

Undent Solutions

Vehicle Lock-Out Prevention System



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Outline

- ⦿ Introduction
- ⦿ Market, Existing Products and Motivation
- ⦿ System Overview
- ⦿ Budget and Timeline
- ⦿ Demo
- ⦿ Acknowledgements
- ⦿ Conclusion
- ⦿ Questions

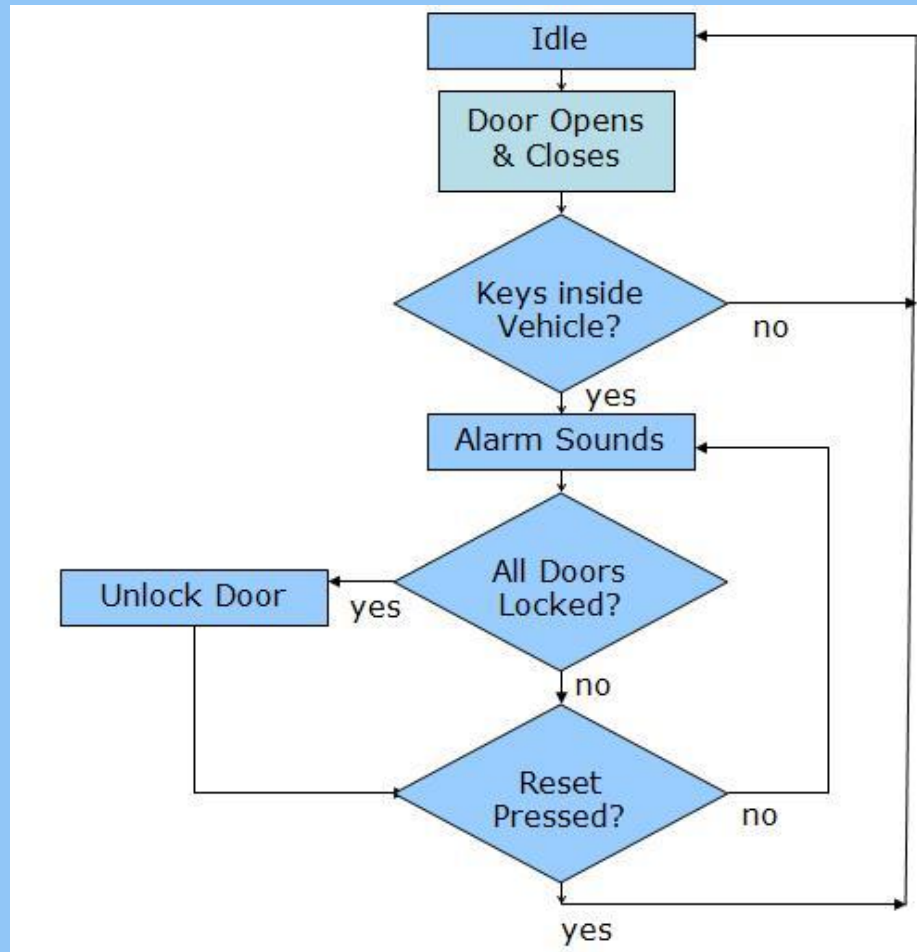
Video Presentation



Introduction

- ⦿ 546 people get locked out every hour [1]
- ⦿ Goal: Prevent vehicle lock-out
- ⦿ Three steps:
 - Sense key inside car
 - Alert user
 - Unlock door (if needed)

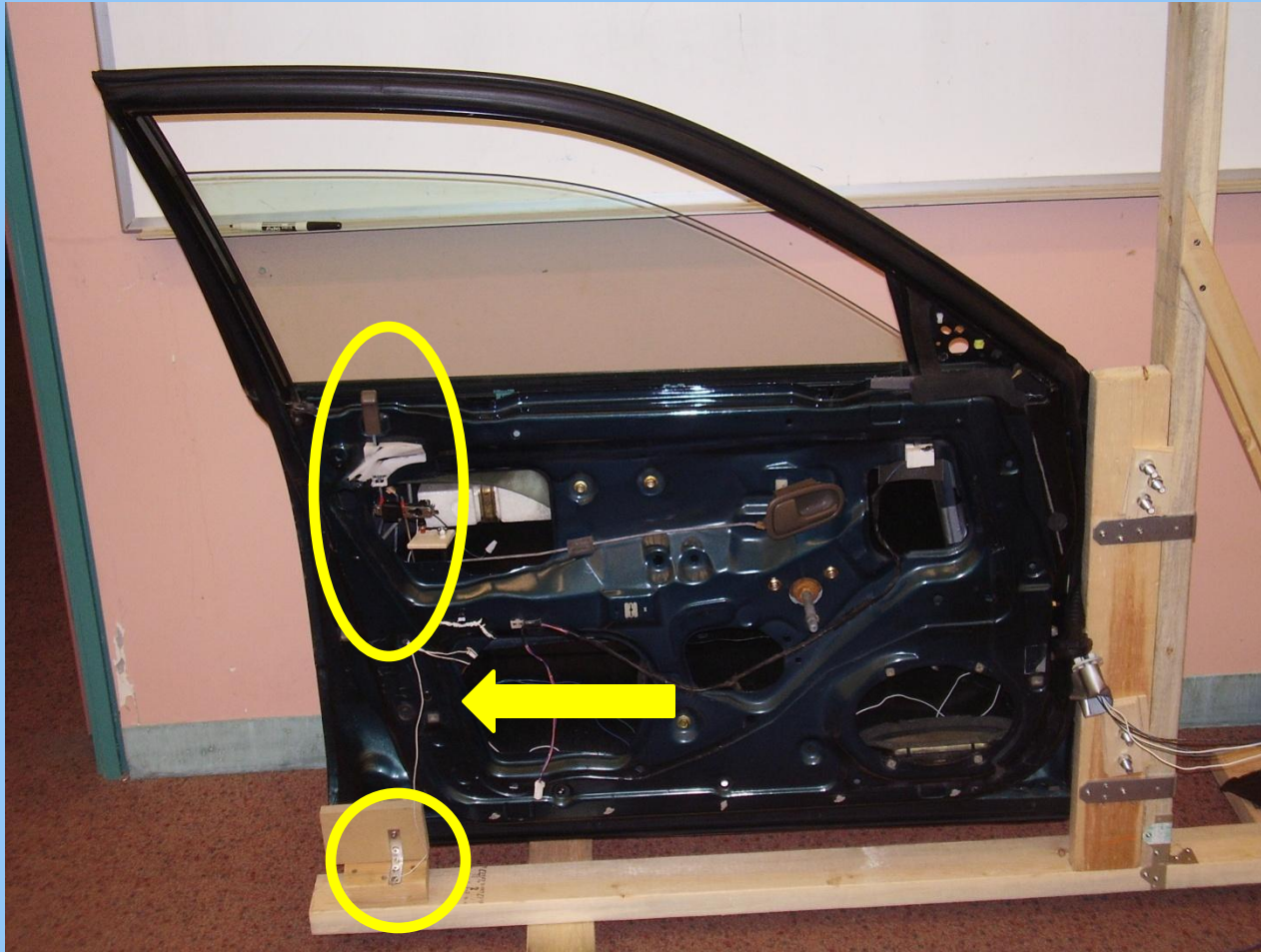
System flowchart



User Interface



Car door



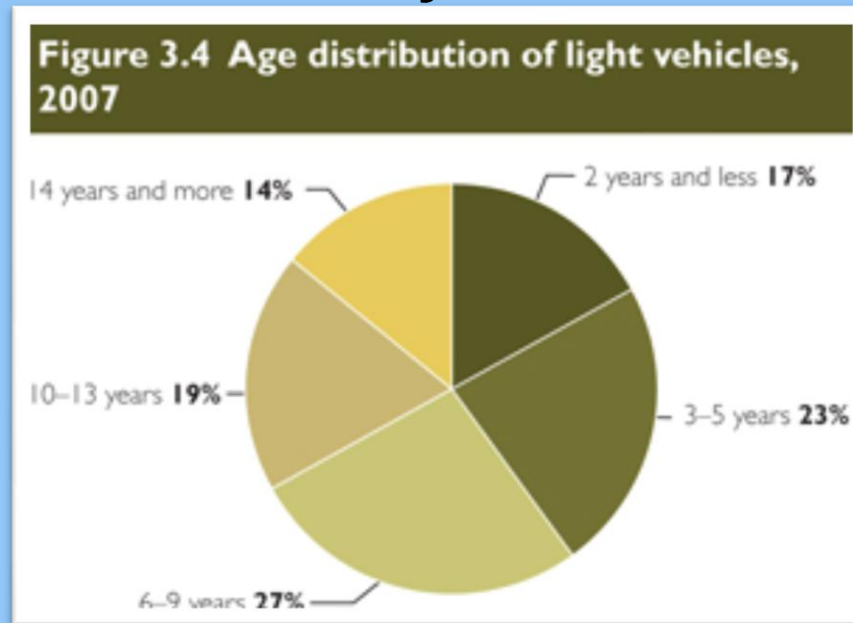
Market

◎ Target :

- Old model cars (manual key and lock)
- new model car (remote control power door lock but not remote keyless system)

Market

- Size of Market: Over 83% !!!
- Market Lifetime: 5 years



Age distribution of vehicles

(Reference: "Canadian Vehicle Survey 2007 Summary Report", *Natural Resources Canada*. [Online]. Available: <http://oee.nrcan.gc.ca/publications/statistics/cvs07/chapter3.cfm?attr=0> [Accessed: Apr 20, 2010].)

Existing Solutions

- ⦿ Metal rod
- ⦿ Calling a locksmith
- ⦿ Taplock finger tap keyless entry system [1]
- ⦿ OnStar Services [2]

Motivation

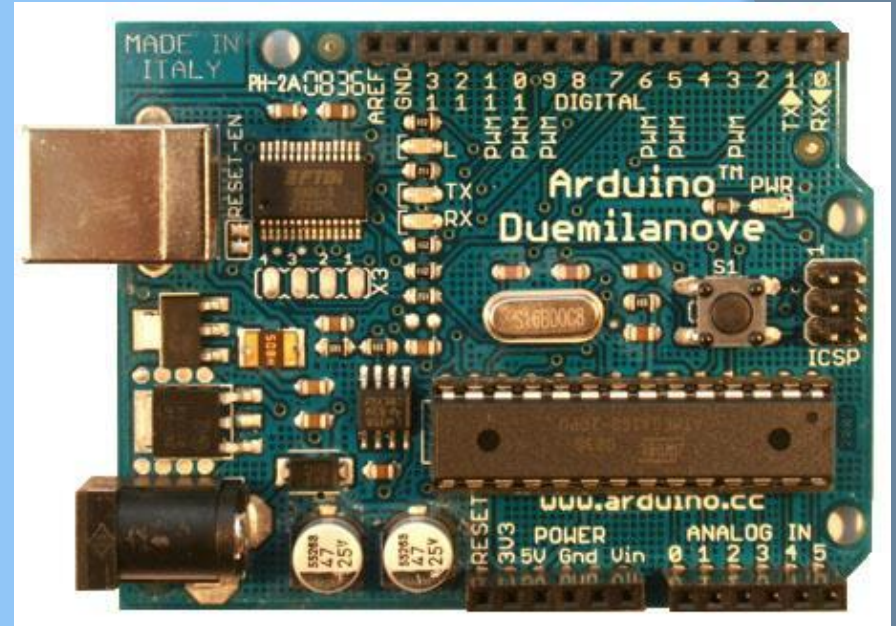
- ④ Design a vehicle lock out system which has the functionality of:
 - Saving time
 - Security
 - Low cost
 - Easy operation

System Overview

- ◎ Software
 - Microcontroller
 - RFID transceivers and tags
- ◎ Hardware
 - Unlocking mechanism
 - Sensors
 - Buzzer
 - Low battery circuit detector

Microcontroller Unit

- Arduino microcontroller board based on ATmega328
- Arduino software (C-like) programming
- Many examples online
- Active online community



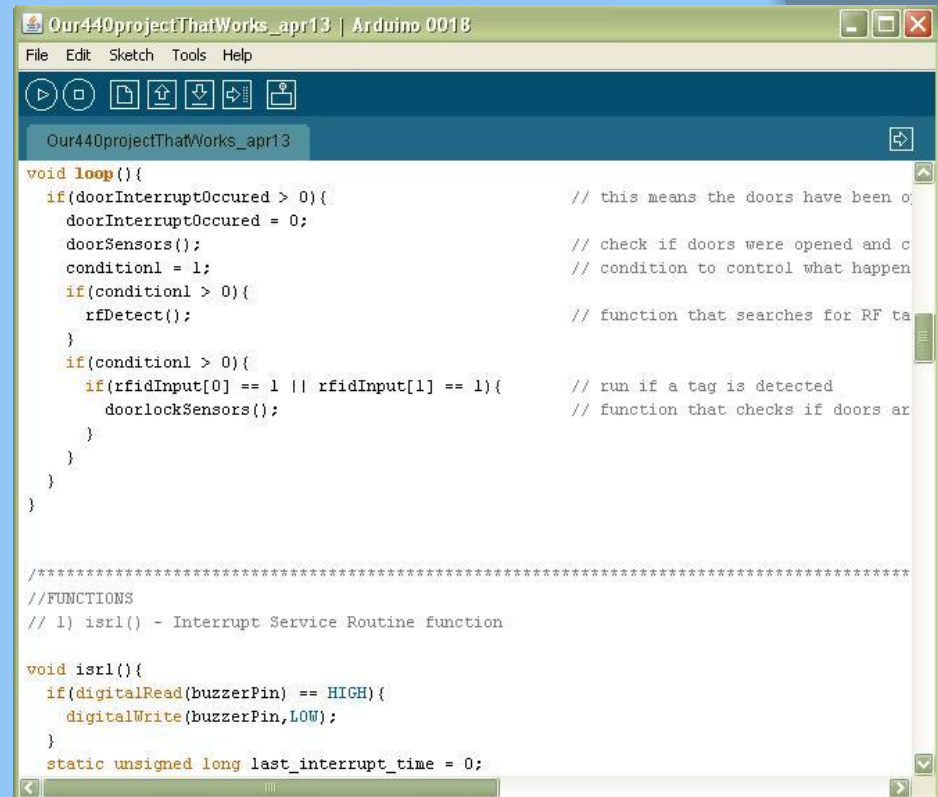
(Reference: Arduino, "Arduino Duemilanove", Feb. 5, 2010. [Online]. Available: <http://www.arduino.cc/en/Main/ArduinoBoardDuemilanove> [Accessed: Feb. 14, 2010].)

Microcontroller tasks

- ⦿ Status of door sensors
 - OR gate triggers interrupt
- ⦿ Powers up RFID transceivers
- ⦿ Listens to the transceivers
- ⦿ Sets buzzer off
- ⦿ Status of door lock sensors
- ⦿ Signals actuator
- ⦿ Software reset

Arduino Software

- ⦿ Include libraries
- ⦿ Declare variables and pin names
- ⦿ Setup() – assign inputs and outputs
- ⦿ Loop() – body of the code and keeps looping



The screenshot shows the Arduino IDE interface with a sketch titled "Our440projectThatWorks_apr13 | Arduino 0018". The code is written in C++ and includes comments explaining the logic. The main loop checks for door interrupts, sets conditions, and calls functions like `rfDetect()` and `doorlockSensors()`. A function `isr1()` is also defined, which checks the state of a buzzer pin and sets a static variable `last_interrupt_time` to 0.

```
void loop(){
  if(doorInterruptOccurred > 0){
    doorInterruptOccurred = 0;
    doorSensors();
    condition1 = 1;
    if(condition1 > 0){
      rfDetect();
    }
    if(condition1 > 0){
      if(rfidInput[0] == 1 || rfidInput[1] == 1){
        doorlockSensors();
      }
    }
  }
}

//*****
//FUNCTIONS
// 1) isr1() - Interrupt Service Routine function

void isr1(){
  if(digitalRead(buzzerPin) == HIGH){
    digitalWrite(buzzerPin, LOW);
  }
  static unsigned long last_interrupt_time = 0;
```

Arduino functions

- ⦿ `isr1()`
- ⦿ `doorSensors()`
- ⦿ `unlocking()`
- ⦿ `rfDetect()`
- ⦿ `doorLockSensors()`

Programming Issues

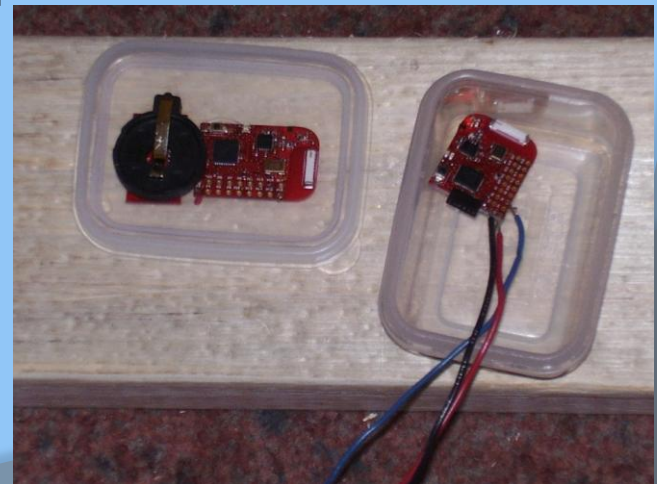
- ⦿ Bouncy signals
- ⦿ Solution:
 - Debounce by adding delays and checking conditions
 - Filter out noise by adding capacitors

RFID transceivers and tags

- ⦿ Texas Instruments eZ430-RF2500
- ⦿ IAR Embedded Workbench
- ⦿ C++ coding
- ⦿ MSP430F2274 – MCU chip
- ⦿ CC2500 – radio chip

RFID transceivers and tags coding

- ◎ Transceivers – Access Point
 - One front and one back transceiver
 - Receives signal strength from tag
- ◎ Tags – End Device
 - Connects to one transceiver



Unlocking mechanism

- ⦿ Only used when all doors locked
- ⦿ Power door-lock actuator
- ⦿ Controlled by H-bridge



Sensors

⦿ Car door sensors

- Push buttons
- Purpose: Checks if door is open or closed
- Placement: Door frames

⦿ Car lock sensors

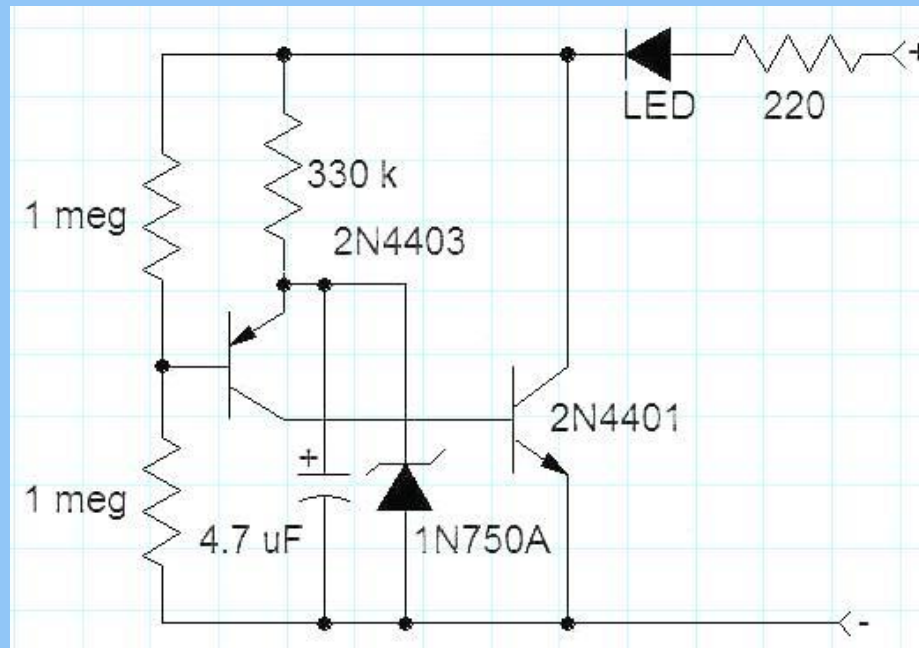
- Push buttons
- Purpose: Check if door is locked
- Placement: Clamped around unlocking mechanism

Buzzer

- ⦿ Send an audio signal to user when key is detected inside the car
- ⦿ Turns off:
 - reset button pressed
 - door opened
- ⦿ Not to exceed 85 dBA

Low battery circuit detector

- ⦿ Checks for battery level $< 5V$
- ⦿ Connected to MCU power



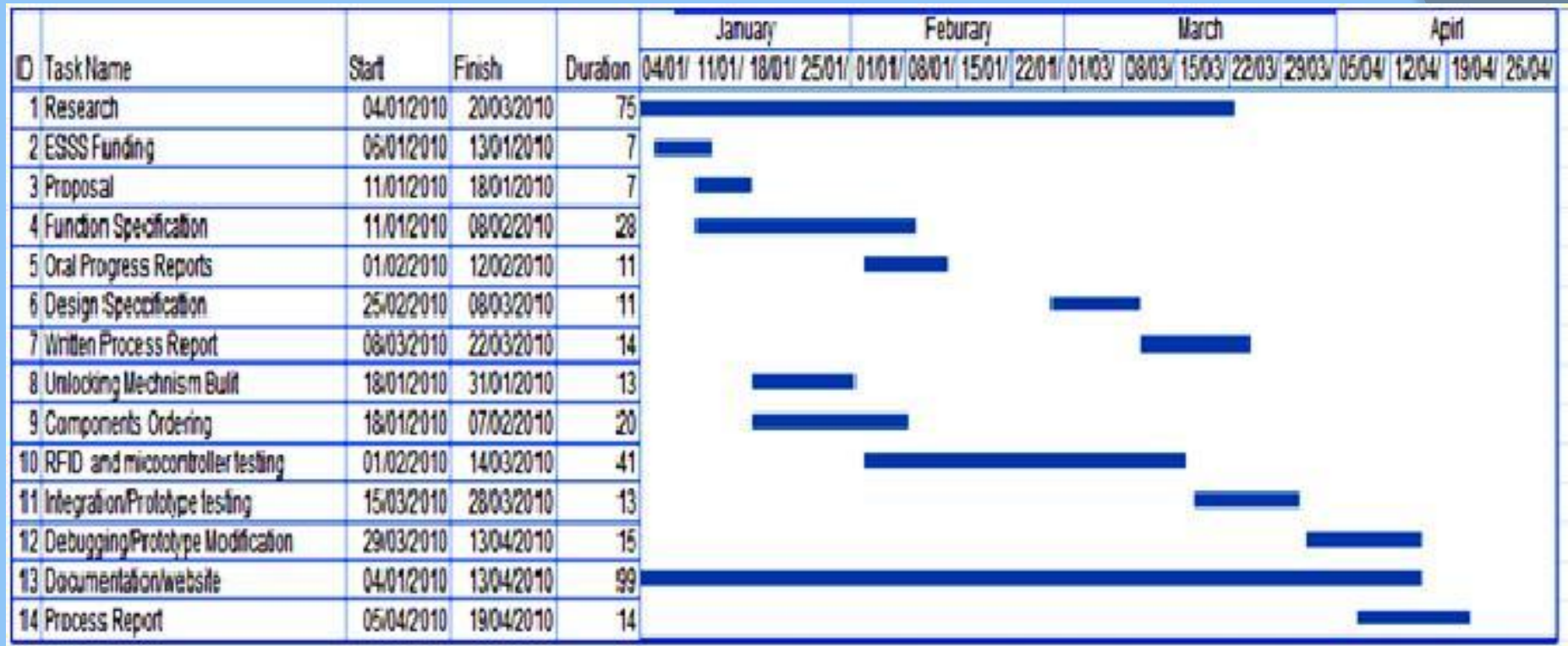
(Reference: Charles Wenzel, "Flasher Circuits", [Online]. Available: <http://www.techlib.com/electronics/flasher.html> [Accessed: Apr 10, 2010].)

Budget

Component	Estimated Costs	Actual Costs
Microcontroller	\$12	\$37
RFID transceiver	\$518	\$57
RFID tags	\$6	\$50
RFID USB debugger	-	Borrowed
Actuator	\$15	\$30
Car door	\$50	\$20
Car lock	-	\$0
Miscellaneous	\$10	\$151
Total	\$611	\$345

- Actual system unit cost: **\$227**
- UNDER BUDGET 😊

Timeline



● ON TIME 😊

Demo

⦿ **Case 1: Driver leaves car**

- Keys inside the car
- Main door opened+locked+closed
- Output:
 - Buzzer goes off within 5 sec
 - Main door unlocks almost immediately

⦿ **Case 2: Driver enters car**

- Keys inside the car
- Door opened+closed and user hits reset
- Output:
 - Nothing if reset was pressed before buzzer

Demo

⦿ **Case 3: Driver & passengers exit car**

- Keys outside the car
- Main door opened
- Secondary door opened
- Main door closed
- Secondary door closed
- Output:
 - Nothing since keys are out of range

Demo

⦿ Case 4: Delayed door locking

- Keys inside the car
- Secondary door opened+closed
- Door locked automatically after 1min
- Output:
 - Buzzer goes off within 5 sec
 - Main door unlocks the moment all doors lock

Demo

⦿ **Case 5: Driver leaves passenger in car**

- Keys inside the car
- Main door opened+closed
- Secondary door unlocked
- Output:
 - Buzzer goes off within 5sec
 - Buzzer turns off when main door opens

Demo

⦿ **Case 6: Keys in the back**

- Keys left on the backseat
- Output:
 - The rear transceiver should detect the tag

⦿ **Case 7: Someone else's keys**

- Unauthorized tag inside the car
- Output:
 - Nothing should happen

Demo

⦿ **Case 8: Low battery tag**

- Tag low on battery
- Output:
 - Red LED flashes

⦿ **Case 9: Low battery MCU**

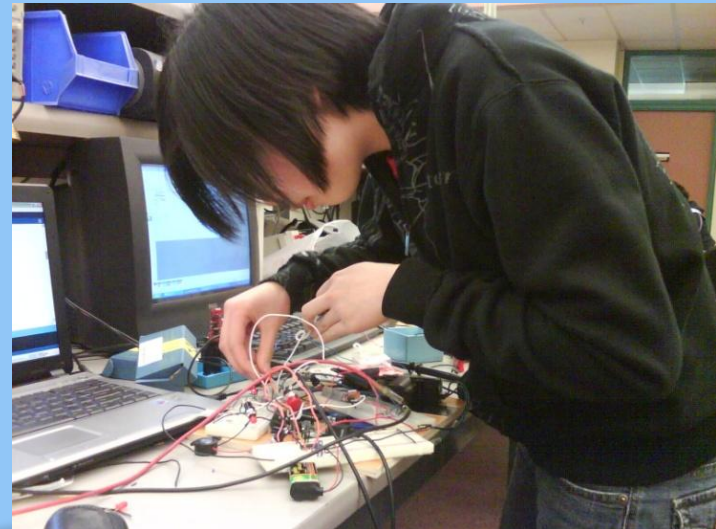
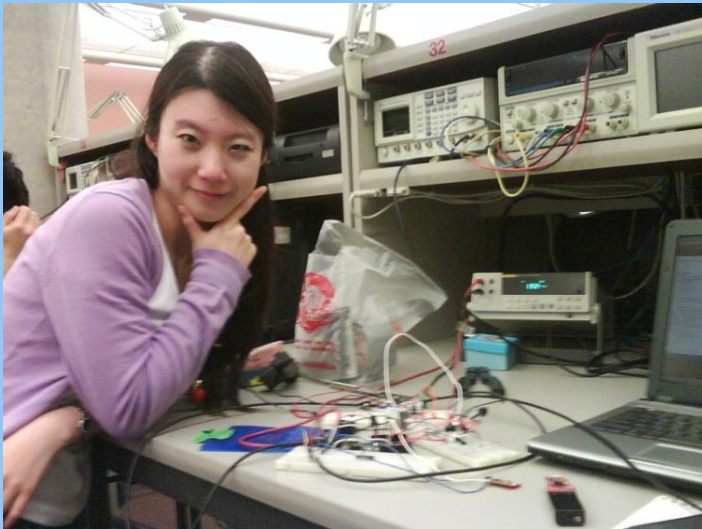
- Microcontroller unit low on battery
- Output:
 - Red LED starts flashing

Acknowledgements

- Priyanka, Surbhi, Rachel and Anna of **Mnemosyne Innovations** (RFID transceiver and tags)
- Ron (Car door)
- Vic Kuang (Car lock)
- Henry Ip (MCU advice)

Conclusion

- ⦿ Vehicle Lock-Out Prevention System solution
- ⦿ VLOPS components
- ⦿ Budget and project timeline
- ⦿ Product Demonstration



References

- [1] Wolfcom Innovations, “TAPLOCK Finger Tap Keyless Entry System”, Aug. 14, 2009. [Online]. Available: <http://www.taplock.com/> [Accessed: Jan. 15, 2010].
- [2] Barbara and David Mikkelsen, “Remote Possibility”, July 7, 2004. [Online]. Available: <http://www.snopes.com/autos/techno/keyless.asp> [Accessed: Jan. 16, 2010].



Questions??

