



Fall Detection System

Team **SightRPI**





SightRPI



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Overview

- Problem Identification
- Value Proposition
- Prioritized Customer Requirements
- Performance Specifications
- Subsystems & Further Improvements
- Test & Analysis
- Safety
- Q&A



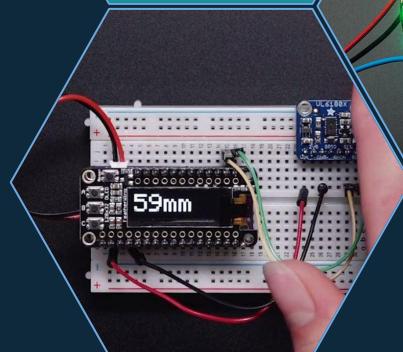
1

Problem Identification

- 
- ◆ **90%** of Americans wish to stay in their homes as they grow older. (*AARP*)
 - ◆ **2.8 million** elderly are treated for fall-related injuries in emergency rooms each year. (*CDC*)
 - ◆ **70%** of elderly made modifications to their home due to safety concerns. (*AARP*)
 - ◆ **60%** of elderly made those modifications to their home to increase the chances that they will be able to live there independently. (*AARP*)



- ◊ Automatically detect falling down
- ◊ Confirm medical emergency case
- ◊ Notify people in or near the house
- ◊ Notify his/her emergency contacts



- [1] http://static.arduino.org/media/k2/items/cache/1d77059d0d8adeb2ceccdbc07bdc73c2_XL.jpg
- [2] https://developer.mbed.org/media/uploads/4180_1/rgrbing.jpg
- [3] Kiwi Electronics B.V.: <https://www.kiwi-electronics.nl/image/cache/data/products/adafruit/sensor/ADA-3316-4-1000x667.jpg>
- [4] <https://cdn-shop.adafruit.com/1200x900/2168-01.jpg>
- [5] <https://img.okezone.com/content/2016/12/08/207/1562378/bluetooth-5-dua-kali-lebih-cepat-dibanding-versi-4-2-4Hni8qpRX0.jpg>
- [6] <https://5.imimg.com/data5/CM/QM/MY-41139568/fire-alarm-speaker-500x500.jpg>
- [7] <https://www.iphonetricks.org/wp-content/uploads/2014/05/phone-5s-incoming-call-menu.jpg>
- [8] <http://www.techaudible.org/wp-content/uploads/2014/07/add-back-clear-all-option-for-notifications-android-l-for-your-nexus-5-nexus-7.w654.jpg>

Bluetooth Module

Range Sensor

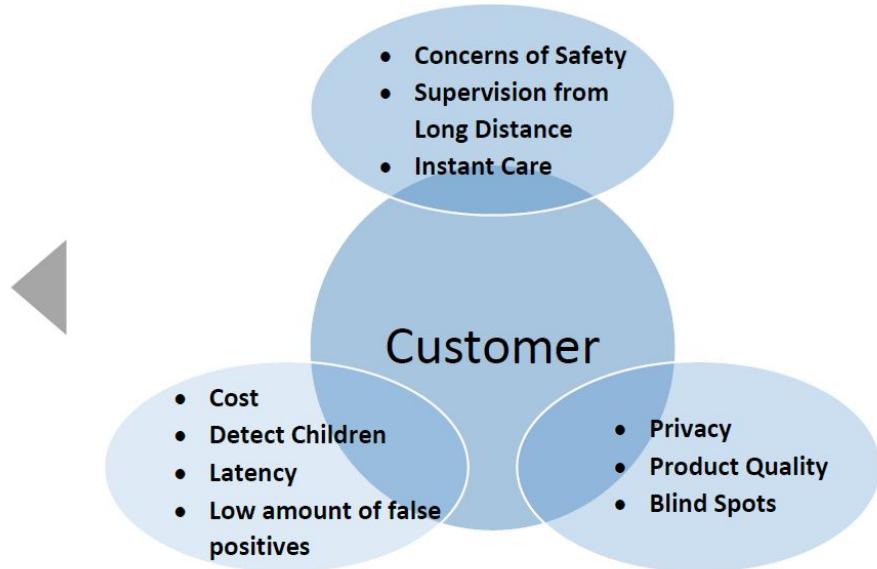
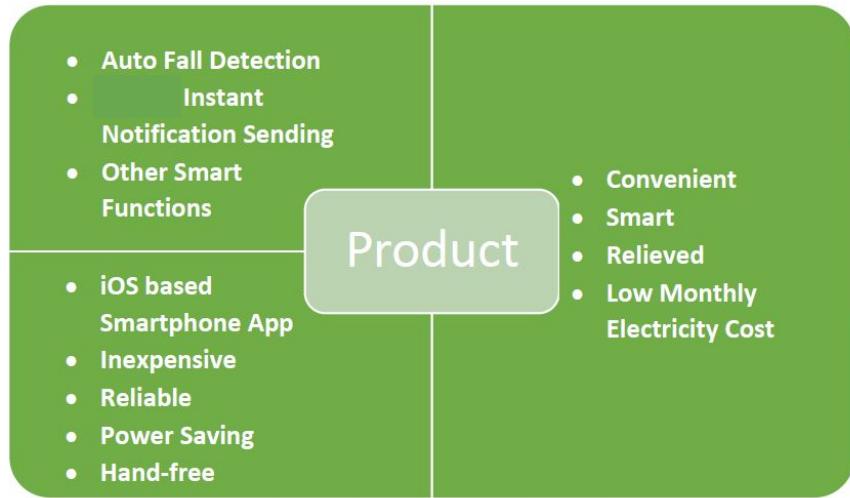
RGB Light

IR break beam sensor



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Value Propositions



- Team: SightRPI
- Product: Fall Detection System
- Ideal Customers: Elderly who spend aging time in their homes

- Life Alert
- LifeStation
- Medical Alert



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Prioritized Customer Requirements



[1] google Forms: <http://www.saryrang.com/wp-content/uploads/2017/02/Google-form.jpg>

[2] Google Logo: <https://yt3.ggpht.com/-DvzUuiYGo/AAAAAAAAl/AAAAAAAAl/YoUb-Vzlova/s900-c-k-no-mo-rj-c0xffffffff/photo.jpg>

[3] AARP: <https://static1.squarespace.com/static/541228a2e4b0a5a88e01308/t/55db77c0e4b0c02d897fb27b/1440446400978/AARP+Logo.jpg>

[4] CDC: <https://www.cdc.gov/about/images/leadership/cdc-socialmedia-600x300px.jpg>

[5] NSC Logo: <https://www.cochranfirmdc.com/wp-content/uploads/2017/02/auto-accident-law-firm-washington-dc.jpg>

[6] Medical Care Alert: http://www.medicalcarealert.com/vspfiles/images/Medical_Alert_logo.jpg

[7] Philips Logo: http://www.underconsideration.com/brandnew/archives/philips_2013_logo_detail.png

[8] MetLife Logo: https://pbs.twimg.com/profile_images/789089759255785472/6S6K_6gd_400x400.jpg

[9] OMRON Logo: <http://news.villagepages.org/files/2012/07/Omrone.jpg>

[10] NAHB: <https://bdmag.com/wp-content/uploads/2015/12/Builder-News-08.jpg>

[11] ADT: <https://securitybaron.com/wp-content/uploads/2015/08/adt-review.png>



Sensitive Fall Detection

- Range sensor
- Fast speed of reading

Low Latency in Signal Transmission

- Wireless Module
- RTT
- Smartphone Application

Allow Deliberate Behavior when User is Safe

- Confirmation System

Low Amount of False Positives

- Accuracy
- Reliability

Customer Needs	Technical Specification	
	Metric	Target Value / Range of Values
I need the light to be soft and doesn't harm my eyes.	Brightness	100-200 lux
I want to know as soon as possible if the one at home is in danger.	(Sensitivity of Fall Detection system) Time between reading all sensors	<100 milliseconds
If I am in my office, I may still want to control.	Wireless Module covering distance	0-∞ meter
Can it cover all area in my home?	Effective area	8 cm^2/sensor (in demo room)
Can it detect a child?	Age	3-10 years old
	height	>2.92 inches (on 1:12 scale)
I don't want my dog to trigger annoying alarm by mistake.	height	>2 inches (on 1:12 scale)
Important. I must receive notification at once.	Communication Latency	<2 seconds
I sometimes lie on the ground to think about things.	(Allow Deliberate Behavior when User is Safe) Confirmation System	# of speaker(s): 1 # of microphone(s): 1
Call 9-1-1 immediately and automatically. Don't let me do this.	Option to call 9-1-1	1 button (to call 9-1-1 required on smartphone application)
	Electronic Voice recorded in smartphone application	1 piece of pre recorded electronic voice stored in system



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Performance Specifications



Performance Specs

- ◊ Occupancy detection:
 - Auto light switch on/off
 - Save power
- ◊ Fall detection:
 - Light blinking in red and send alarm
 - Emergent contact get notification
- ◊ Remote control:
 - Switch on/off light
 - Change color

Item	Quantity	Unit Price	Subtotal	Shipping
Arduino kit	1	\$34.99	\$34.99	\$0.00
Lux distance sensor	1	\$13.49	\$13.49	\$0.00
IR break beam sensor	2	\$3.90	\$7.80	\$15.00
Foam board	2	\$6.99	\$13.98	\$0.00
Miscellaneous hardware	-	various	\$6.38	\$0.00
Bluetooth Module HM-10	1	\$11.99	\$11.99	\$0.00
Figure set(Human)	1	\$11.99	\$11.99	\$0.00
Figure(Dog)	1	\$2.00	\$2.00	\$0.00
Total			\$117.62	

\$117.62



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Subsystems





Demo Room

Scale model created with
foamboard

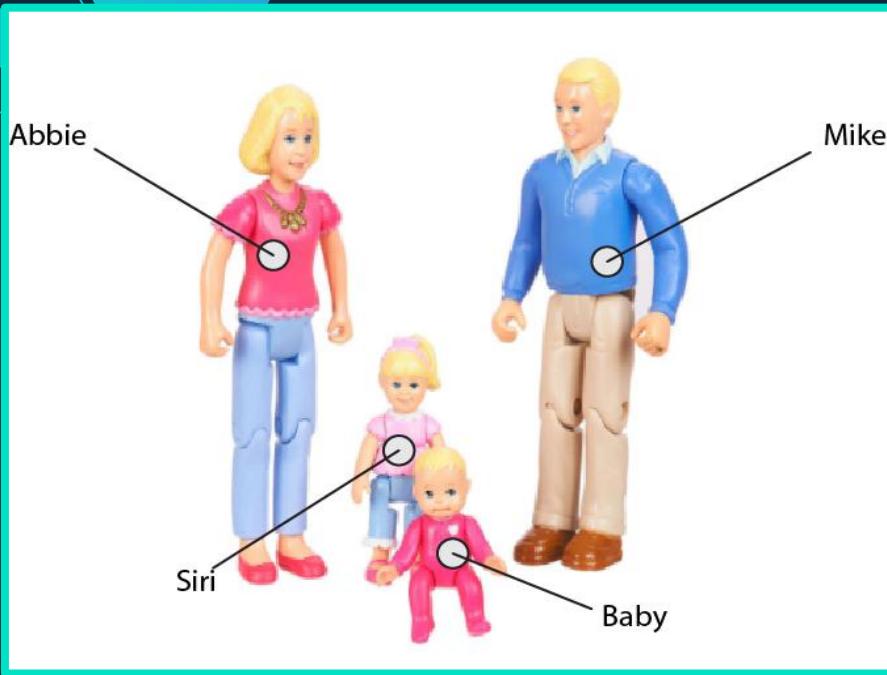


	Demo Room Material			
	Wood	Plastic (3D Printing)	Foamboard	Sheet Metal
Selection Criteria				
Will not interfere with sensors	-1	1	1	-1
Cost	1	-1	1	-1
Feasibility	1	-1	1	-1
Easy to work with	0	-1	1	-1
Makes sense for our scale	1	-1	1	0
Sturdy	1	1	0	1
Sum of +1's	4	-1	6	-2
Sum of 0's	3	-2	5	-3
Sum of -1's	2	-3	4	-4
Net Score	3	-2	5	-3

*Drawing not to scale



Human Models



- No metal
- Correct heights for our scale

Average Height of Americans (CDC)

	Average Height (inches)	Height according to our scale (inches)
Men	69.3	5.775
Women	63.8	5.316
Average	66.55	5.546

*Images not to scale

Pet Model

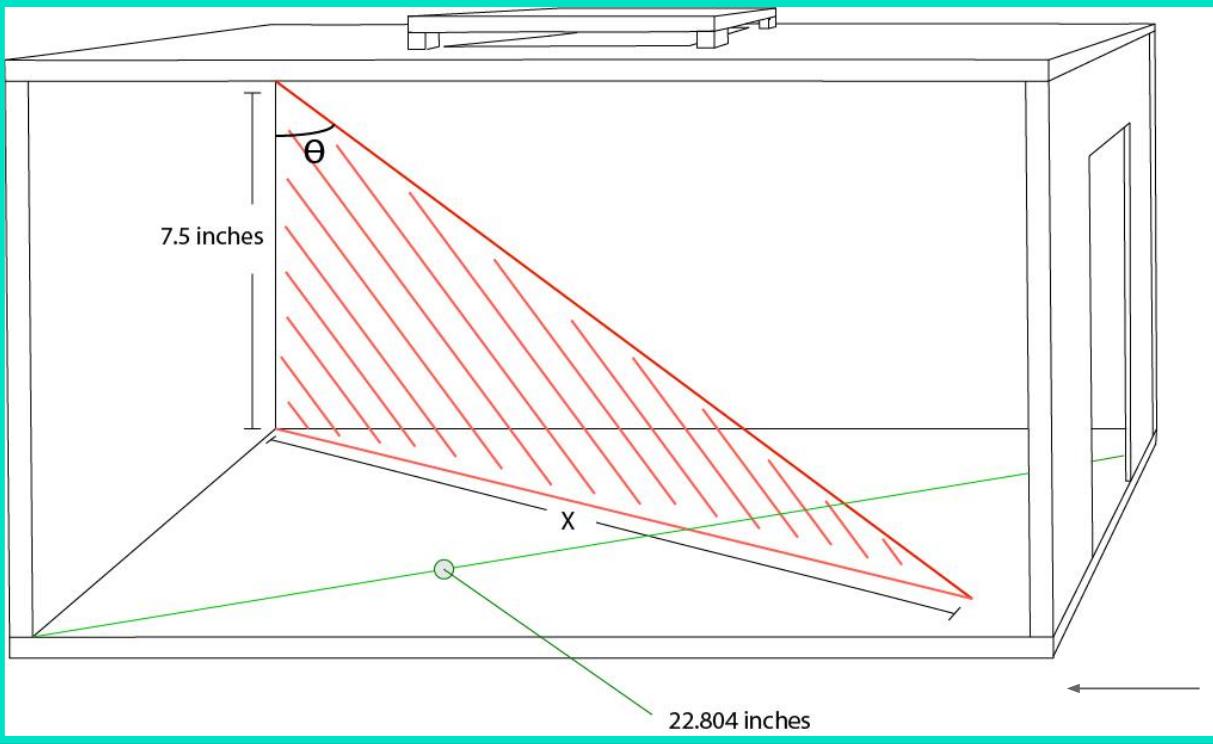


Height: 2 inches



Future Iterations For Demo Room

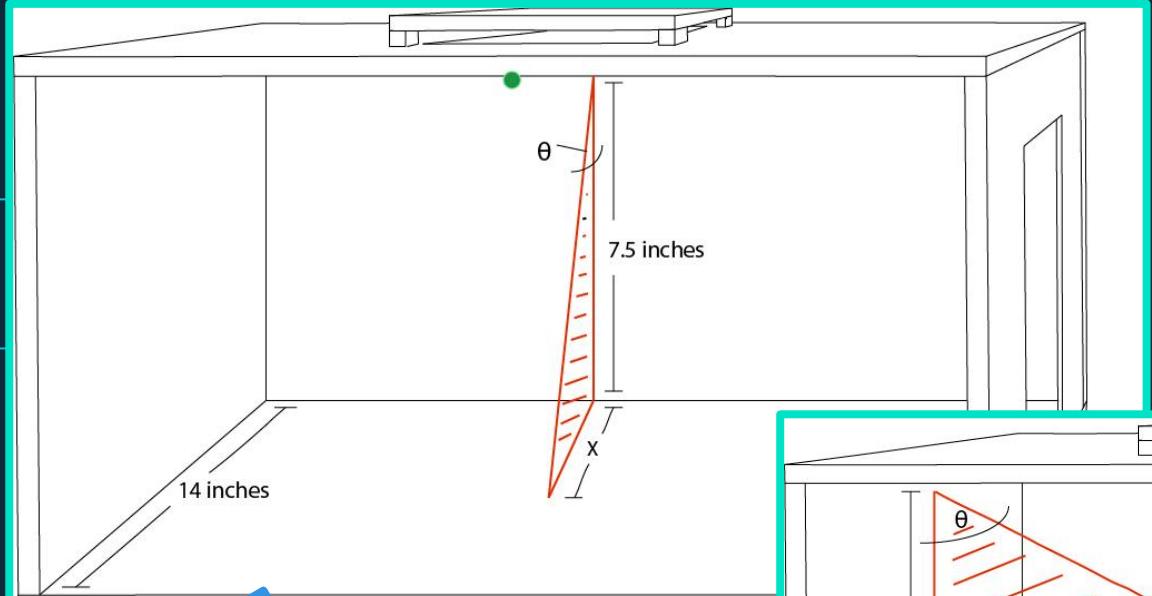




θ (degrees)	X (inches)
10°	1.322
20°	2.73
30°	4.33
40°	6.29
50°	8.94
60°	12.99
70°	20.6
80°	42.53

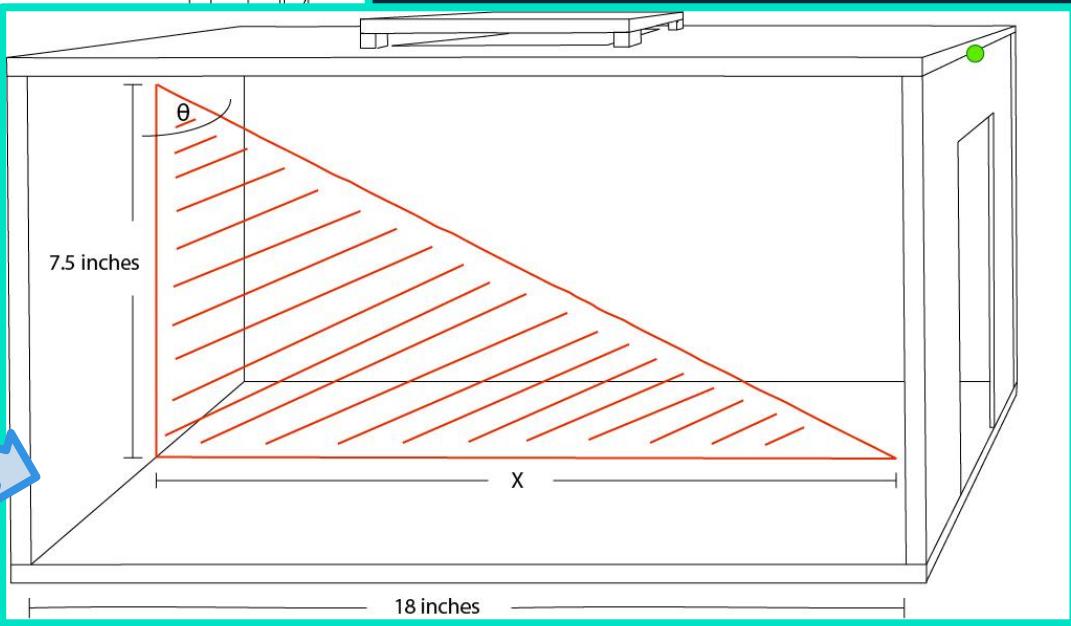
Equation used
 $7.5\tan(\theta) = X$

- Sensors along top of the walls to add more coverage
- Angle of sensor can be adjusted for room size



60° is the best angle here

65° is the best angle here





Circuit Design

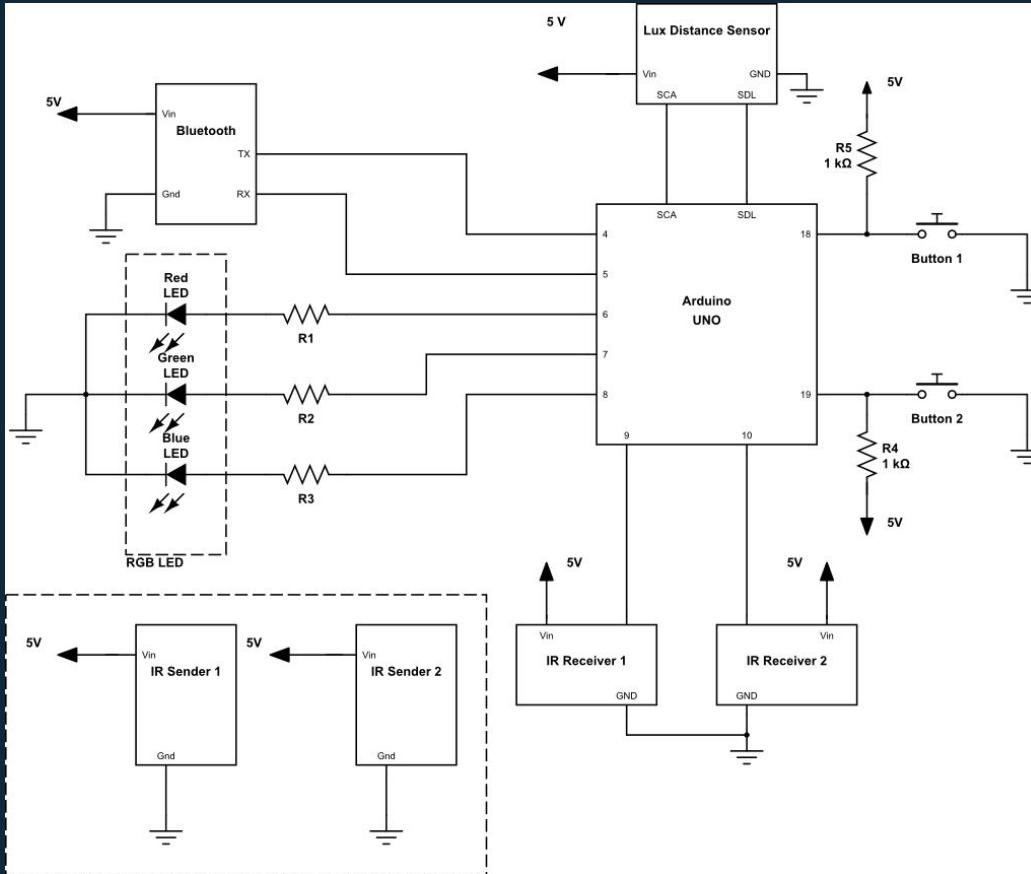




Circuit Components

- Arduino
 - IR Break Beam Sensor*2
 - Range Sensor
 - RGB LED
 - Push Button*2
 - Bluetooth Module
- 

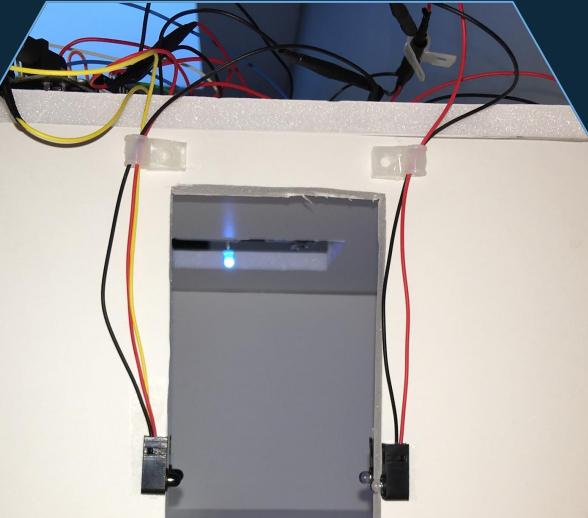
Schematic



Door (Right View)

IR Break Beam Sensor:

- Detect entering or leaving the room
- Calculate the number of people inside the room (Emergency System is off when the room is empty)

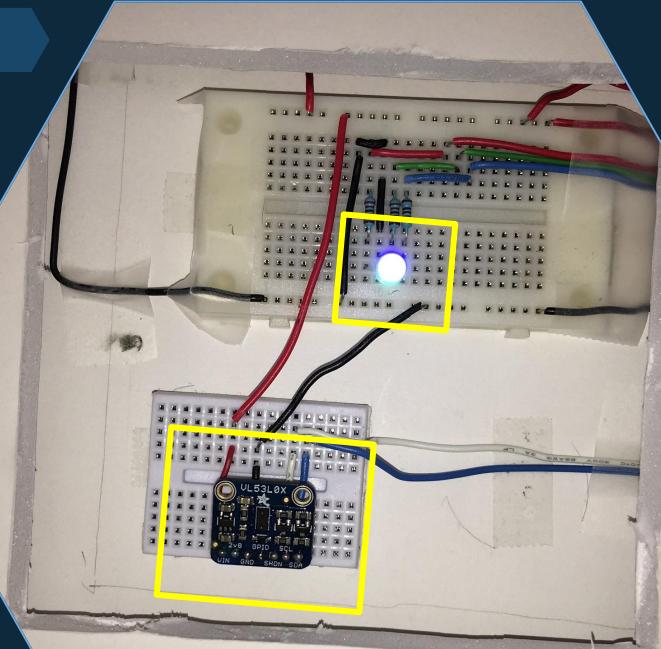




Top of the Room (Inner View)

Range Sensor VL53L0X:

- Measure the distance

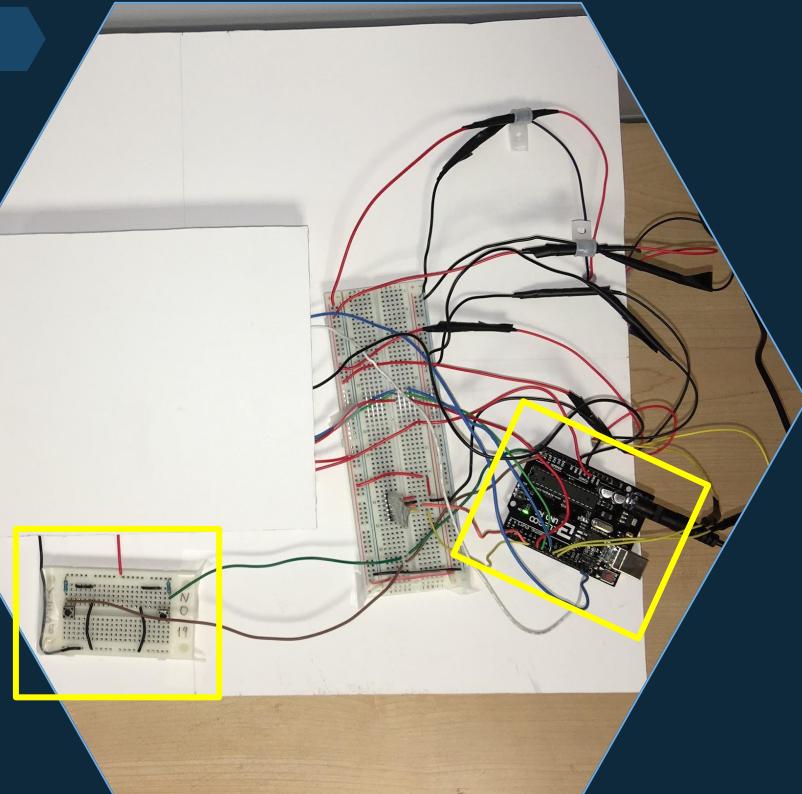


RGB LED (4 pins):

- DIY Colors
- Smart Control
- Emergency Mode



Other components (Top View)



Arduino

- Sense and control the devices.

Bluetooth Module

- Sending data to the phone app & Receiving data from the phone app

Yes & No Push Button

- Yes: “I’m OK”
- NO: “I’m not OK”





Fall Detection & Confirmation System





Reading Values from Range Sensor



Time:13521
Distance (mm) : 225
7

Time:13563
Distance (mm) : 224
8

Time:13604
Distance (mm) : 224
9

Time:13604
Distance (mm) : 224
9

Time:13645
Distance (mm) : 224
10

Time:13697
Distance (mm) : 224
Are you OK

Time:13275
Distance (mm) : 225
1

Time:13316
Distance (mm) : 223
2

Time:13357
Distance (mm) : 225
3

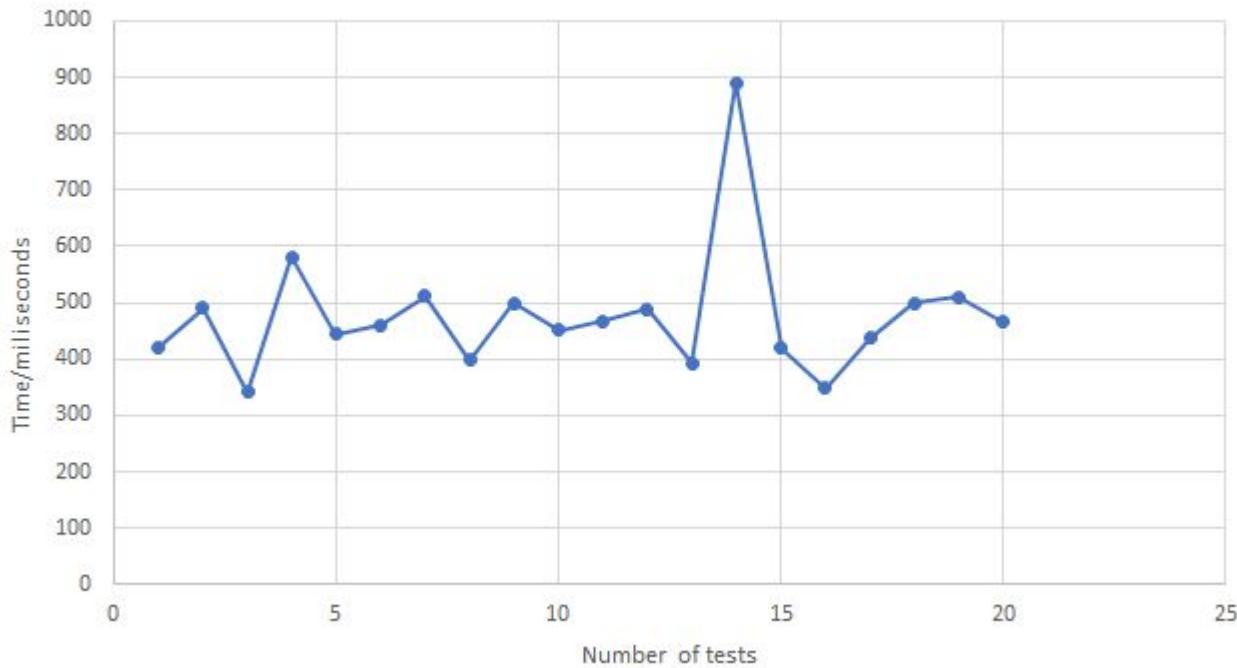
Time:13398
Distance (mm) : 225
4

Time:13440
Distance (mm) : 224
5

Time:13480
Distance (mm) : 222
6

Response
Time: 422
(milliseconds)

the response time for the fall detection



Average response Time: 476.1 (milliseconds)



Wireless Module

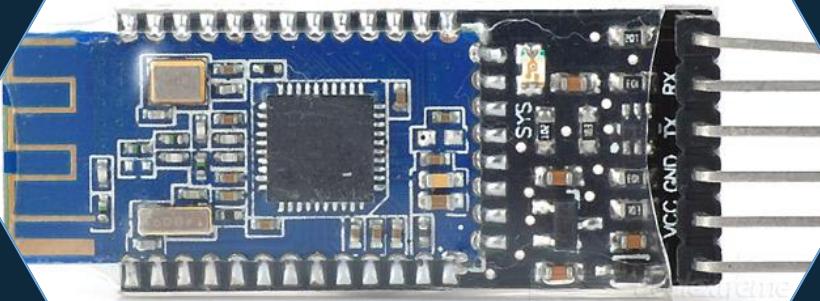
HM-10 Low-Energy Bluetooth



Low-energy Bluetooth Modules

Selection Criteria	HC-05	HM-10	HM-11
Difficulty	1	1	1
Cost	1	0	-1
Reliability	0	1	1
Feasibility	-1	1	1
Further Assembly/Soldering	1	1	-1
Power	-1	1	1
Net Score	2	4	1
Rank	2	1	3
Continue?	No	Yes	No

HM-10



- 60 meters range [1]
- 100 mW power [1]
- Existing libraries free to use
 - SoftwareSerial.h
 - BluetoothSerial.swift

[1] http://fab.cba.mit.edu/classes/863.15/doc/tutorials/programming/bluetooth/bluetooth40_en.pdf



Future Iterations For Wireless Module





\$5
a month

512 MB Memory
1 Core Processor
20 GB SSD Disk
1 TB Transfer*

Select

\$10
a month

1 GB Memory
1 Core Processor
30 GB SSD Disk
2 TB Transfer*

Select

\$20
a month

2 GB Memory
1 Core Processor
40 GB SSD Disk
3 TB Transfer*

Select

\$40
a month

4 GB Memory
2 Core Processor
60 GB SSD Disk
4 TB Transfer*

Select

\$80
a month

8 GB Memory
2 Core Processor
80 GB SSD Disk
5 TB Transfer*

Select

* Some types of data transfer in excess of data transfer included in your plan is subject to overage charges. Please see the [FAQ](#) for details.

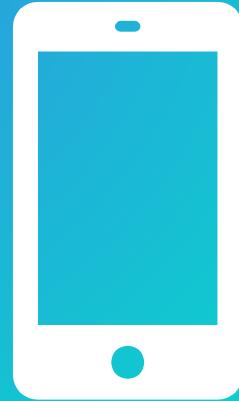
AWS Logo: <https://gigaom.com/wp-content/uploads/sites/1/2012/08/awslogo.jpg?w=300>

Amazon Lightsail Logo: <https://btmagazin.net/wp-content/uploads/2016/12/amazon-lightsail.jpg>

Price:

<http://zdnet2.cbsistatic.com/hub/i/r/2016/11/30/81e07ee5-3547-407b-9fe1-c191302d0ebd/resize/770xauto/f436467273ec50ddd9a7434c35b21894/amazon-lightsail.jpg>

Back

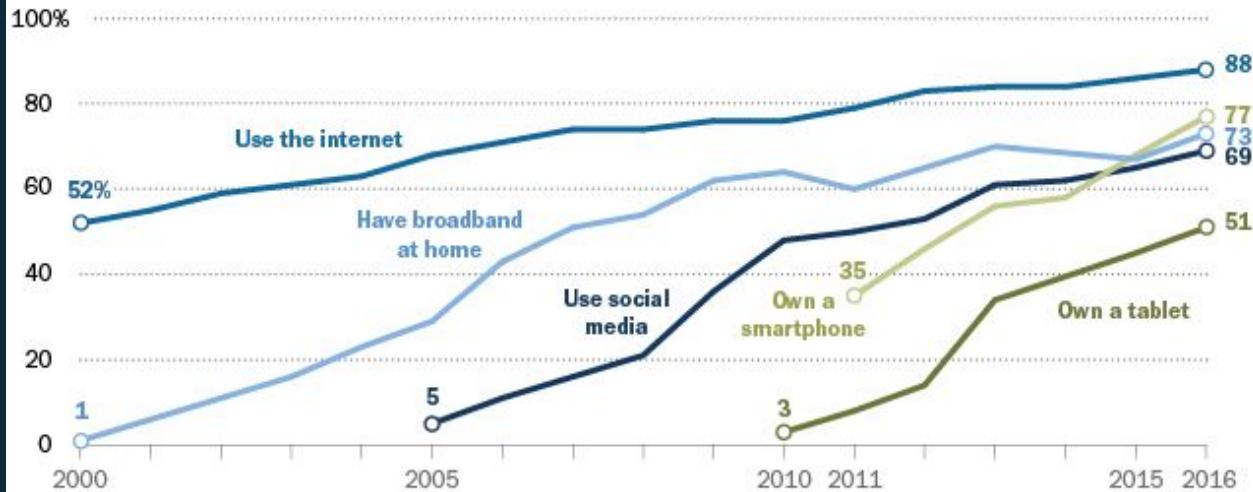


Smartphone Application

iOS based App -- SightRPI

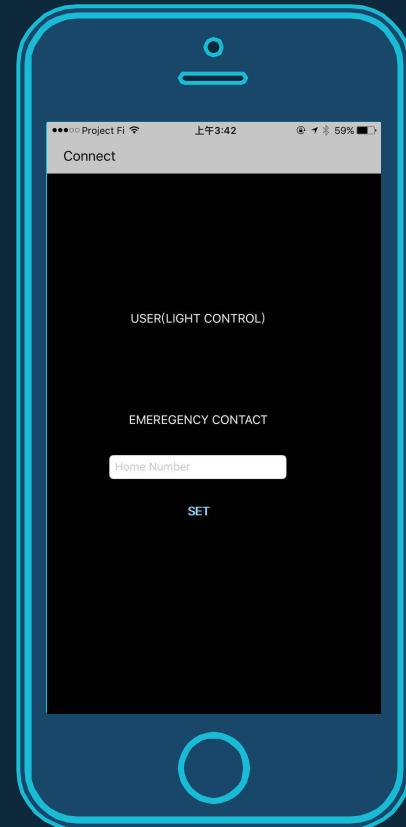
The evolution of technology adoption and usage

% of U.S. adults who ...

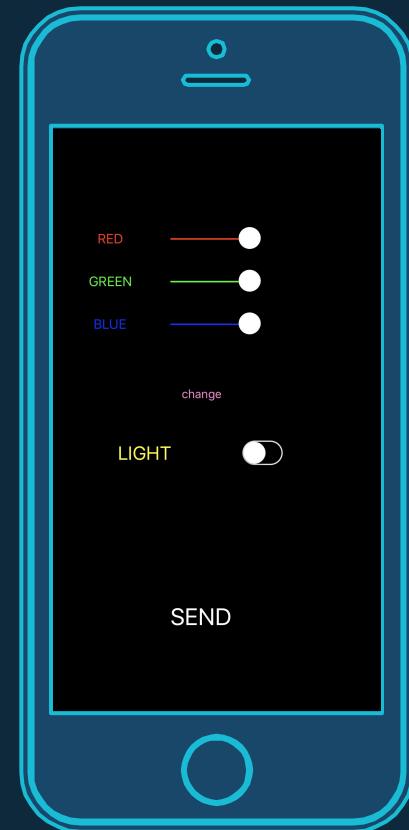


Source: Surveys conducted 2000–2016. Internet use figures based on pooled analysis of all surveys conducted during each calendar year.

PEW RESEARCH CENTER



Home Page



Light Control Mode



Emergency Mode

Next



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Test & Analysis



Test & Analysis

Test case	Metric	Results
Adults (Primary)	Average height: 66.55 inches In our scale: 5.546 inches	<u>Pass</u> Can be detected
Pets	Average height: 26 inches In our scale: 2.167 inches	<u>Pass</u> Can't be detected
Children above 3 years old	Average height: 34.8 inches In our scale: 2.9 inches	<u>Pass</u> Can be detected
People deliberately lying under sensor	Confirmation System replying "Yes" and "NO"	<u>Pass</u> People can keep lying without triggering the alarm system



*Using 1:12 scale for our demo room.

*Using dog figure to test our demo because it's the most common pet (AVMA)

*IR Beam is set 2.32 inches height



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Safety

Safety

- ◆ Residential lighting requirements
- ◆ User information security and privacy





Acknowledgement

Special thanks to professors of RPI: (sorted by alphabetical order of last name)

- ◊ Professor Kenneth A. Connor
- ◊ Professor Casey T. Jakubowski
- ◊ Professor Hisham Mohamed





Your
Suggestions &
Questions
always help.

-- by Team SightRPI





Thanks!

**Any interest or further
questions?**

You can find us at:

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