Smart Mirror

Group K

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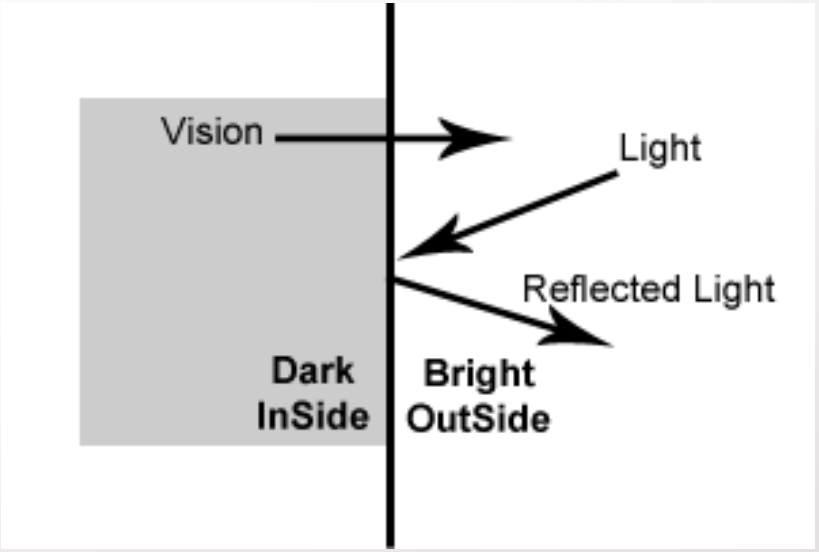
Motivation

- Seamless integration of technology into people's daily lives
- Smart Home technology is a blooming new field
  - Google Home (Nest)
  - Amazon Echo
  - Windows 10 IoT
- Extend the idea of a 'Digital Assistant' to a room people use every morning

What Is It

- One-Way Mirror in front of large display
- White/Light-colored pixels bleed through mirror
- Dark pixels appear off and mirror reflects



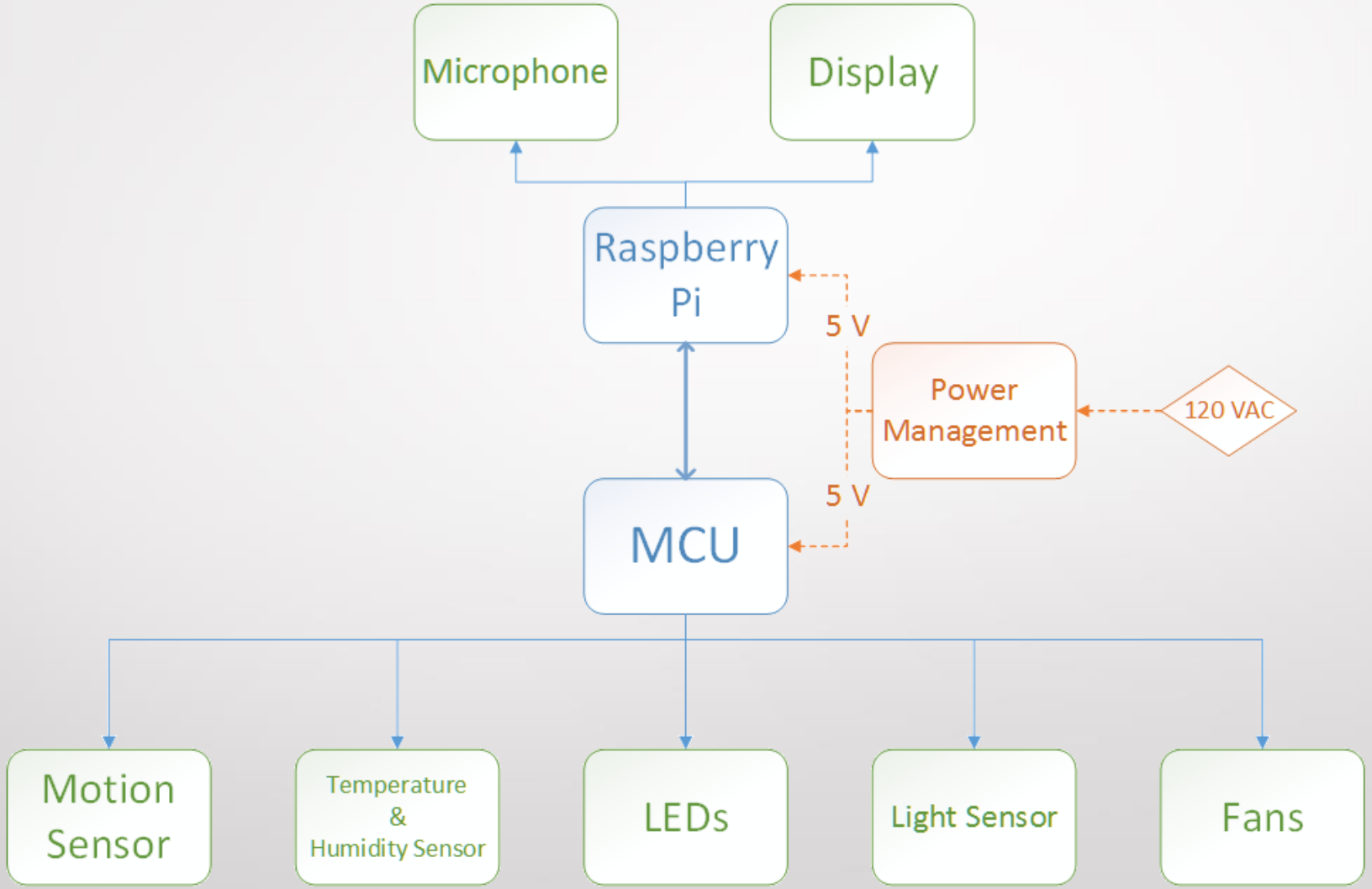
Goals and Objectives

- Quality of Life improvement in the mornings
- Provide users with information they utilize regularly
- Implement a convenient user interface
  - Voice Commands
  - Limited Gesture Control

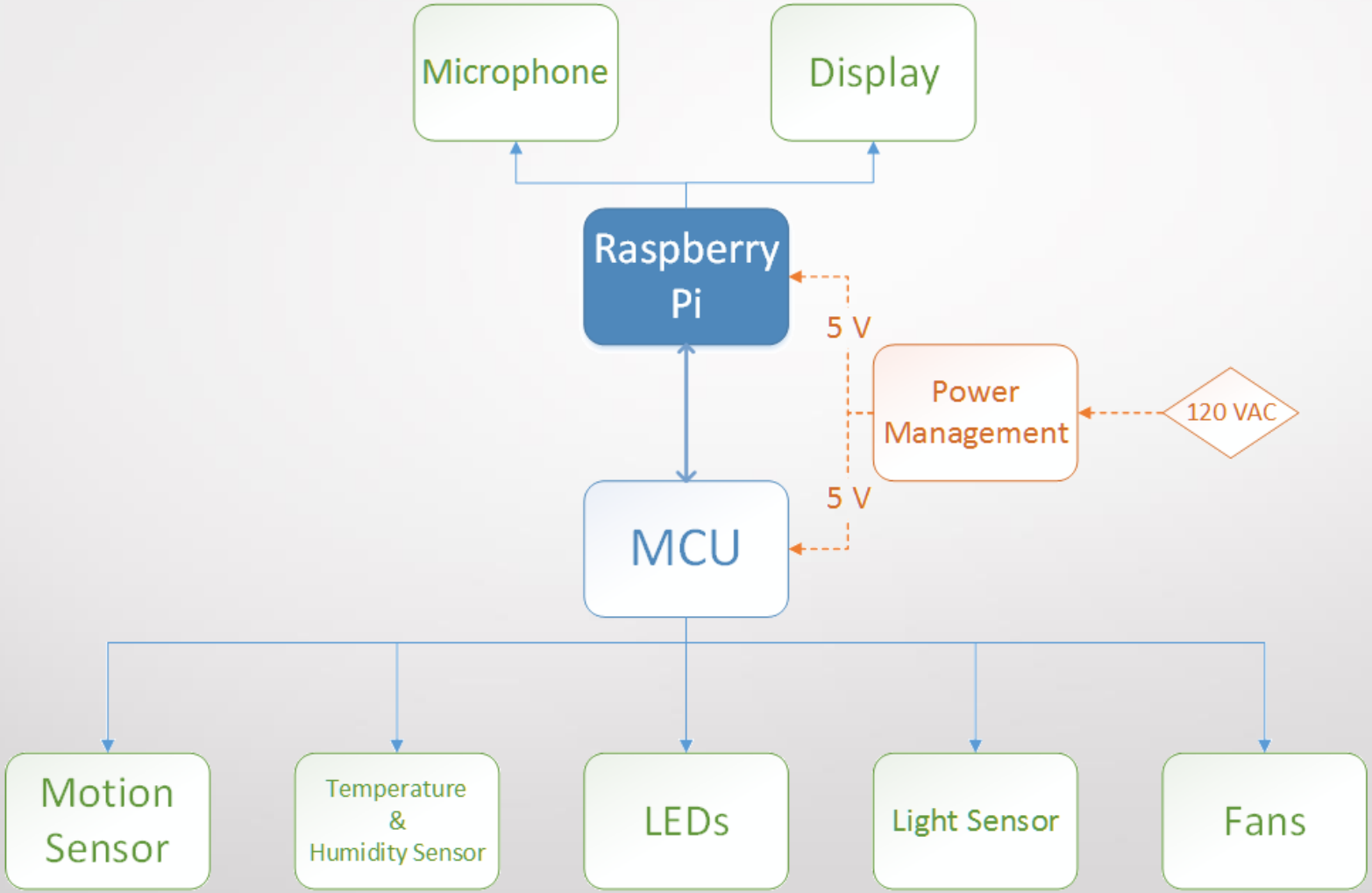
Specifications

Voice Recognition Range	Up to 5 Feet
Voice Recognition Success Rate	>80%
Display Auto-Off	After 2 Minutes of No Motion Detection
Temperature Sensor Accuracy	+/- 1 °C error
Humidity Sensor Accuracy	+/- 2.5% error
Motion Detection Distance	5 Feet
Gesture Recognition Success Rate	>90%

Overall Hardware Diagram

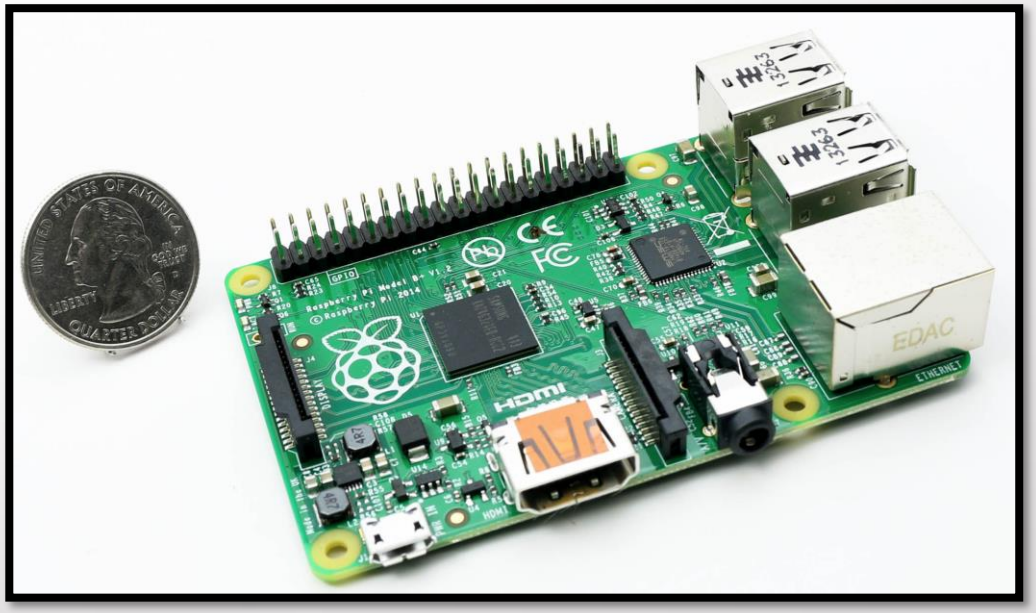


Raspberry Pi



Raspberry Pi 2

Raspberry Pi 2 Model B	
CPU	Broadcom Quad-Core ARM7 900MHz
Memory	1GB SDRAM
Storage	8GB microSD
Power Supply	5V microUSB
Wi-Fi Module	802.11b/g/n
Video	HDMI 1.4
Audio	3.5mm Audio Port
USB	4x USB 2.0
GPIO	40 pin extended GPIO
OS	Windows 10 – IoT Core



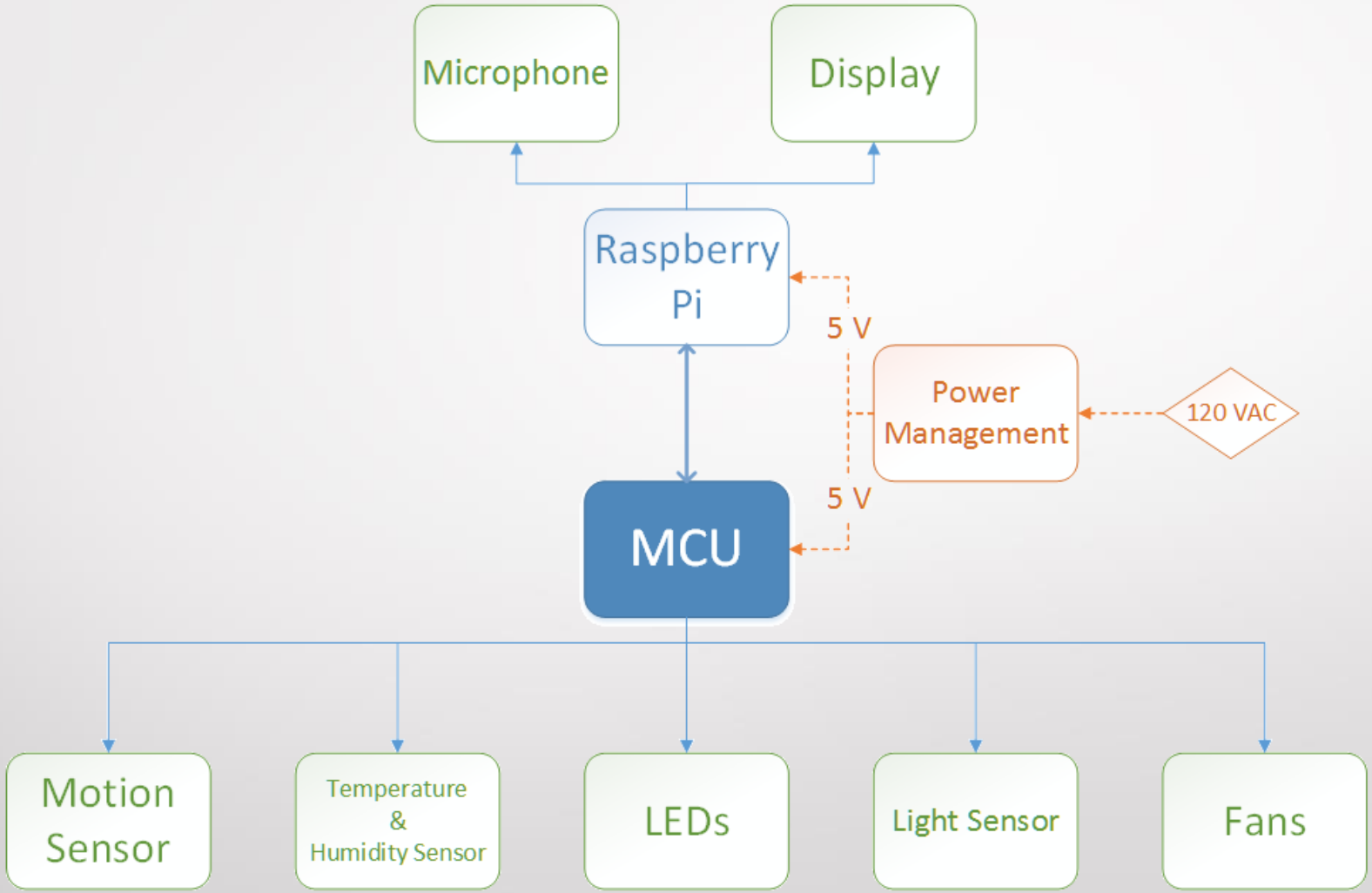
Price: $35

Size: 86mm x 57mm

Raspberry Pi vs Minnowboard

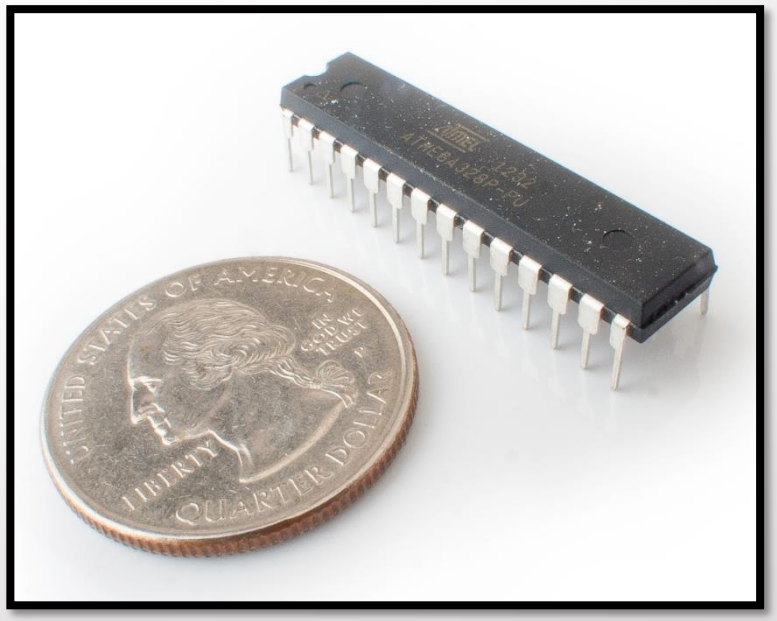
- Minnowboard MAX
  - Higher cost
    - $139
  - More powerful
    - Doesn’t meet requirements for Microsoft Kinect

MCU

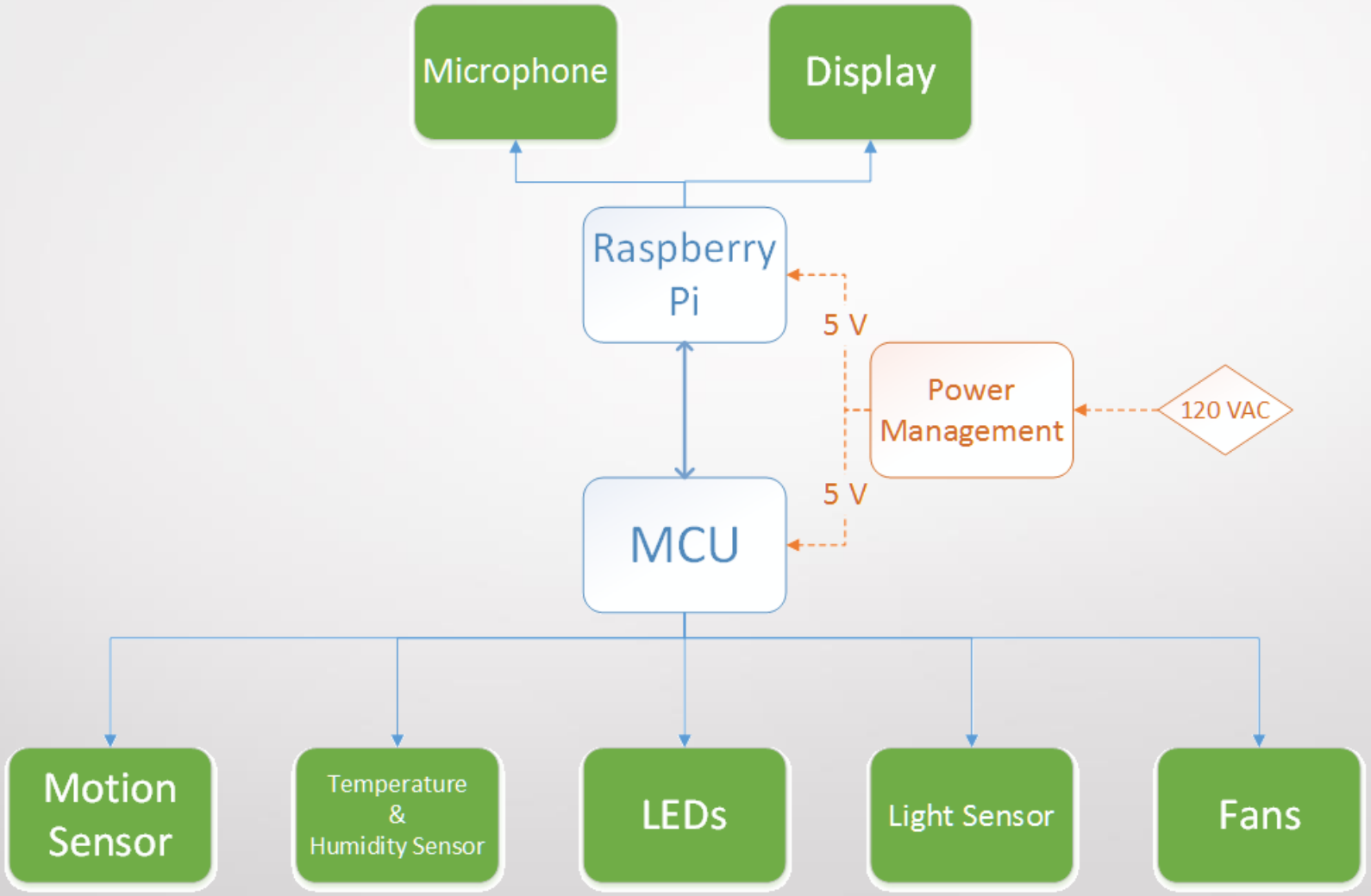

Microphone
Display
Raspberry Pi
5 V
Power Management
120 VAC
5 V
MCU
Motion Sensor
Temperature & Humidity Sensor
LEDs
Light Sensor
Fans

MCU Specs

Parameter	ATmega328-PU	MSP430
Operating Voltage	1.8 to 5.5 V	1.8 to 3.6 V
Operating Temperature	-40 to 80 C	-40 to 85 C
EEPROM	1 KB	-
SRAM	2 KB	512 B
Digital Pins	14	6
Analog Pins	6	8
Clock Speed	16 MHz	16 MHz
Price of Development Board	$9.99	$19.81



Sensors


Microphone
Display
Raspberry Pi
5 V
Power Management
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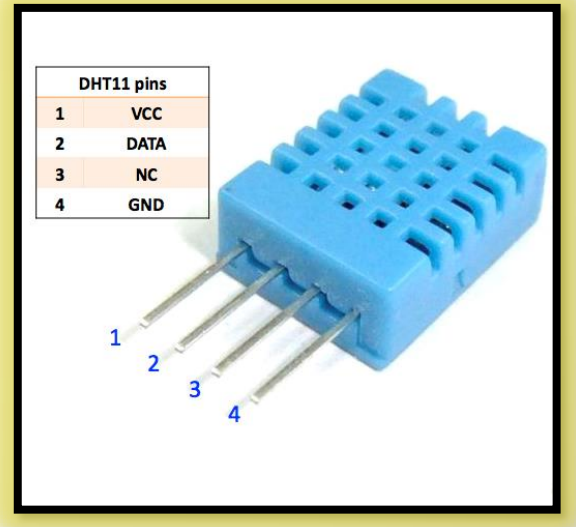
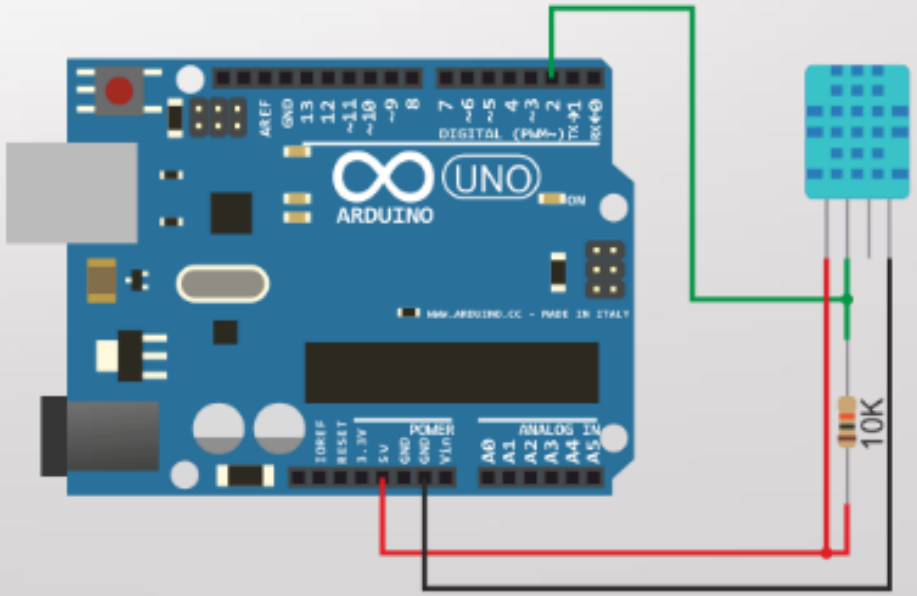
5 V
MCU
Motion Sensor
Temperature & Humidity Sensor
LEDs
Light Sensor
Fans

Temperature & Humidity Sensor Specs

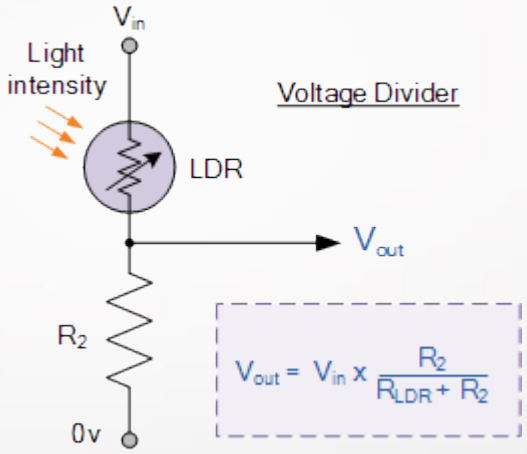
Parameter	TMP 36	DHT11
Voltage Supply	2.7 to 5.5 V	3 to 5.5 V
Current Supply	<50 µA	0.5 mA
Humidity Temperature Range	N/A	20 to 95%
Operating Temperature Range	-55 to 150C	0 to 50C
Accuracy (Humidity)	N/A	+/- 5% RH
Accuracy (Temperature)	+/-2C	+/-2C
High Chemical Resistance	N/A	low
Hysteresis	N/A	+/-1.0 % Rh
Response Time	N/A	6 s
Price	$3.79	$1.75

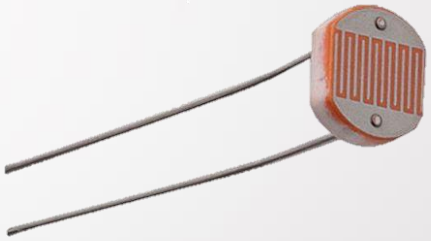


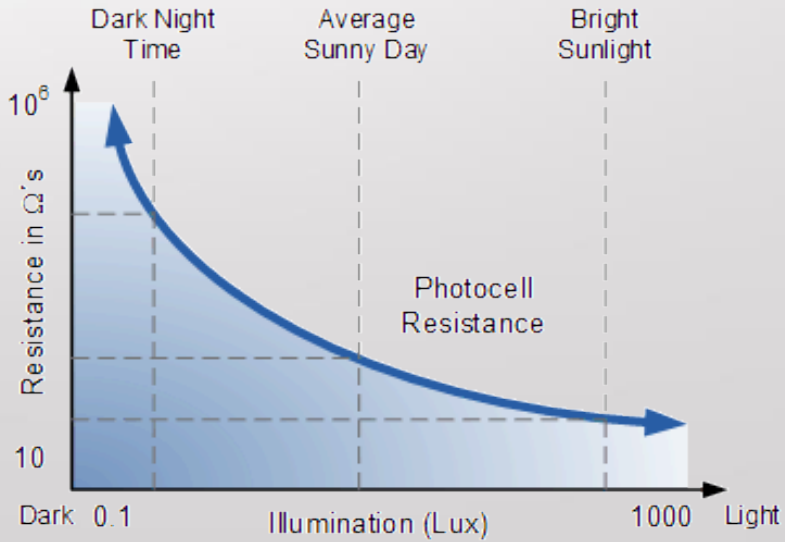


Light Sensor Specs

- Converts light energy into an electrical signal output
- A piece of exposed semiconductor changes its electrical resistance

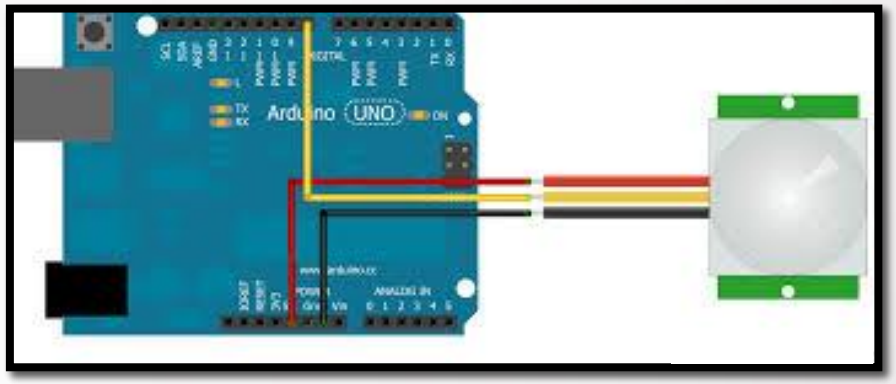


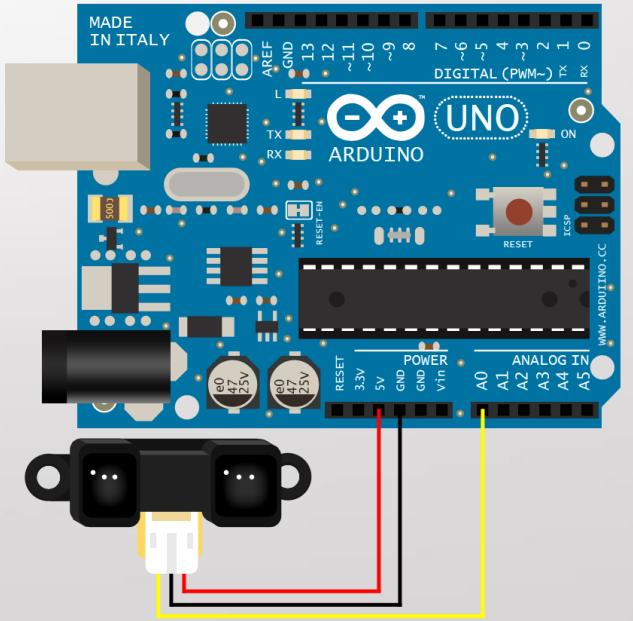




Long Range Motion Sensor Specs

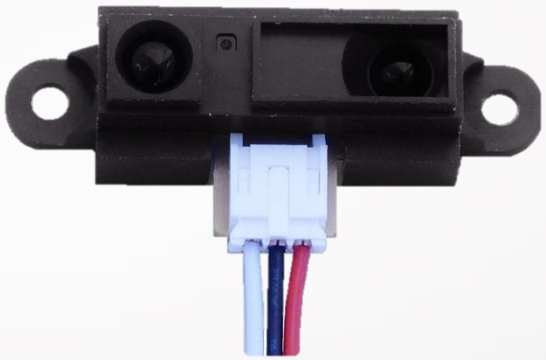
Parameter	HC- SR501	GP2Y0A02YK0F
Voltage Supply	5 to 20 V	4.5 to 5.5V
Current Supply	65 mA	33 mA
Output type	Digital	Analog
Output Voltage	3.3V	-0.3 to 5.7V
Maximum Sensing Distance	7m	150 cm
Operating Temperature	-15 to 70 C	-10 to 60 C
Price	$1.80	$12.95

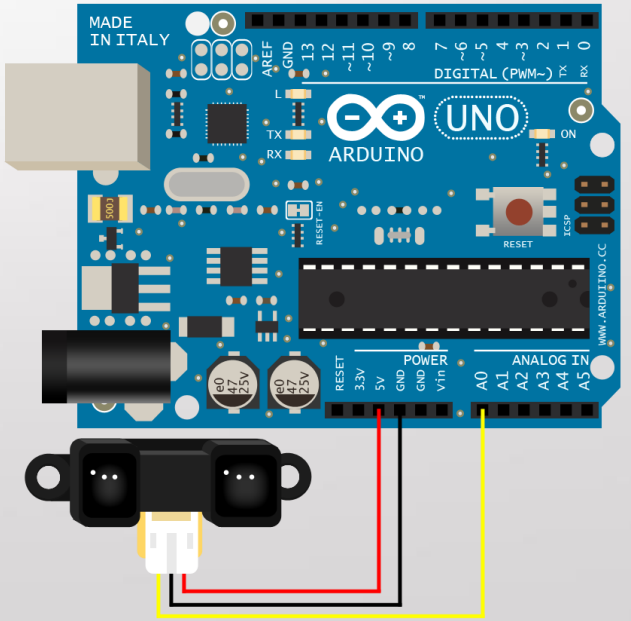




Short Range Motion Sensor Specs

Parameter	GP2Y0A02YK0F
Voltage Supply	-0.3 to 7 V
Power Consumption	40 mA
Output type	Analog
Output Voltage	+/- 0.3 VCC
Maximum Sensing Distance	80cm
Operating Temperature	-10 to 60 C
Price	$9.90

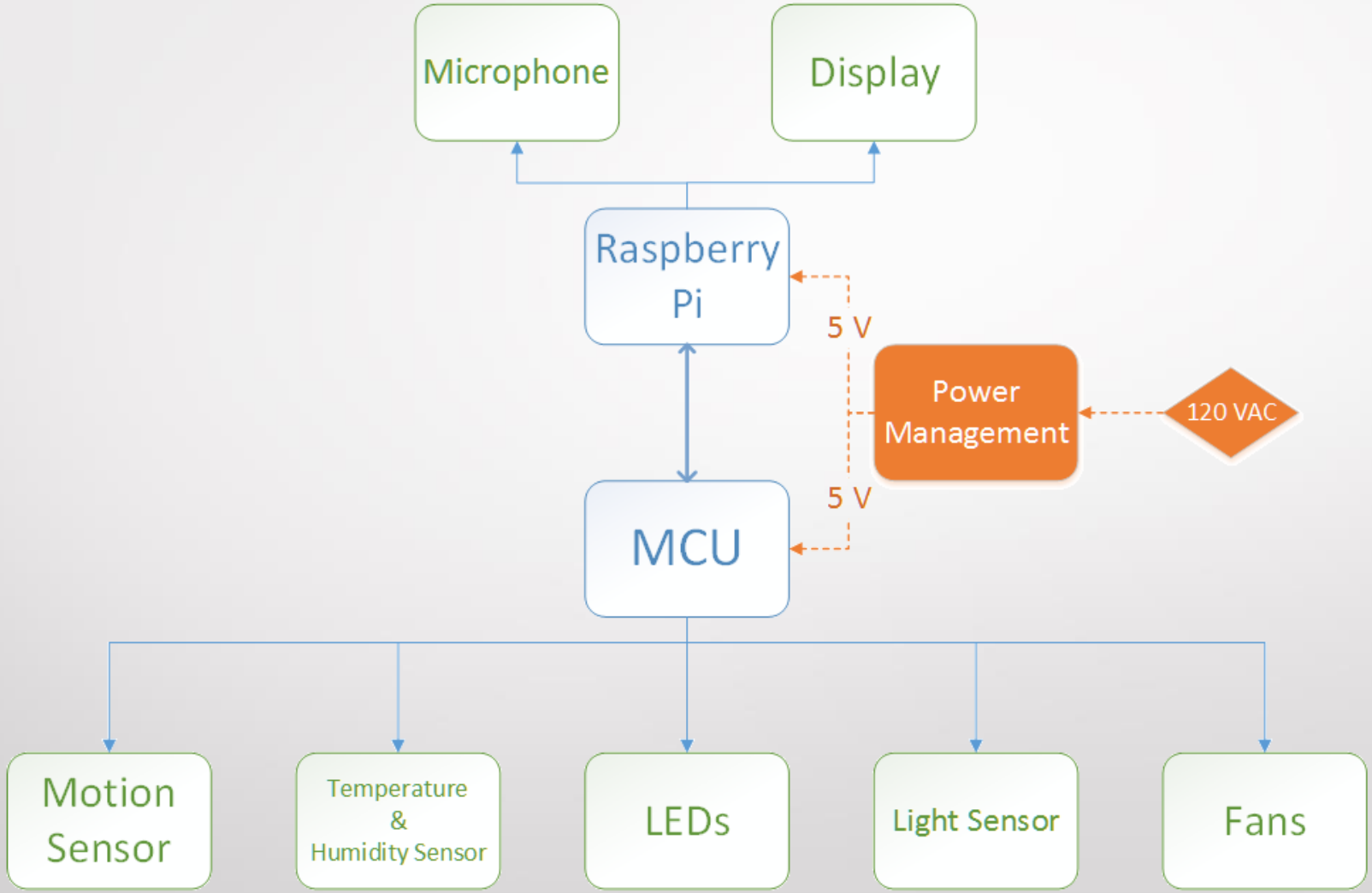




Other Hardware

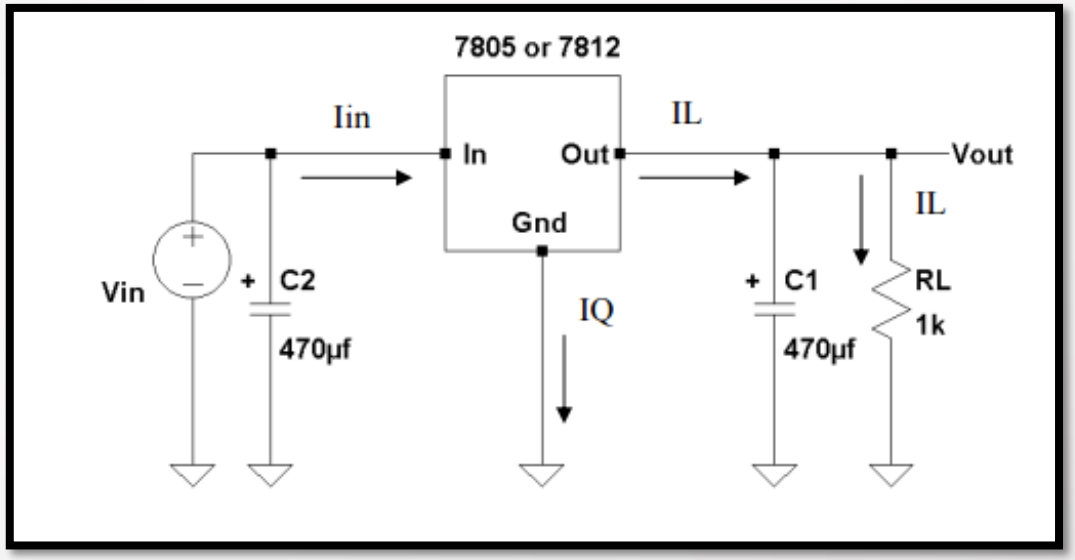
- Display Device
  - 32-inch television behind one-way mirror as earlier discussed
- Speakers
  - External speakers via 3.5mm audio out from Raspberry Pi
  - Internal speakers are present, pending update from Microsoft for audio over HDMI
- Microphone
  - Webcam mic – Logitech C920 Pro
- 3W LED on top of mirror for low-light scenarios

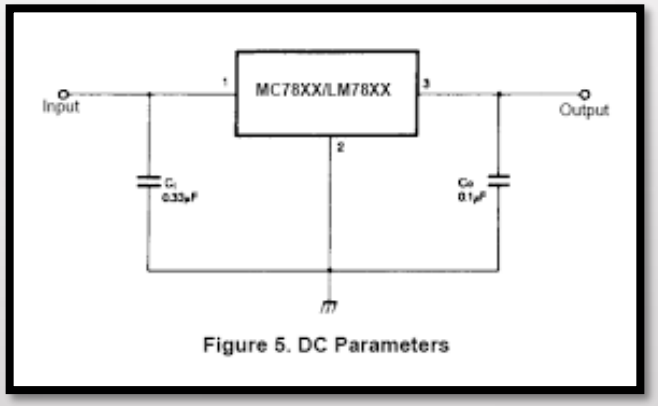
Power Control

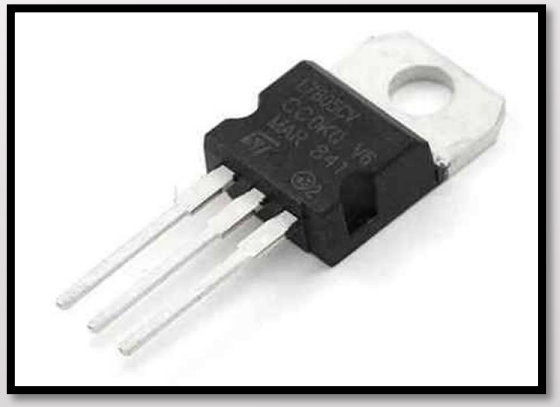


Linear Voltage Regulator

- Same as the ones used in Experiment #3 from EEL 4309 – Electronics II
- 12 V
- 5 V

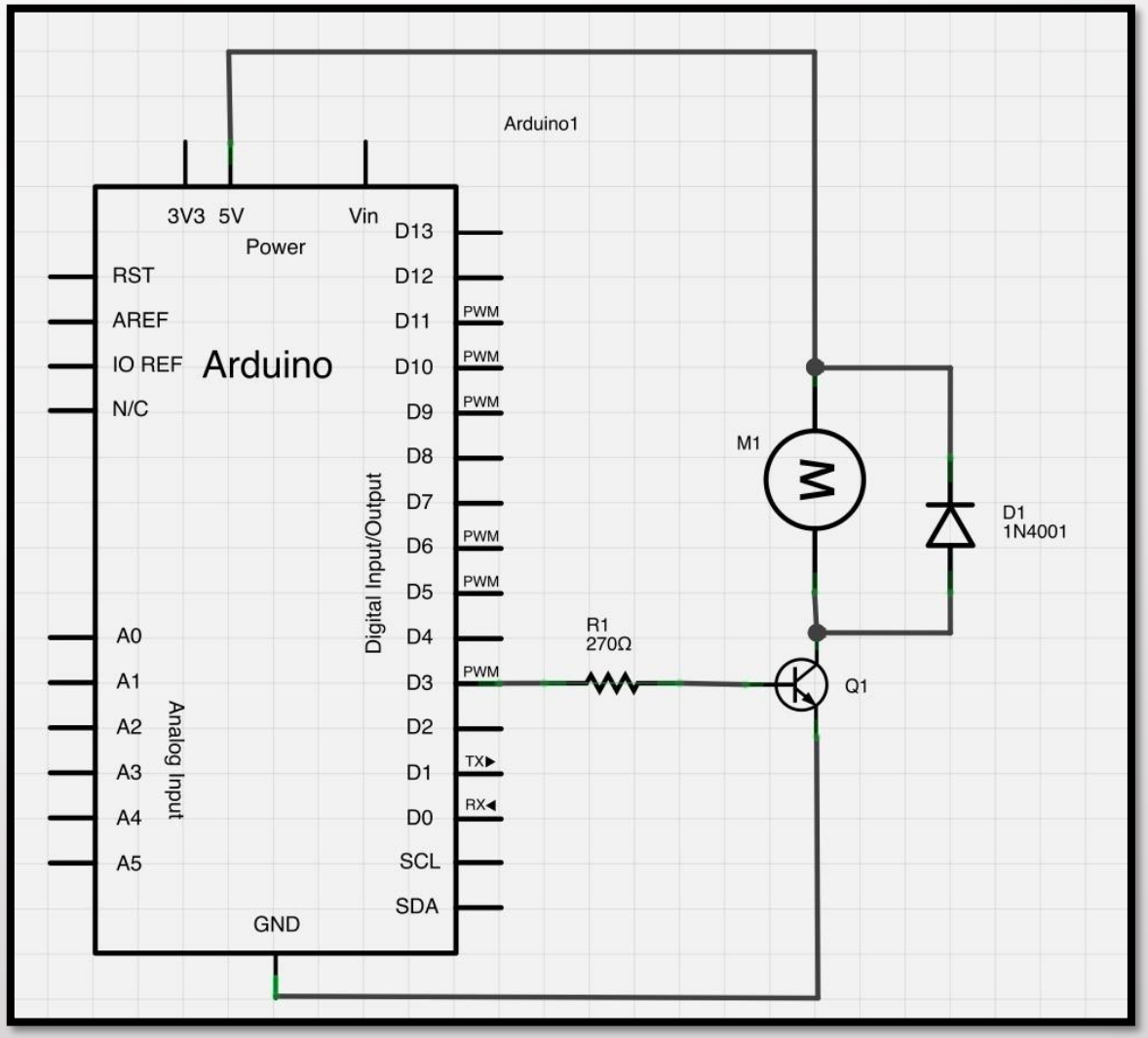




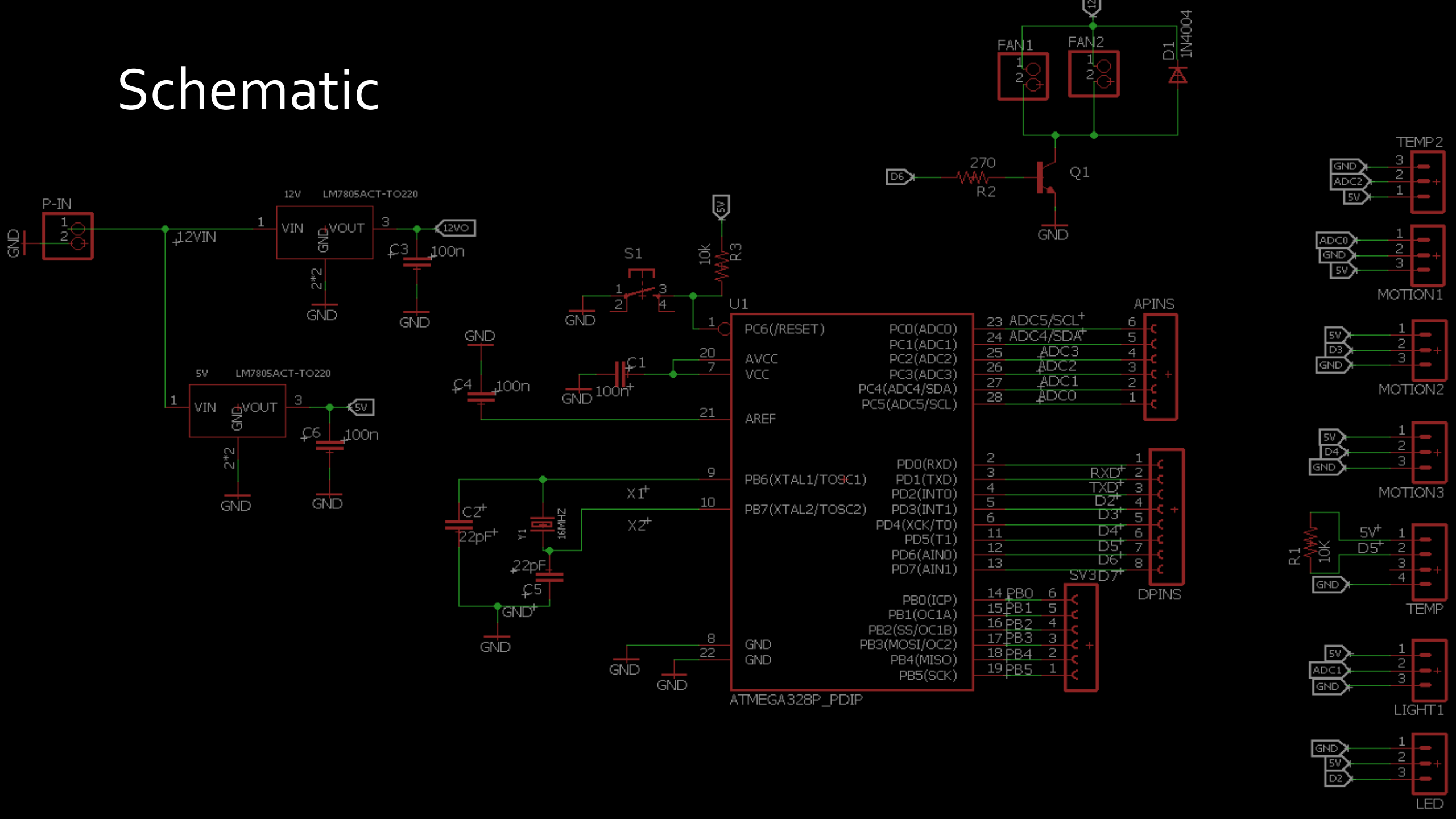


12V Fan Power

- MCU will send signal to the desired pin and complete the circuit that will activate the fans

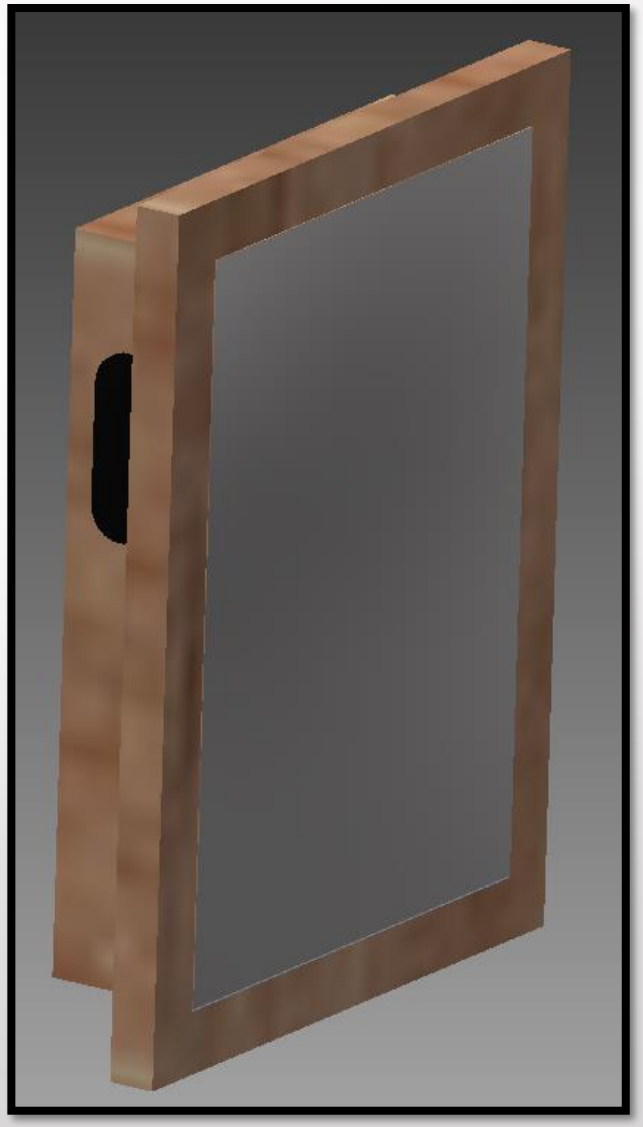


Schematic


P-IN
12V
LM7805ACT-TO220
VIN
VOUT
GND
12VIN
12VO
C3
100n
2*2
5V
C6
C4
C1
S1
10k
R3
U1
ATMEGA328P_PDIP
PC6(/RESET)
AVCC
VCC
AREF
PB6(XTAL1/TOSC1)
PB7(XTAL2/TOSC2)
PC0(ADC0)
PC1(ADC1)
PC2(ADC2)
PC3(ADC3)
PC4(ADC4/SDA)
PC5(ADC5/SCL)
PD0(RXD)
PD1(TXD)
PD2(INT0)
PD3(INT1)
PD4(XCK/T0)
PD5(T1)
PD6(AIN0)
PD7(AIN1)
PB0(ICP)
PB1(OC1A)
PB2(SS/OC1B)
PB3(MOSI/OC2)
PB4(MISO)
PB5(SCK)
X1
X2
C2
22pF
Y1
16MHz
C5
APINS
DPINS
SV3D7
FAN1
FAN2
D1
1N4004
D6
270
R2
Q1
TEMP2
ADC2
MOTION1
ADC0
MOTION2
D3
MOTION3
D4
R1
D5
TEMP
LIGHT1
ADC1
LED
D2

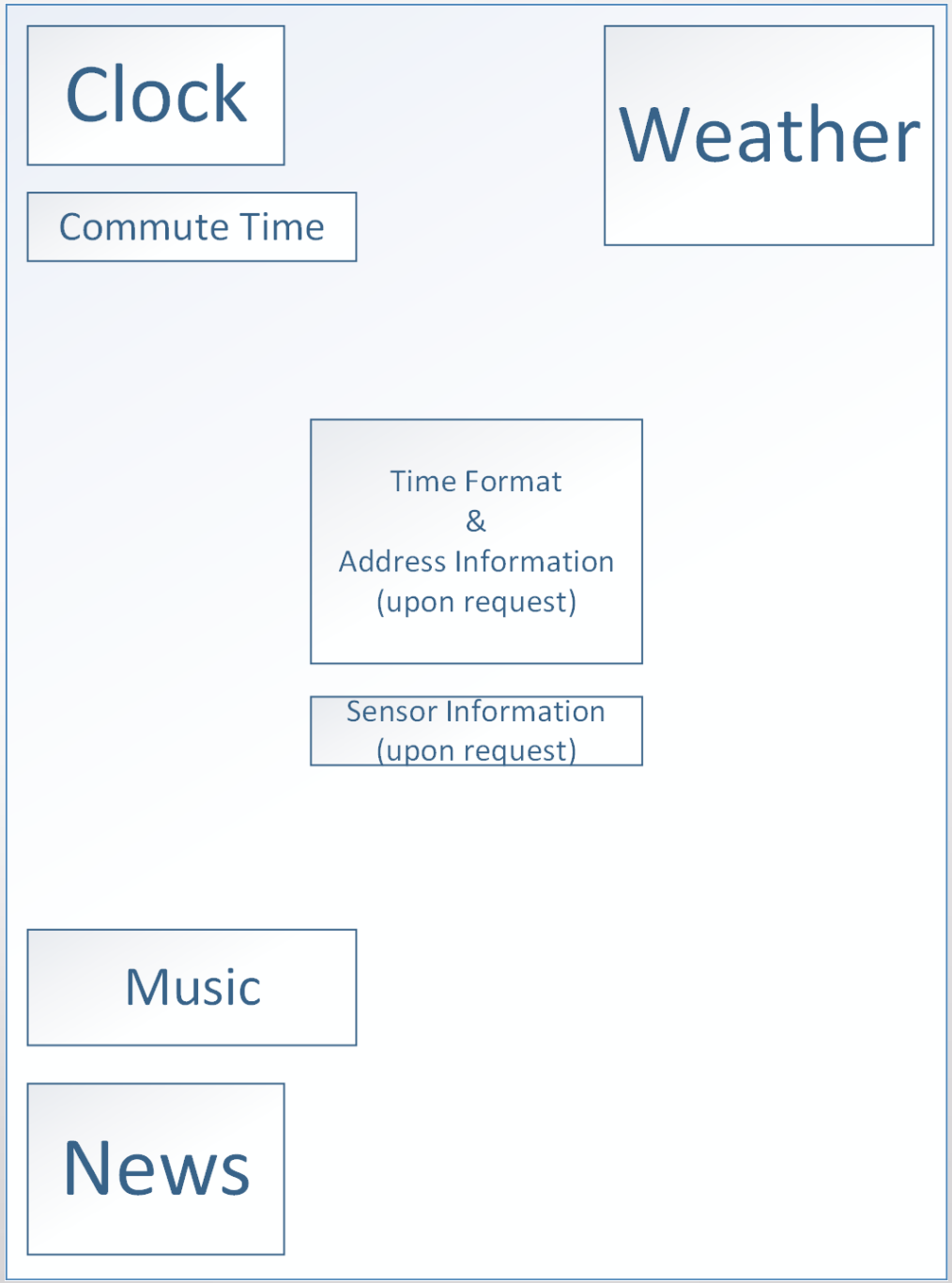
Mirror Housing

- Stained Wooden Frame
  - Frame backed by sturdy housing
- One-Way Mirror In Front of TV
- Motion Sensor Mounted on Bottom
- Speakers on Sides
- Raspberry Pi USB access on Side
- Single LED Mounted on Bottom



Display Layout

- Offer information at all times
- Preserve mirror space
- Display important information closest to where your eyes fall
- Removable display elements for different use cases



Software Design

Considerations

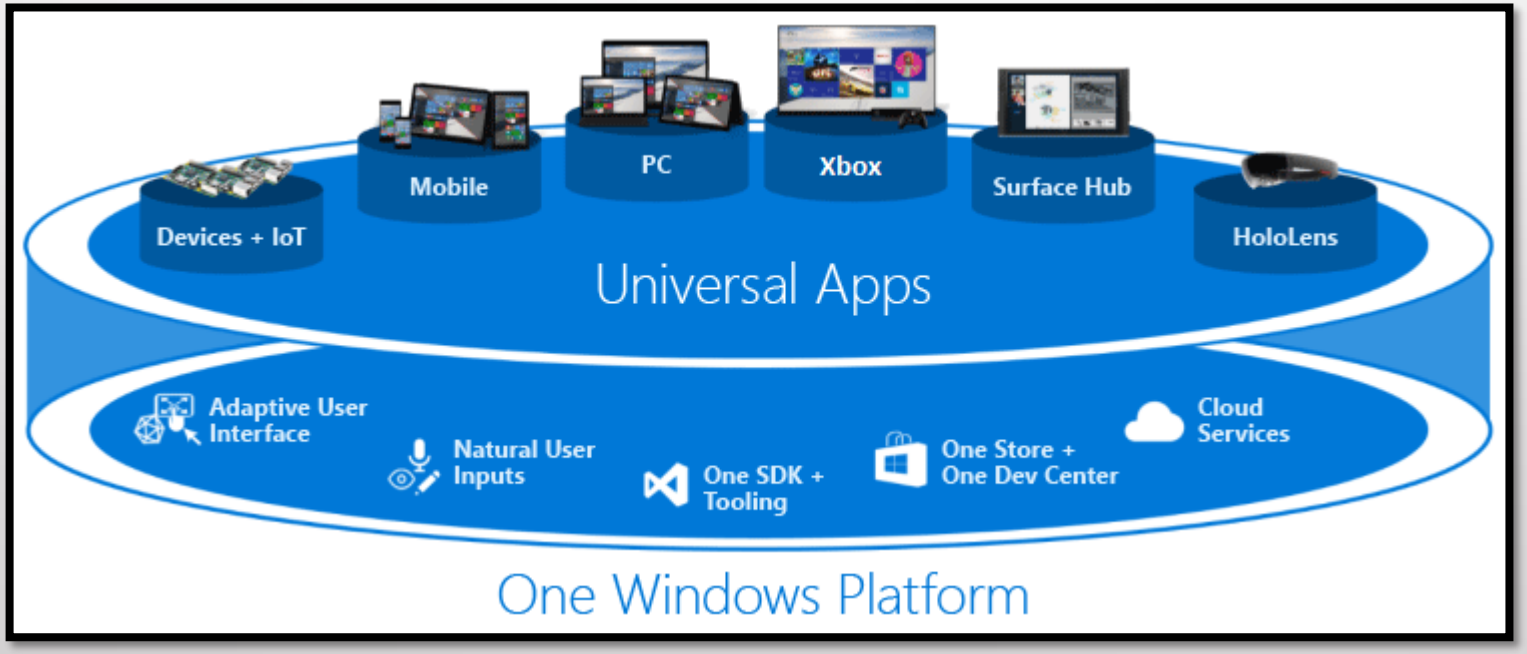
- Run on multiple platforms seamlessly
- Adaptable UI across platforms
- Modularity
  - For ease of creation with multiple developers
  - For future additional features

Results

- Universal Windows Platform
- Model-View-View Model Pattern

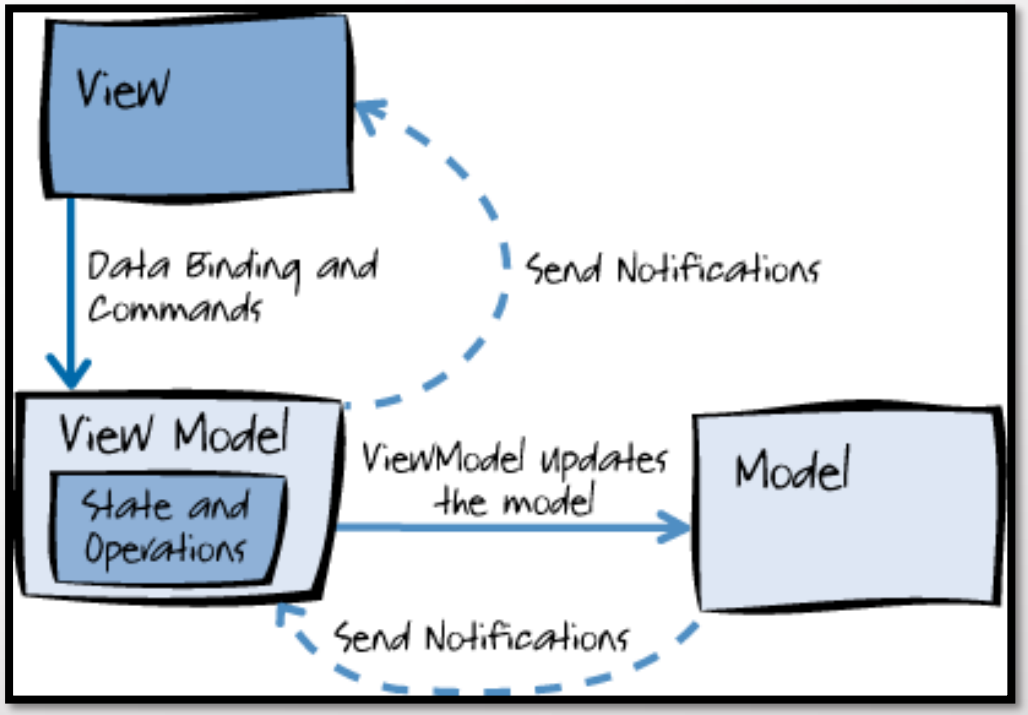
Universal Windows Platform (UWP)

- Standard Windows 10 runtime model
- GUI defined by XAML files using data binding for modularity
- Common API accessible by all Windows 10 devices
- Different API's accessible by individual platforms

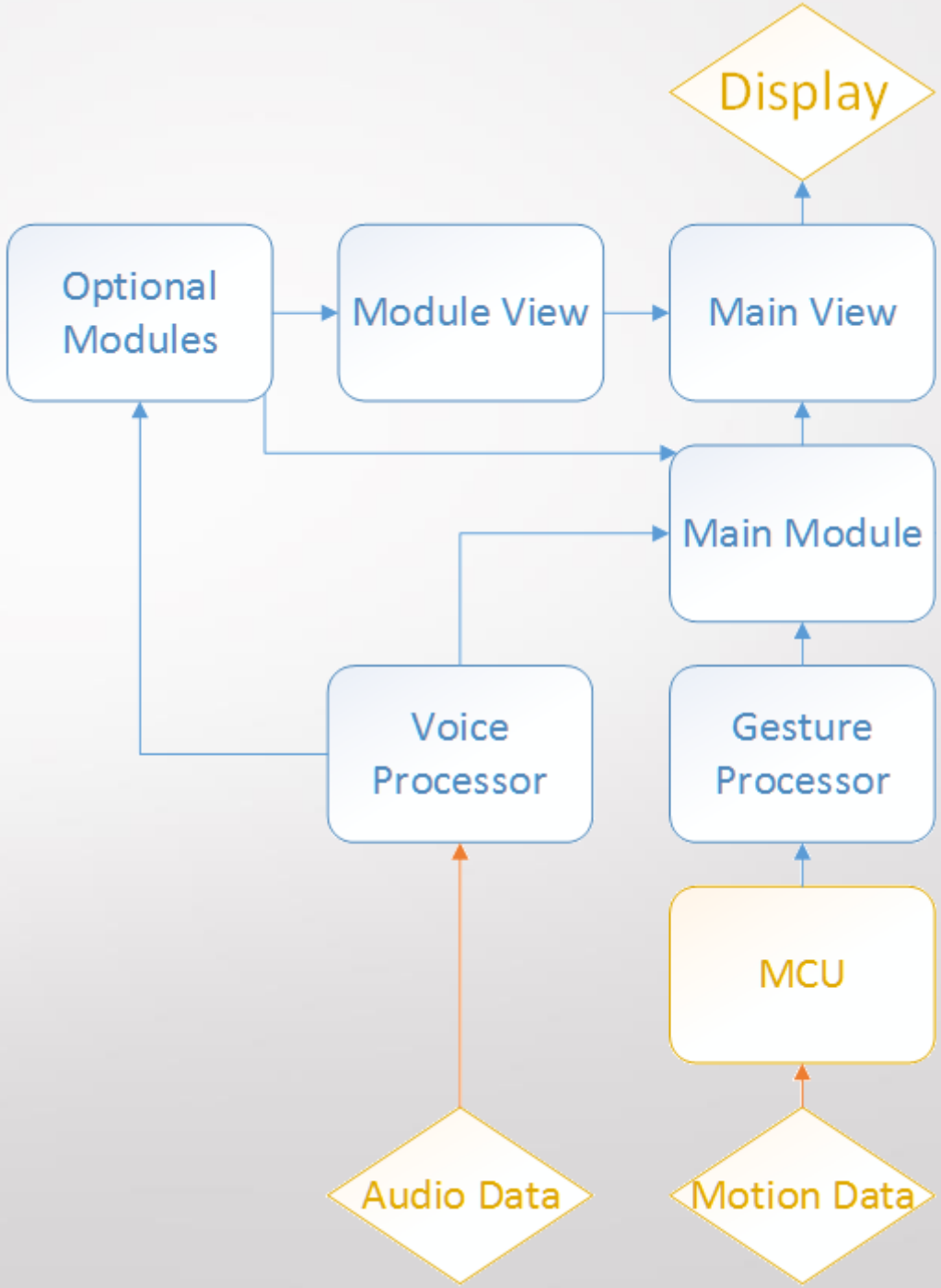


Model-View-View Model (MVVM)

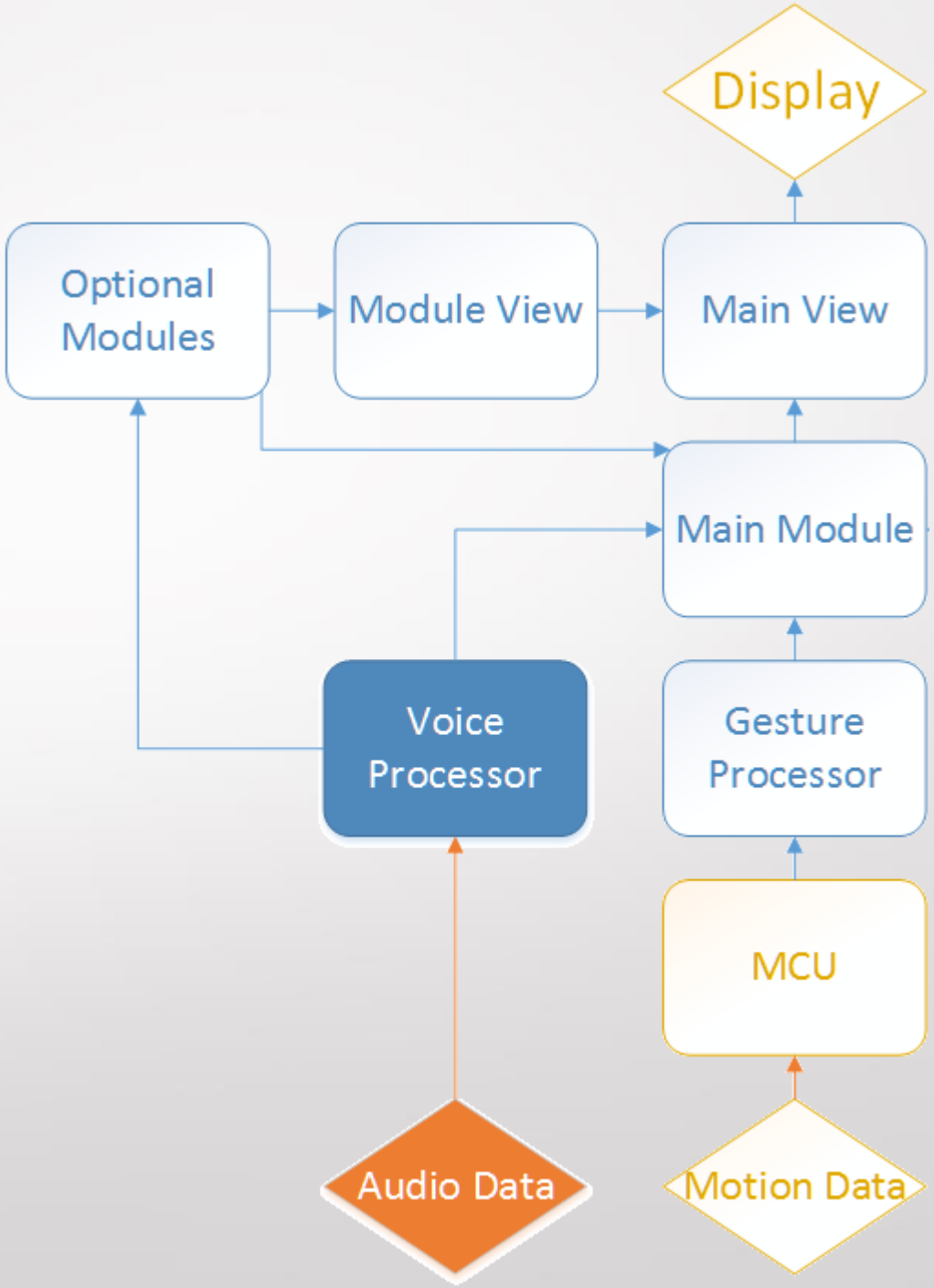
- Two reasons
  - Works great with UWP
  - Supports Modularity
- Loose coupling with Data Binding allows information to be seamlessly switched
- Easily format different data into similar layouts
- Easily create multiple GUI layouts from the same data bindings



Software Design

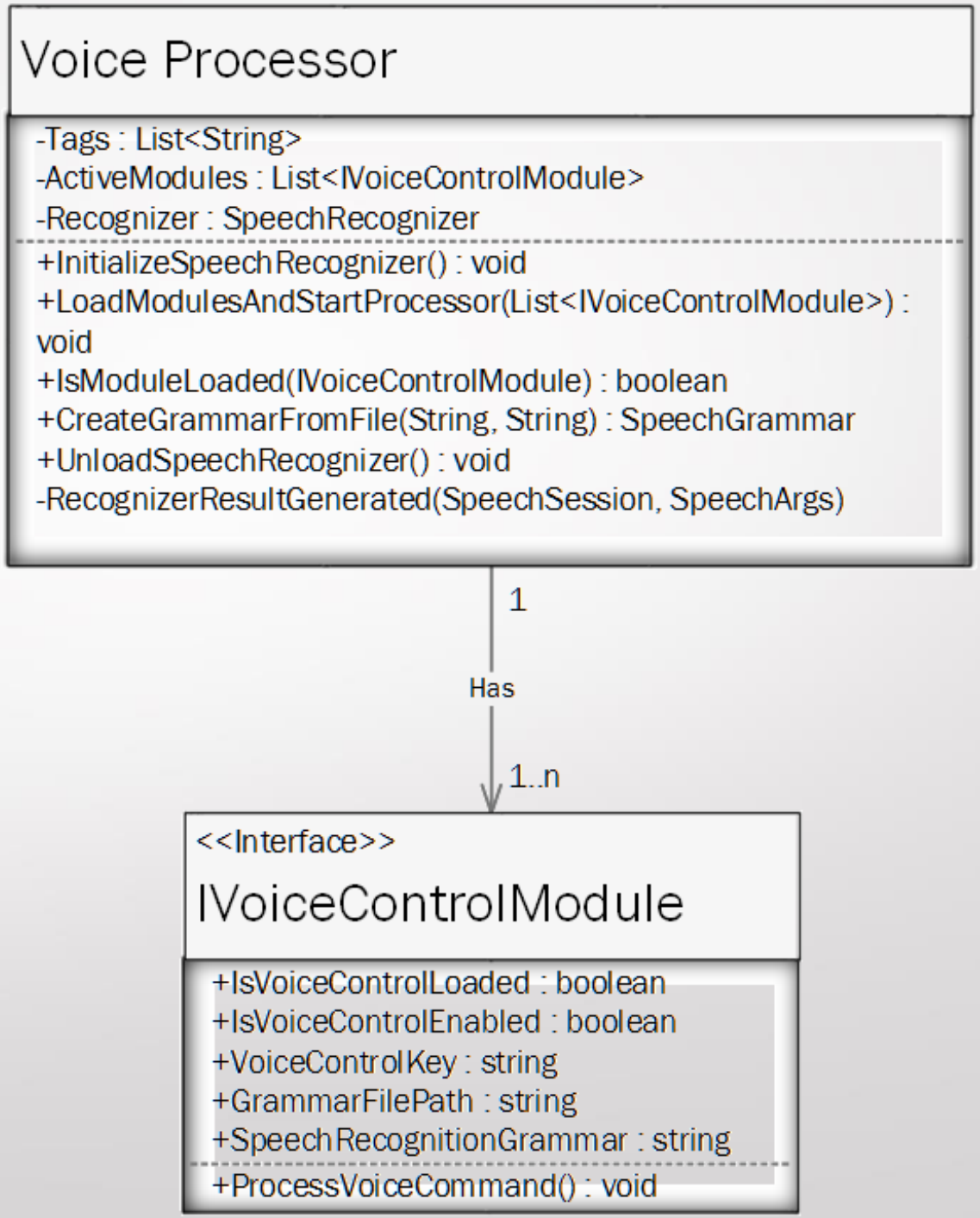


Voice Processor

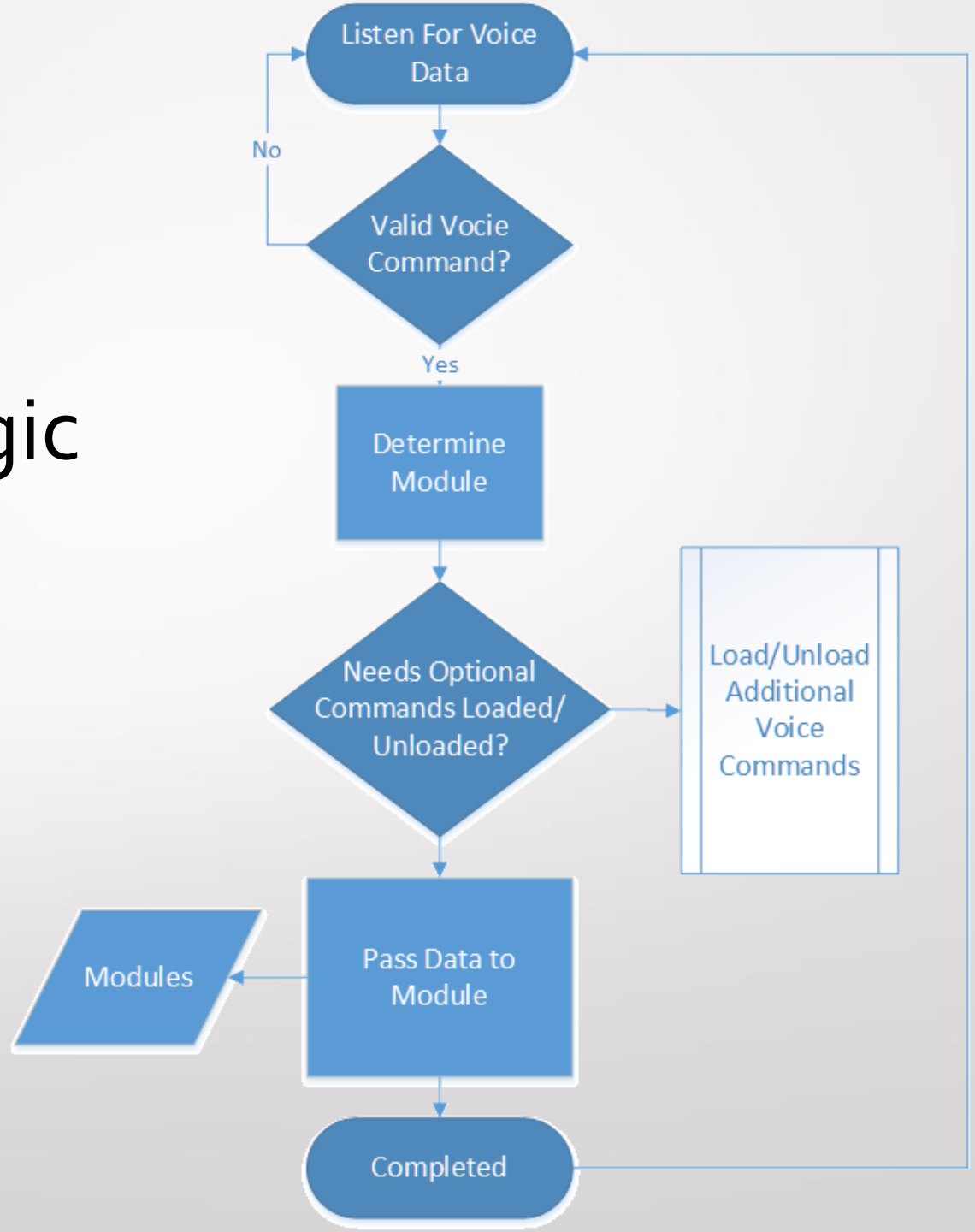


Voice Processor Class Diagram

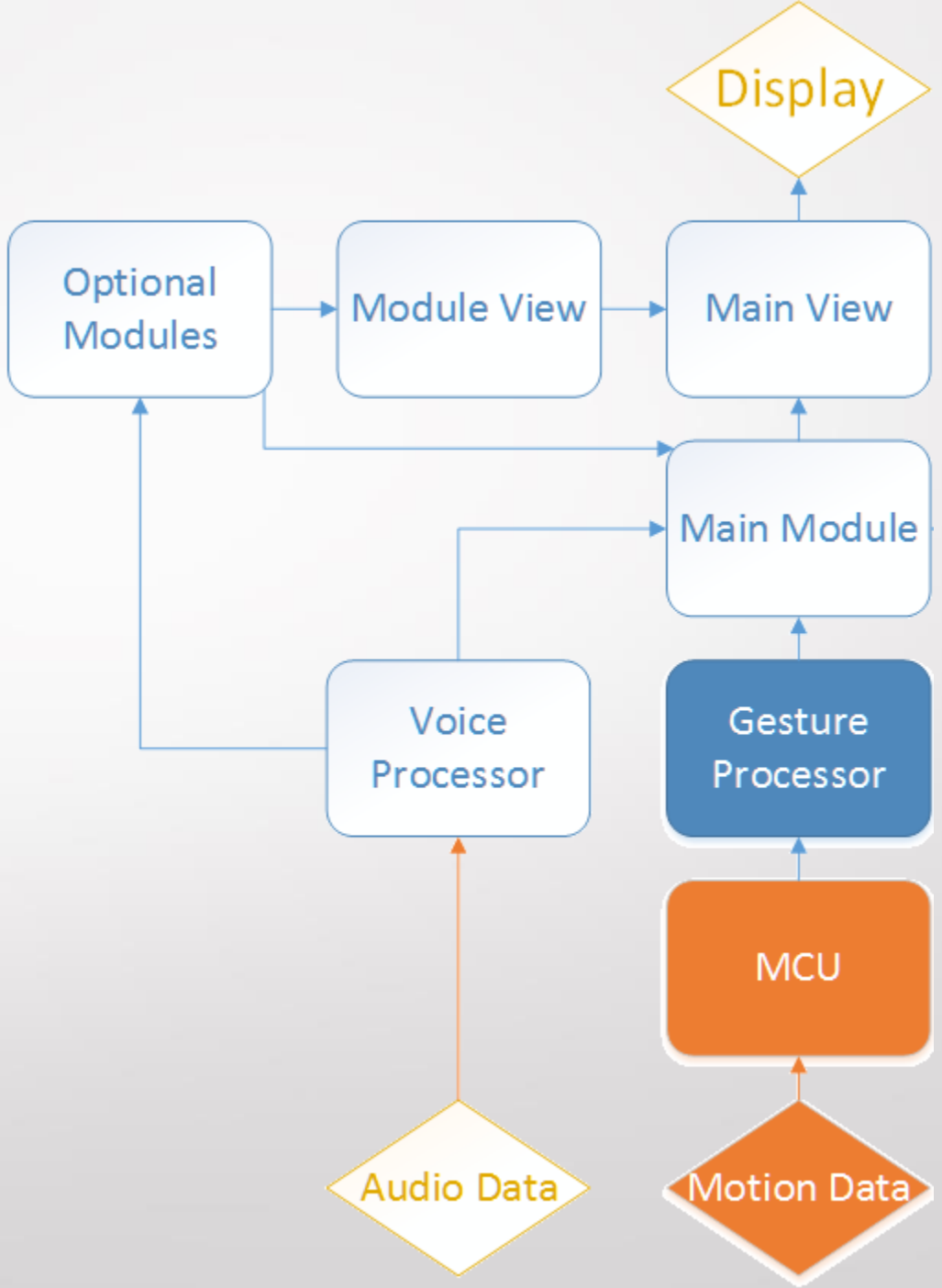
- Singleton Class
- Runs in separate thread
- Contains reference to all voice controlled modules
- Passes control to appropriate module when command received



Voice Processor Logic



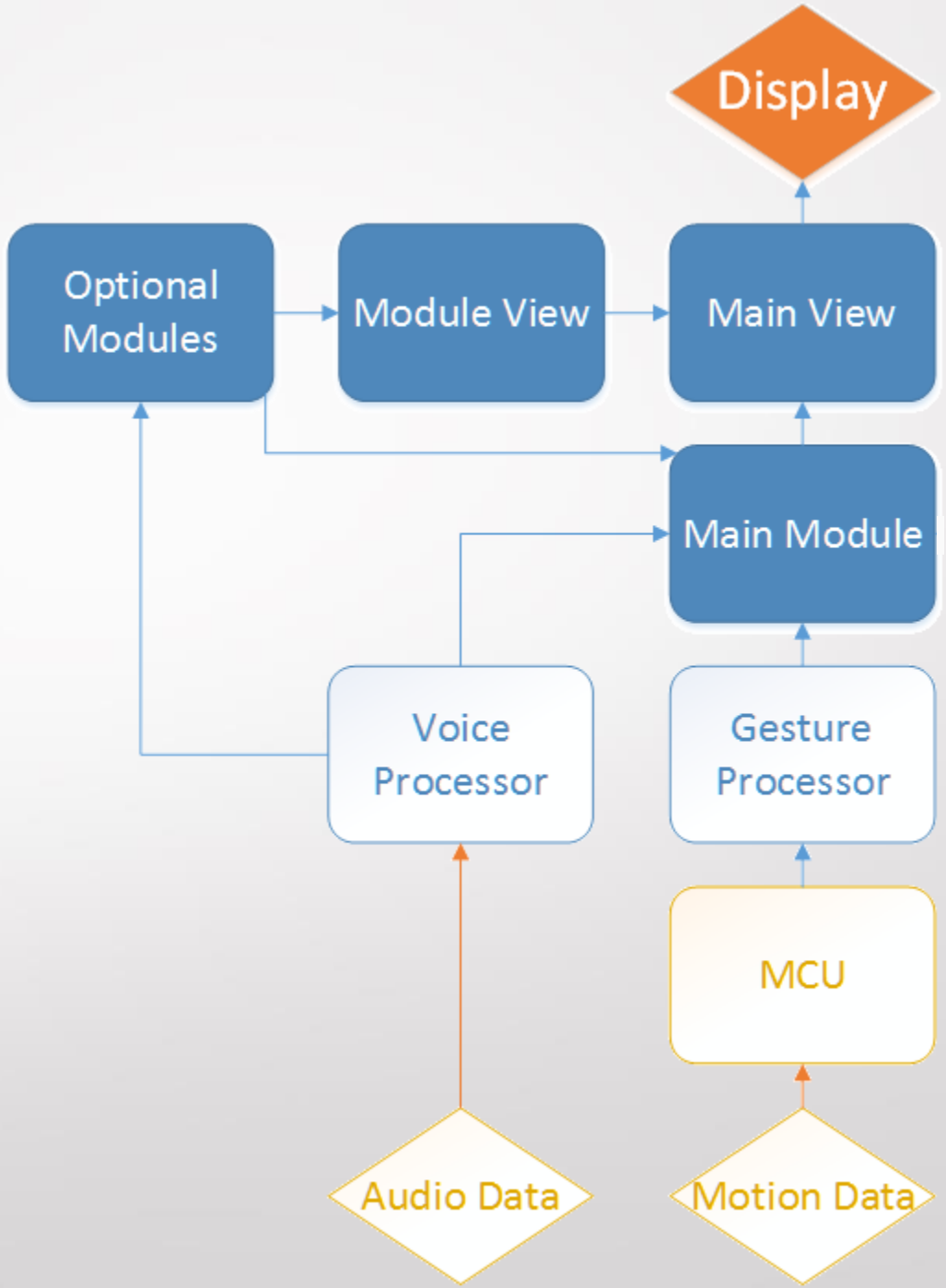
Gesture Controls



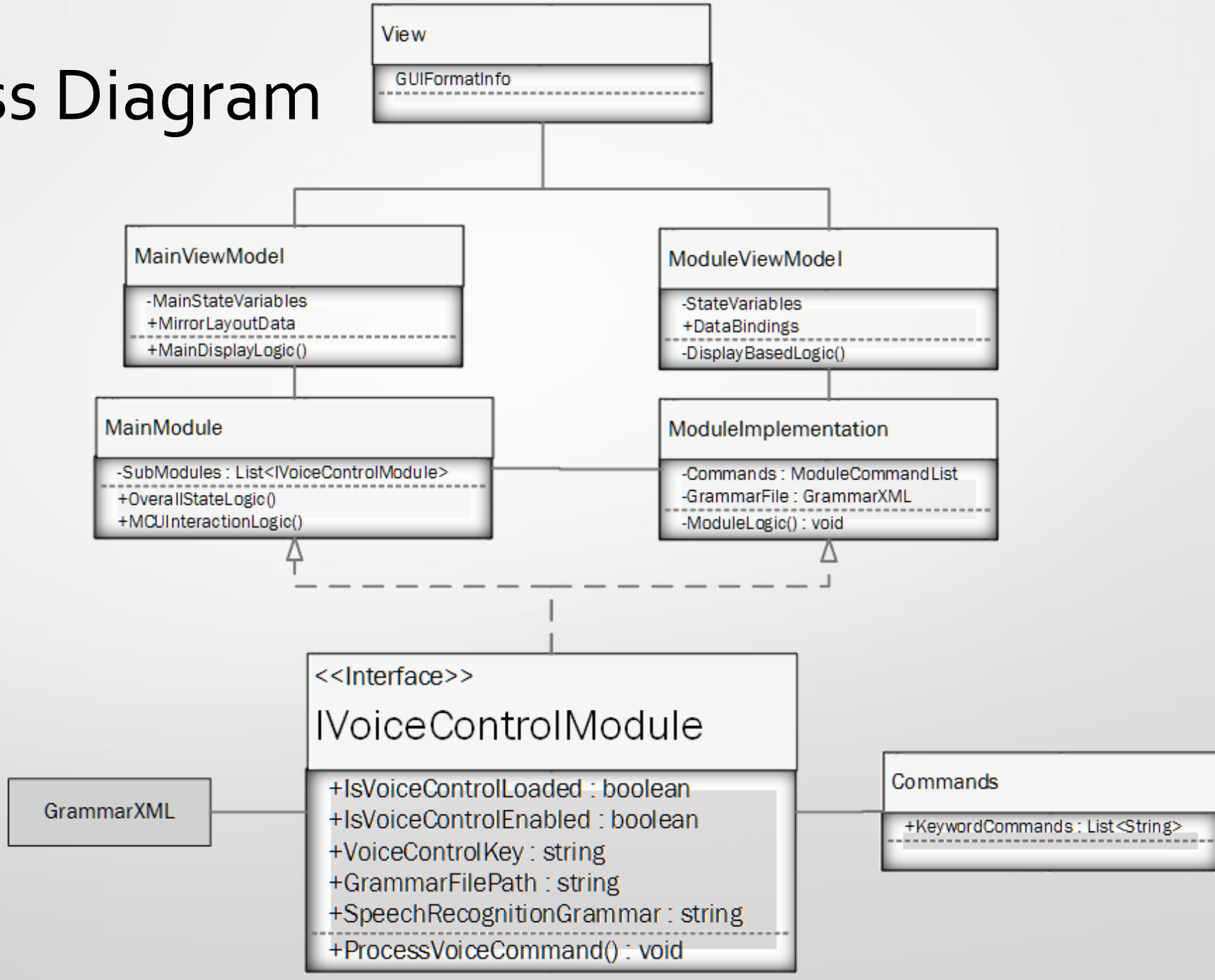
Gesture Controls

- Simple Gesture Controls
  - Use of the mirror itself
  - Hardware Limitations
    - Kinect: 3.1GHz Processor, USB 3.0, 4GB RAM
    - Leap Motion: 2GB RAM
- Uses
  - Initiate Music Playback
  - Next song
  - Stop Music

Software Modules



Module Class Diagram



Main Module

- Boot into Main Module on startup
  - Win10 IoT boot option
- Maintains a reference to all submodules for information exchange
- Handles all sensory information from MCU

Software Modules

- Clock
- Weather
- News
- Music
- Commute Time

Clock

- Digital Format
- Uses System Time
  - Raspberry Pi – Windows 10 IoT
    - NTP server
- Military 24-Hour Format
  - User setting

09:58

Weather

- OpenWeatherMap API
  - Returns JSON object
- Formats:
  - Current Weather
  - Today's Weather
    - 3 hour intervals – Highs and Lows & Icon
  - Tomorrow's Weather
    - 3 hour intervals – Highs and Lows & Icon
  - Week's Weather
    - 5-day forecast – Highs and Lows & Icon

News

- News Headlines
  - List of 4 Headlines
- CNN
  - RSS2JSON API
    - Returns JSON object
- Request different categories via Voice Command
  - Top News
  - Business
  - Technology
  - …

Music

- Local Media
- Now Playing View
  - Artist – Song
- Music playback controlled with gestures
- Sound output to external speakers

Commute Time

- User sets location
  - Work | School

Commute Time

- User sets location
  - Work | School
- Google Maps
  - Distance Matrix API
  - Fetch travel time from current location

Configuration & Setup

- Initial User Setup
  - 24-Hour Clock Format
  - Work/School Locations
  - Time to leave for work/school

Administrative Content

Work Distribution

Name	Embedded Hardware	Voice Recognition	Software Modules	Frame Design
Hector Zacarias	P			S
Justin Gentry	S	P	S	P
Michael Trivelli		S	P	S

Budget

Item	Quantity	Cost
MCU	0	$0
Power Relay	1	$1.41
Fan	2	$20.48
Diodes	1	$0.32
Proto Broad	2	$0.76
Motion Sensor (Long-Range)	1	$1.80
Motion Sensor (Short-Range)	2	$9.90

Item	Quantity	Cost
Humidity and Temp	1	$1.75
PCB	10	$14.00
32-inch 1080p HDTV	1	$100.00
Raspberry Pi 2 Kit	1	$114.95
Microphone	1	$0
Speakers	1	$0
Mirror Assembly/Frame	1	$104.25
Total:		$369.62

Issues

- Motion/Light sensor
- False voice recognition
- Eagle learning curve

Questions