



Neptune

Team 16
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Team 16 Introduction



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What is the Problem?



- Drownings are a leading cause of accidental injury-related deaths throughout the world.
- Several factors contribute to risk of drowning including:
 - Lack of swimming ability
 - Lack of necessary barriers
 - Lack of close supervision
- These tragic deaths can be prevented in some cases.

How significant is the problem?

- Est. 370,000 drownings worldwide per year
- From 2005-2009, there were an average of about 3,900 drowning deaths per year in the US¹
- About half of these deaths occurred in swimming pools.¹



- Drowning ranks 5th in the leading causes of unintentional injury death in the US. 1st among children aged 1-4.¹

¹CDC. (2012, May 18). Drowning - United States, 2005-2009. *Morbidity and Mortality Weekly Report*, 61. Retrieved from <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6119a4.htm>

Context: Effect on Individuals

Scott



- Greatly decrease the chances of children and adults drowning in swimming pools.
- Help lifeguards do their jobs more effectively.
- Help homeowners protect their pools. Insurance discount?

Context: Effect on Groups



- Loss of loved ones has an inexplicable impact on families as well as the communities in which they live.
- Parents especially vulnerable
- Monitoring public swimming pools.

- **Features:**

- Cameras detect and track movement in the pool
- Artificial Intelligence which differentiates between "normal" and "suspicious" behavior
- Security Display from which every camera feed can be monitored

- **Alert**

- LED Sign
- Alarm

- **Capacity**

- Covers an entire pool

- **Cost**

- Starts at \$60,000 and maxes out at \$150,000

Bunyan, N. (2005, September 1). Underwater camera save pool girl from drowning. *The Telegraph*. Retrieved at <http://www.telegraph.co.uk/news/uknews/1497363/Underwater-cameras-save-pool-girl-from-drowning.html>

Existing Solution - iSwimband

Greg

- **Features**

- Headband or wristband
- Detects how long user has been submerged

- **Alarm**

- Bluetooth alert sent to cell phone

- **Capacity**

- Eight bands per smartphone

- **Cost**

- \$40-\$50 for one headband and one wristband



Our solution: Neptune

- **Features**

- Uses multiple ultrasonic sensors to detect people's and animal's positions in the pool.
- Data is compiled in the control center where 2D maps of the pool are created and displayed on the monitor.

- **Alert**

- LEDs and audible alarm goes off upon drowning detection.
- SMS alert also sent to the user's phone upon detection.

- **Cost**

- Budget: \$500 (not including installation)

- **Our design proposal is based on the human approach to determine drowning**
 - Lifeguards are taught to identify a drowning victim based on their movements in the water.
 - Typical drowning victims appear to struggle and thrash around while remaining in the same spot.

Requirement Analysis: Specifications

- Detect people entering the pool
- Alert nearby people
- Minimize false alarms from a person “standing still” versus an unresponsive individual
 - Doppler shift³ for sound yields:

$$f_{target} = f_{source} \frac{(v_{sound} \pm v_{target})}{(v_{sound} \pm v_{source})} \text{ where } v_{source} = 0 \text{ m/s}$$

³Redner, S. (2006, February 11). The Doppler Effect. *Boston University*. Retrieved at http://physics.bu.edu/~redner/211-sp06/class19/class19_doppler.html

Requirement Analysis: Inputs and Outputs

Input:

- Pool environment

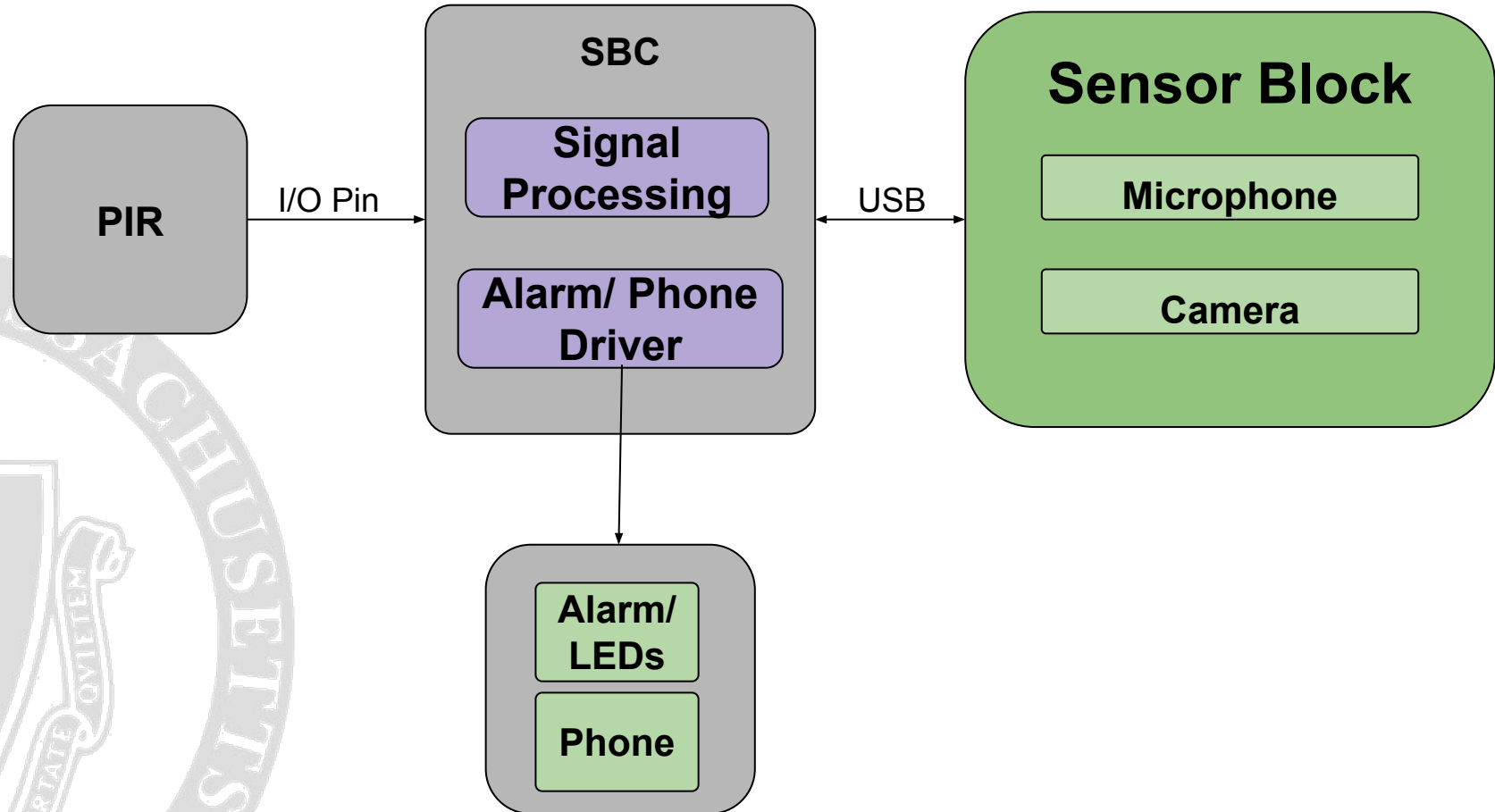


Output:

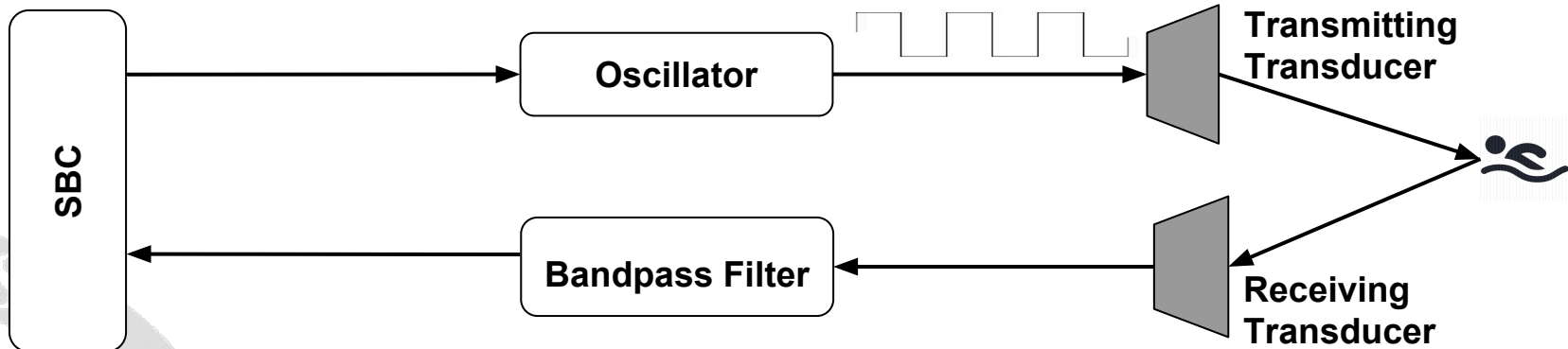
- Text message
- Audible alarm
- Flashing LEDs



Block Diagram



Block 1: Ultrasonic Sensor



- **Transmitter:**

- Generate ultrasound at a frequency over 40 kHz

- **Receiver:**

- Center bandpass filter around $f_c = 40$ kHz
- Apply Doppler shift equation:
 - $f_{low} = 32$ kHz and $f_{high} = 48$ kHz

Block 2: Control Station

Greg

- **Single Board Computer**

- CPU: 1.6 GHz ARM Cortex-A9 quad core
- Memory: 1GB
- Storage: Micro-SD card
- Wifi
- Supports Linux and Android OS
- 2 USB Ports
- HDMI Port

- **Display**

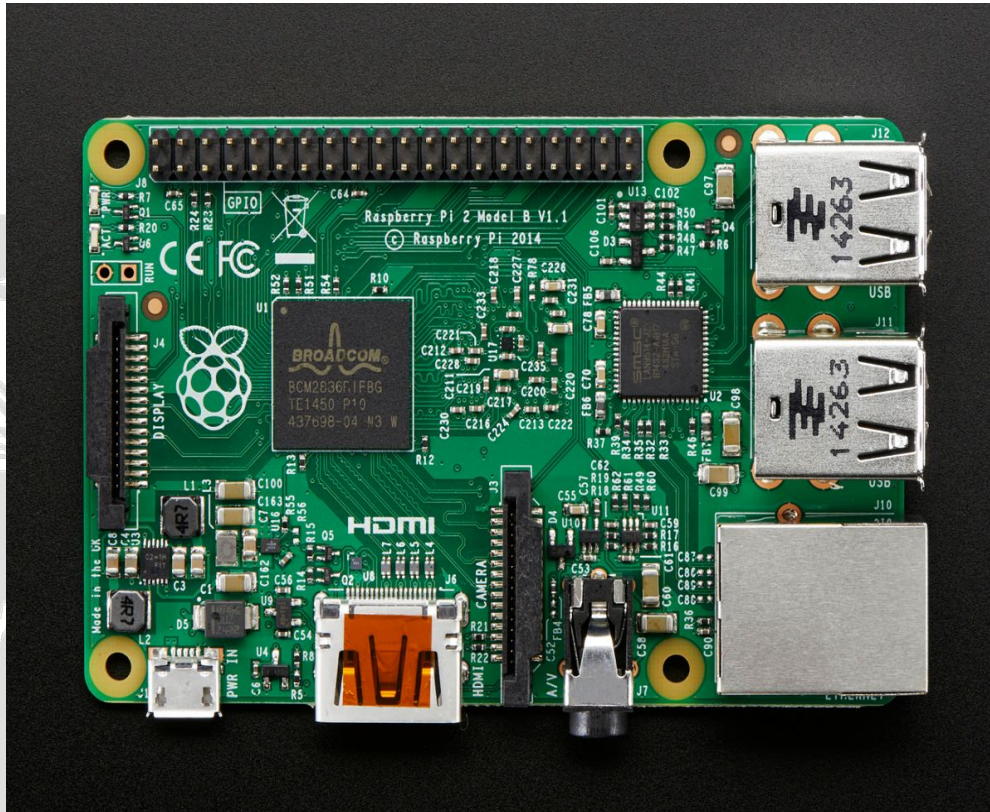
- HDMI Monitor

- **Alarm**

- Visual and audible notification



Design Alternatives - Using Raspberry Pi



Raspberry Pi 2 Model B

- ARM Cortex A7 Processor
- 1 GB RAM
- 4 USB Ports
- Ethernet Port
- HDMI Port

Cons:

No Analog/ Digital

Conversion support

Design Alternatives - Wristband Sensor

- **Description:**
 - Built-in pulse oximeter to constantly monitor blood oxygen level, and alert someone once the oxygen level dramatically decreases
- **Advantages:**
 - Low power
 - Long range
 - Lightweight
- **Disadvantages:**
 - Expensive (one per person)
 - Difficult to stay on kids
 - Unable to detect location



- **Description:**

- Monitors and tracks people actions to detect drowning behaviors and/or motionless victims

- **Advantages:**

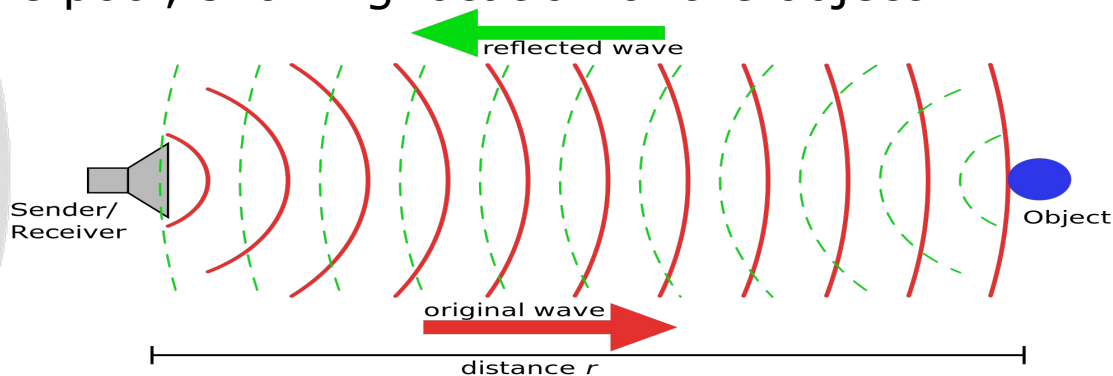
- Accurate
- Time-saving

- **Disadvantages:**

- May not function at night
- Expensive



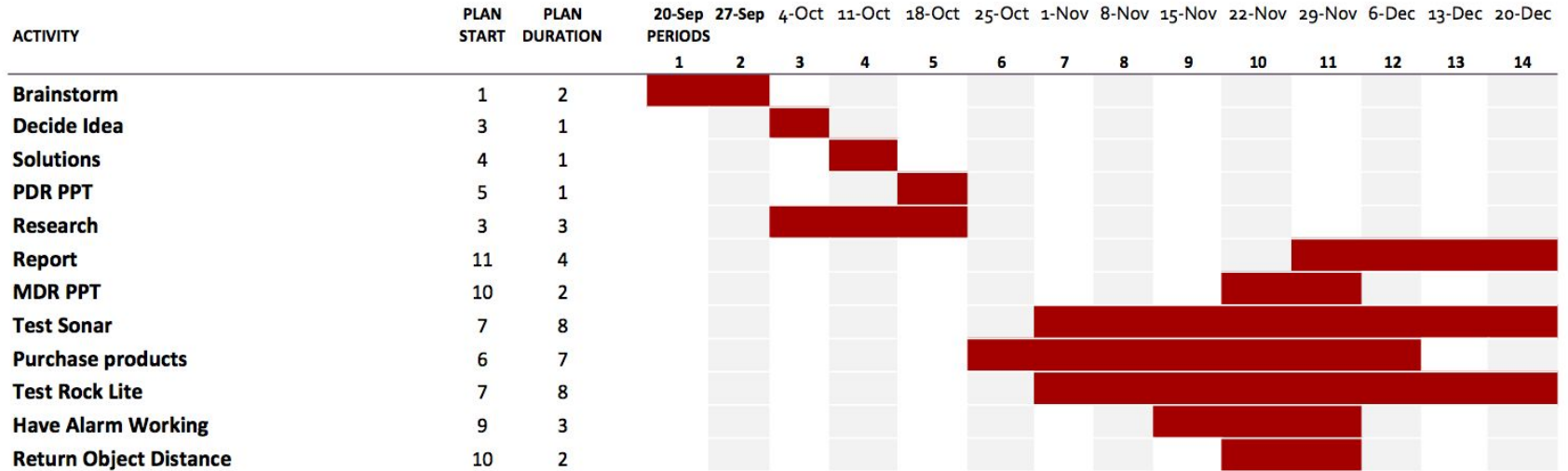
- Prospective MDR deliverables
 - Using a small body of water (bucket/bowl):
 - i. Working sonar sensor capable of detecting the presence of and distance of an object on one axis.
 - ii. Alert functionality (flashing LEDs, and alarm)
 - iii. Process received signals in order to create a “map” of the pool, showing location of the object.



Gantt Chart



SDP-16



Thank You! Questions?

