity Sensor Software Design
Define Pins
Read Value from IR Sensor (Volts)
Convert Volts to Distance
Is Distance <= 30cm
YES
NO
Unlock Solenoid
10s Delay
Lock Solenoid
Conversion Calculations used in Code:
Volts = value from sensor * 5/1024
distance=13*(Voltage)-1
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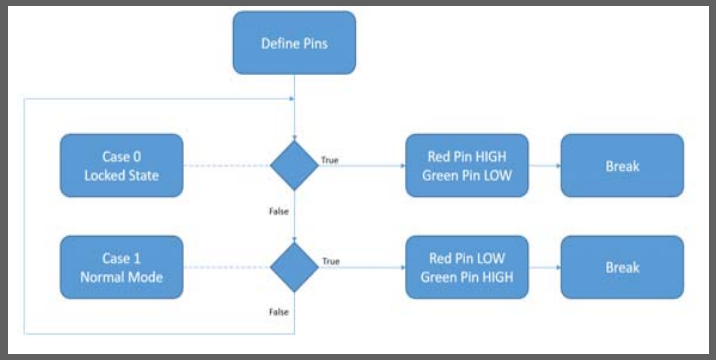
User Interface Software Design



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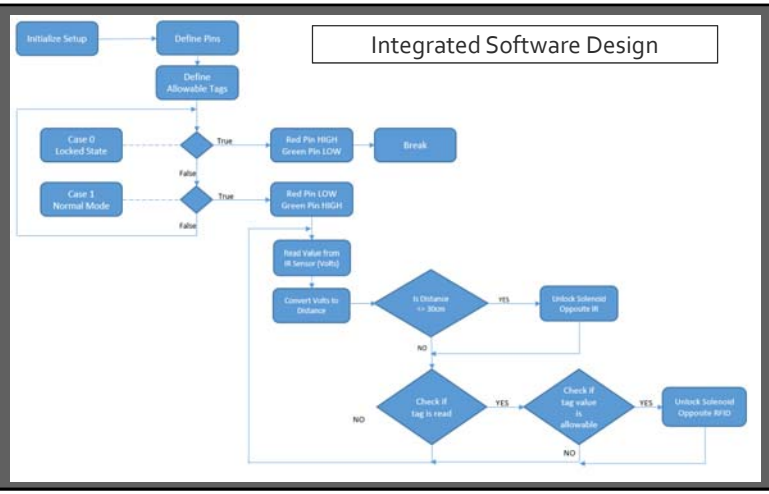
Integrated Software Design



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TIME MANAGEMENT

Planned Schedule: 20 weeks/200hours
Start: mid July
Finish: mid November

Executed Schedule: 12 weeks/138hours
Start: mid September
Finish: December 6

Smart Pet Door

LEVEL	WBS ID	WBS Description	Estimated Hours	Actual Hours
1	0	Smart Pet Door	200	138
2	1.0	Development	175	128
3	1.1	Research	60	40
4	1.1.1	RFID technology	20	
4	1.1.2	Arduino microcontroller coding	25	
4	1.1.3	Research for additional sensors	15	
3	1.2	Design System	35	40
4	1.2.1	Schematic Development	10	
4	1.2.2	Develop finalized parts list	10	
	1.2.3	Coding for Microcontroller	15	
3	1.3	Construct Prototype	40	20
4	1.3.1	Build Antenna	15	
4	1.3.2	Integrate RFID reader to microcontroller	5	
4	1.3.3	Integrate technology to Pet Door	20	
3	1.4	Testing	40	20
4	1.4.1	Test Antenna & RFID Reader	10	
4	1.4.2	Test Microcontroller Logic	10	
4	1.4.3	Environmental testing	10	
4	1.4.4	Test finished operation	10	
2	2.0	Report	13	10
3	2.1	White Final Report	13	10
4	2.1.1	Overview/Introduction	3	
4	2.1.2	Technical/Design	5	
4	2.1.3	Findings/Test Data/ Conclusion	5	
2	3.0	Presentation	12	8
3	3.1	Prepare Presentation	12	8
4	3.1.1	Overview/Introduction	2	
4	3.1.2	Technical/Design	5	
4	3.1.3	Findings/Test Data/ Conclusion	5	

COST BREAKDOWN

Estimated Material/Tool Cost

Item	Qty	Cost Each	Total Cost	Comments
Microcontroller Kit	1	$ 50.00	$ 50.00	Arduino Uno, LCD, Keypad
RFID Antenna	1	$ 80.00	$ 80.00	
RFID Tags	4	$ 2.00	$ 8.00	
Pet Door	1	$ 20.00	$ 20.00	May end up making pet door
Proximity Sensor	2	$ 15.00	$ 30.00	
Solenoid Locks	4	$ 10.00	$ 40.00	
Power Supply	1	$ 20.00	$ 20.00	
Magnet Wire	1	$ 10.00	$ 10.00	
Misc. Components (resistors, etc.)	1	$ 50.00	$ 50.00	
Misc. Hardware (nuts, bolts, etc.)	1	$ 20.00	$ 20.00	
Misc. Tools	1	$ 122.00	$ 122.00	
		Material Total	$ 450.00	

$1,821.00

$79.99

Market Comparison

Actual Material/Tool Cost

Description	Cost
(5pcs) Plastic Electronics Case	$ 6.99
(30pcs) Double sided PCB Prototype Boards	$ 10.99
AC adapter 12V Power Supply	$ 7.99
1N4004 diode (250pcs)	$ 7.99
Soldering Iron Kit	$ 25.99
Rubber Sheet (Door Material)	$ 3.50
Resitor kit	$ 10.86
(5pcs) MCP23017 port expander	$ 23.95
22guage Solid wire	$ 20.50
(2pcs) Hall Effect Sensor	$ 5.99
(4) 12V Solenoid Cabinet Locks	$ 12.99
UNO R3 Complete Starter Kit (includes, microcontroller, RFID module, tags, user interface items, resistors, etc)	$ 52.99
wood/hardware for door	$ 18.73
(3pcs) TIP120 darlington transistor+shipping	$ 11.50
SHARP IR Sensor + Shipping	$ 17.26
UART RFID Module (second module)	$ 12.50
Additional Tags (5pcs)	$ 2.50
Expedited shipping	$ 21.33
Second SHARP IR Sensor + Expedited shipping (replacement for damaged sensor)	$ 39.26
Total Cost	$313.81
Estimated Cost	$450.00
Under Budget	$136.19

Requirement Data			Verification Planning		
ID	Requirement Typ	Requirement (Shall or Should statements)	Verification Method	Date Verifi	Verification Repor
1	Environmental	Outdoor circuitry (antenna) Shall operate in a temp range of -25ºC to 45ºC	Test		FAIL / Not Tested
2	Environmental	Outdoor circuitry Should operate in a temp range of -40ºC to 60ºC	Test		FAIL / Not Tested
3	Environmental	Antenna should be water resistant	Test		FAIL / Not Tested
4	Functional	RFID sensor shall read RFID tag	Test	26-Nov-17	PASS
5	Functional	Infrared Proximity Sensor shall be used to sense the proximity of the pet	Inspection	26-Nov-17	PASS
6	Functional	Infrared Proximity Sensor shall unlock door from inside to let pet out	Test	26-Nov-17	PASS
~~7~~	~~Functional~~	~~Hall Effect Sensor shall sense when door is in closed position~~	~~Test~~		Removed From Design
8	Functional	There should be a 'lock' setting that will not let ANY pets in or out	Test	26-Nov-17	PASS
9	Functional	There should be an "unlock" setting to return to normal operating mode	Test	26-Nov-17	PASS
~~10~~	~~Functional~~	~~When RFID read on LCD display, prompt user to store tag (yes/no)~~	~~Demonstration~~		Removed From Design
11	Operational	Shall independently sense pet(s) on either side of the door	Demonstration	26-Nov-17	PASS
~~12~~	~~Operational~~	~~User shall be able to enter a list of allowable RFID codes~~	~~Demonstration~~		Removed From Design
~~13~~	~~Operational~~	~~an audible beep shall be generated when RFID tag is read~~	~~Test~~	26-Nov-17	Solenoid Unlocking Sound to Replace Beep
14	Operational	door shall unlock when RFID tag is read	Test	26-Nov-17	PASS
15	Operational	The Pet Door Shall lock/unlock when sensing a pet near the door	Demonstration	26-Nov-17	PASS
16	Operational	door shall lock after pet is through the door and flap closes	Test	26-Nov-17	PASS
17	Performance	RFID sensor should read RFID tag on collar from a distance of at least 6 inches	Test	26-Nov-17	FAIL
18	Performance	Shall only open when sensing an RFID code pre-registered	Demonstration	26-Nov-17	PASS
19	Performance	Shall be able to register a minimum of 2 RFID codes	Demonstration	26-Nov-17	PASS
20	Physical	door opening shall be between 15 and 24 inches tall	Inspection	26-Nov-17	Pass
21	Physical	door opening shall be between 15 and 24 inches wide	Inspection	26-Nov-17	Pass
22	Physical	There shall be a user interface for user to edit list of allowable RFID codes	Inspection		Removed From Design
23	Physical	There shall be an LCD inside that will display RFID code when read	Inspection		Removed From Design
24	Physical	There shall be at least two buttons included on user interface	Inspection	26-Nov-17	Design Modified, One button used as two

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LESSONS LEARNED

- Spend more time on research in the beginning
  - Arduino Mega > Arduino UNO
  - RFID issues
- Time Management is KEY
  - Planned time ≠ Available time, Plan Accordingly
  - Expect the unexpected
- Start the project EARLY
  - Getting started takes longer than you think
  - It is difficult to catch up when you start out behind
  - issues may have been resolved if I started early and was able to put in more time
- Don't Take on too many new things at once
  - New to Arduino
  - RFID
  - Built physical door myself, no prior skills or knowledge

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Thank You!

Questions?

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Demo

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