Pool-AID: A Drowning Prevention System

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***Abstract*— The following paper outlines the design of a pool-alarm system that detects possible drowning activity. The main motivation behind this device is the number of accidents that have been linked to the lack of supervision around backyard pools. Pool-AID attempts to address this safety gap between existing pool-safety technologies and real-time alerts for busy parents through the use a passive infrared sensor and a gyroscope. Once activity is detected in the body of water, an alarm is sounded and images of the body of water are captured. The end-user can view those images via a connected mobile application that stores any activity logged by the free-floating system. The use of a device whose only job is to detect drowning activity could be much more reliable than a parent juggling between multiple tasks at once. Pool-AID will ensure the safety of their loved one and provide much needed surveillance with little to no effort from the user.**

Keywords — Drowning Detection, Alarm, Wireless Communication, Mobile Application, Gyroscope, Motion, Waterproof, Solar Powered, PCB.

I. Introduction

The idea of the Pool-AID came to life when a team member received news that, yet another toddler had lost their life falling into an unmonitored pool. According to the CDC, drowning is the third leading major cause of accidental deaths, after medical overdoses and traffic accidents, and the top-ranking cause of children fatalities. In the United States alone, drowning-related incidents have led to an average of ten deaths per day. The motivation behind Pool-AID is to create a system that is easy to use, water resistant, and affordable for families to keep their loved ones, young or old, safe. With technologies developing in every aspect of the world today, it is our responsibility to make sure that technology is also used to help prevent such tragic events from happening. The leading causes of drowning, as reported by the CDC, can be traced back to a lack of supervision and neurological disorders. The ultimate purpose of the project is to notify the homeowners, lifeguards, or babysitters if anyone has accidentally entered the pool and is struggling inside the body of water. With most drowning-related incidents happening in less than a minute, our system will be designed to recognize a child or person in distress in a reasonable timeframe.

While swimming is a fun activity to do in the warm summer days, it is not as compelling of an experience in the wintertime, so the pool area might be deserted with not much activity. Owning a pool requires some effort and weekly maintenance, regardless of the current season. Different safety devices like fences and rope lines have been used in the past; however, their reliability and efficiency levels are limited. A fence will not prevent a child from accessing the pool once it has been overcome, just like a rope line cannot aid an infant with no physical strength. The only way to prevent children drowning incidents from happening is through the help of an adult. Our device will be used to seek the attention of any present or nearby adults when swimming or drowning activity has been detected.

Drowning is an issue that needs to be taken as seriously as the other top leading issues have been taken in the past. For example, to avoid medical overdoses, child-proof packaging was designed to ensure the safety of kids under five. Similarly, car seats are required by law for children ages five and under to help prevent severe injuries after a car accident. Our project, Pool-AID, is intended to provide an effective solution to help prevent drowning incidents from happening. Pool-AID will be a tool every family with children will want to have in their pool to ensure the safety of their little ones. It will guarantee pool supervision without the risk of not paying attention or multitasking as its only task is to detect drowning activity in the pool. Regardless of the previous safety measures taken to keep toddlers and children away from different bodies of water, kids have limited notion of sensing danger. Whether it is to dip their hand into the water or fill a little bucket with water, kids will frequently try to interact with any type of water source near them. The goal of this design project is to minimize the number of accidental drowning deaths happening around the world and in the United States. Our drowning prevention system includes a wide range of features to help minimize drowning accidents in residential, private pools. The main objective of this device is to provide parents with a reliable surveillance system to alert them when suspicious pool activity has been detected.

II. Engineering Requirements

While there are multiple requirements our team designed the system to meet, there are three verifiable specifications we wanted to demonstrate. Table I below shows the specifications that Pool-AID was able to promise and deliver in the final demonstration video. The specifications focus on the system's response time, mobile application, and overall fault tolerance.

TABLE I. – Major Engineering Requirements

Requirement	Specification
Receiver's response time shall trigger the alarm in no longer than the specified duration.	$\leq$ **8 seconds** after activity is confirmed in the pool
The mobile application shall retrieve and display image captures in less than the specified duration	$\leq$ **15 seconds** after alarm sounds
The system shall maintain a minimal fault rate	**$\leq$ 10 %**

A. Goals & Objectives

Our drowning prevention system will include a wide range of features to help minimize drowning accidents in residential and private pools. The main objective of this device is to provide parents with a reliable surveillance system to alert them when suspicious pool activity has been detected.

i. The system must be waterproof and be able to float in a standard-sized pool. To cover a significant range of the pool, the device should float along the center of the body of water.

ii. The system will be accurate and reliable. Reliability is crucial as its failure means the system could not address its primary motivation of preventing children from drowning.

iii. The device will be portable, easy to set-up, and priced below previously marketed devices. We want the cost of our device to encourage parents to purchase the safety tool.

iv. The device will have low power consumption with solar panels being the primary source of power.

v. Our system will be able to trigger an alarm once the PIR and GY-87 sensors have given sufficient data showing a target is in distress.

vi. The alarm of the safety system should be heard within a range of 50 ft.

vii. The device will capture the activity with the relative timestamps and send it over to the mobile application where it can be accessed by the user.

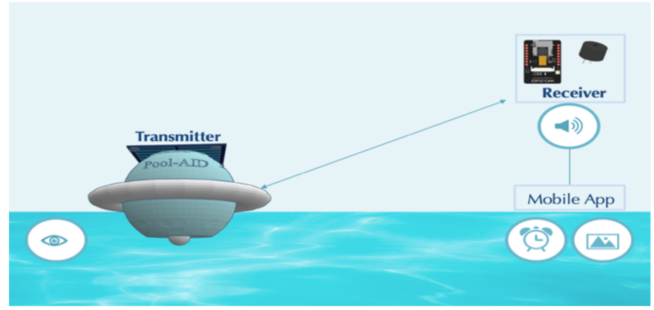
viii. The Pool-AID application must be user friendly and provide the user with the option to configure their saved data history.

III. System Concept

Pool-AID is a device that will provide parents with easily accessible pools a security system that alerts them any time their child is near the pool and triggers an alarm once activity has been sensed underwater in the same time frame. Pool-AID will come with two units: the receiver and the transmitter. *Fig. I*, below, shows the two separate units and their primary duties. The transmitter is responsible for detecting the tilting and filtering the kind of object in its proximity. Close to the pool, the receiver would be waiting for messages from the transmitter which would either trigger the camera to capture an image or do both, capture an image and sound the alarm.

The transmitter will be the sphere-like looking figure, while the receiver will look like a classic alarm in a rectangular container. The transmitter should be set in a standard-sized pool, or the area closest to the nearest exit point of the house. Note that the transmitter is waterproof and is able to float. We want the receiver to be closer to the home but not too far from the pool. The reason for that is we want the adult inside the home to hear the alarm when it sounds. The closer we have it to the indoor space, the more likely they are to respond to the activity. Allowing the receiver to be between both locations will also allow the camera to capture

FIGURE I. – Design Implementation



an image of the activity. In essence, the user would want to position the receiver so that the camera captures the entirety of the pool in its frame.

A. System Flowchart

Fig. II, shows the breakdown system flowchart of both the transmitter and receiver for the Pool-AID system. Once connection to the Wi-Fi is established by both devices the Wi-Fi module will wait to receive data from the MCU on the transmitter. The Pool-AID design makes use of a two-step verification system with regards to a living being contacting the pool. The transmitting side is based on two functions, one for the PIR and another for the IMU module. If both readings return true, we send an "ALARM_ON" and "EVENT_LOG" message to the receiver; otherwise, if only one returns true, only an "EVENT_LOG" message is sent. If both devices return true meaning motion and IR was detected within the pool, an alarm on trigger and event log is sent to the transmitters Wi-Fi module. If only one sensor returns true, only an event log is triggered. The Wi-Fi module on the transmitter will then send the triggered events to the ESP32 module on the receiver. The receiver first checks if the event is an alarm on trigger or just an event log, if it is only an event log it will trigger the camera to take a picture and upload to firebase and from there send to the mobile application. If the alarm on trigger is received the capture image will be triggered as well as the buzzer alarm of the receiver. From there the alarm will trigger, awaiting response from the user for a reset. Once the alarm is triggered and the user responds, the receiver remains idle until a message is received and the process is triggered again.

FIGURE II. – System Flowchart

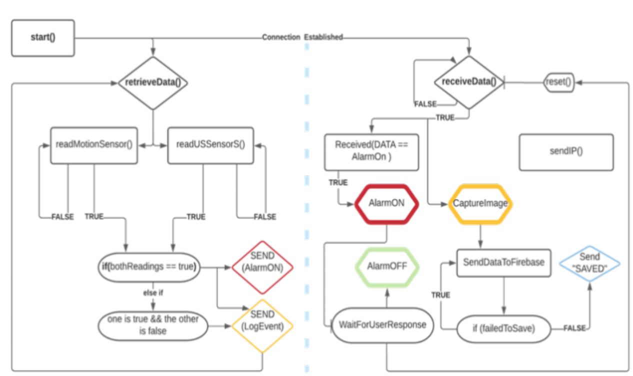
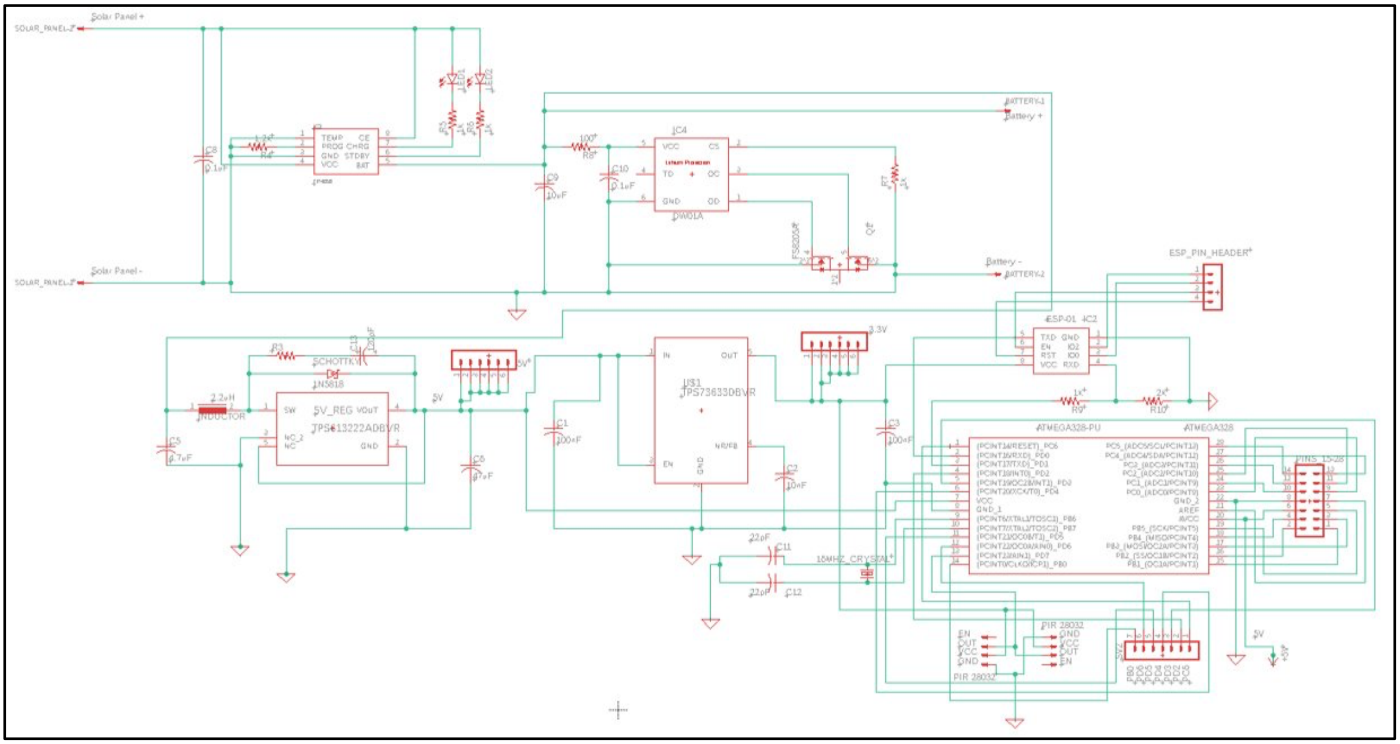


FIGURE III. – Transmitter Schematic



IV. Major Design Constraints

A. Economic

A major constraint for the Pool-AID is the economic, financial constraint. Having an affordable device was one of the market requirements that is intended to be satisfied so that the device is affordable to an average-income household. The Pool-AID in intended to provide the user with the safety mechanism intended for the system at a relatively affordable price of $200 or lower.

B. Health and Safety

Health and safety are constraints that are paramount to the motivation behind Pool-AID. Pool-AID is a device that will minimize drowning, a safety issue that has the potential to be fatal or impose lifelong health conditions. As the device is meant to operate in a body of water, it must be insulated and waterproofed with no room for error. Pool-AID will be designed in a careful manner to help prevent any harm or injuries to the user.

C. Social

Societal values, ethical and moral, play an important part in the realization of the Pool-AID as these are the core values that determine what is viewed as appropriate for the sensitivity, means, and validity of the mechanisms at play for this device. It is important to meet the criteria imposed by society as a device that does not adhere to these expectations is likely to be regarded as faulty, dangerous, and/or unserviceable. Without a proper understanding of the constraints that are imposed by societal values, a design that is accepted and understood by the general public would be very difficult to create.

V. Transmitter PCB Design & Overall Schematic

The PCB design of the transmitter serves to connect the various components necessary to detect and transmit underwater motion with those required to power and regulate these components. A look at Figure III shows the overall schematic design for the transmitter PCB which includes the battery charging circuit, 5 and 3.3 V regulator circuits, Wi-Fi module, MCU, and pin headers. The design of the PCB utilizes a two-layer board layout with 25 mil traces for all power signals and 10 mil traces otherwise.

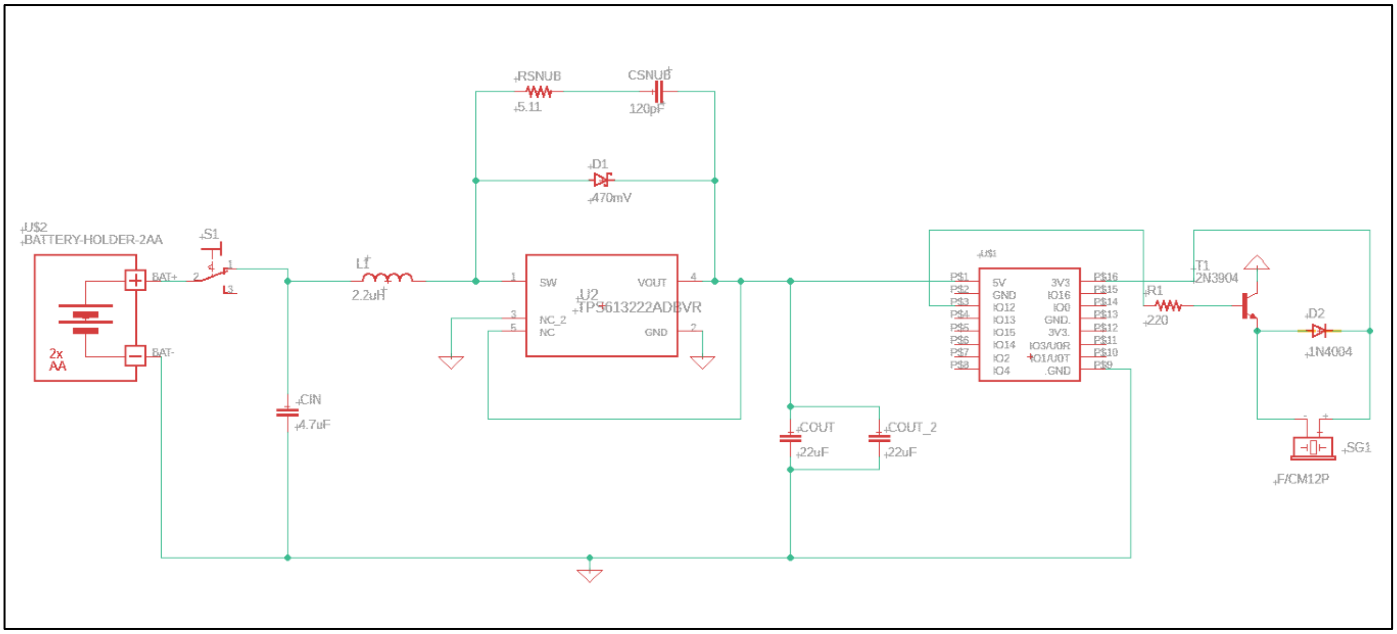
A. Voltage Regulators

The components for the transmitter require either 5V or 3.3V to power them. To that end, there are two voltage regulators included in the design. The first is a 5V regulator using the TPS613222ADBVR in a boost converter topology that will take the 3.7V input from the LiPo battery and boost it to 5V. Only the GY87 module requires 5V to be powered. The 3.3V regulator uses the TPS73633DBVR in an LDO topology that will supply power for the MCU, Wi-fi module, and PIR sensor. This part of the board is fed from the output of the 5V regulator. The output of the LDO connects directly to the MCU and also to a row of pin headers in order to interface with the other peripherals.

B. Battery Charger

The battery used for the transmitter is a LiPo battery providing approximately 3.7V. To charge the battery a circuit is implemented to allow for a solar panel to interface with the

FIGURE IV. – Receiver Schematic



PCB. This circuit has pin headers for solar panel input and battery output. It includes overcharge protection and LEDs to indicate when the solar panel is actively charging the battery or if it is idle.

C. PIR

The passive infrared sensor, or PIR, is the primary detection protocol for determining if an object underwater is living or inanimate. To this end the Parallax 2308 sensor is placed through a hole in the bottom of Pool-AID's housing allowing for a 360-degree viewing radius. The PIR connects to the transmitters MCU through pin headers on the board and sends digital signal to the MCU when underwater motion by a living object is detected. The PIR is powered by 3.3 V and is connected either via the voltage regulator pin headers or the designated PIR pin headers on the board. The sensor has a total of four pins, one for Vcc, ground, output, and enable. The enable pin is unique to this sensor and serves as a nighttime enhancement mode for low visibility. It is unused in the design.

D. GY-87

The GY-87 module works in conjunction with PIR sensor in order to detect anyone interacting with the pool. The GY87 has several components however the main feature used is the accelerometer and gyroscope which serves as the preliminary indicator of pool motion. By detecting changes of its locational axis, it functions as an initial trigger of pool motion with the PIR sensor being used to determine if the object that cause motion of the Pool-AID was in fact a living being. This module is located off board and connected via pin headers and is screwed down as any unwanted erroneous motion could cause triggers. It communicates with the MCU via I^2C and provides us with readings from the gyroscope and accelerometer to determine the tilting caused from an event.

E. ESP32

The ESP32 Wi-Fi module is used on both the transmitter and receiver. However, the receiver has added features to support the camera functionality. This module interfaces with the MCU and sends alerts to the receiver Wi-Fi module for two distinct circumstances. When one sensor is triggered, the event is logged, and the Wi-Fi module sends an alert for the receiver to take a picture. When both sensors are triggered an alert for both a picture and buzzer alarm is sent to the receiver.

F. MCU ATmega328P

The ATmega328P was the chip chosen for the transmitter design. It interfaces and controls the communication necessary between all the transmitter's peripheral devices such as the Wi-Fi module, PIR sensor, and GY87 module. It's primary functionality on the transmitter board is to act as a sort of liaison between the sensors and the Wi-Fi module. It does this by determining when the sensors have detected an event and sending a notification to the Wi-Fi module to send to the receiver. The layout of the chip on the board was kept generic with pin headers placed on the board to allow for flexibility during the testing process. This also enabled the sensors to be placed off board which was necessary for successful implementation of the design.

VI. Receiver PCB Design & Overall Schematic

The PCB design of the receiver serves to implement the alerting functionality of the project using primarily a combined camera/Wi-Fi module. A look at Figure IV shows the overall schematic design for the receiver PCB which includes the 5V regulator circuit, MCU/Camera/Wi-Fi module, and the buzzer circuit. The design of the PCB, like that of the transmitter PCB, utilizes a two-layer board layout with 25 mil traces for all power signals and 10 mil traces otherwise.

A. Voltage Regulators

The receiver only required a single voltage regulator because all components of the circuit run off 5V logic. The voltage regulator was designed using Texas Instruments' WeBench power design tool. For the input parameters, a minimum voltage of 2.4V and a maximum voltage of 3.2V was selected because the power input for the receiver was two AA batteries, which should be around 3V total but can vary slightly. The maximum current required was calculated to be 300mA and was inputted into WeBench along with the desired 5V output voltage. With these factors entered, WEBENCH generated a DC-to-DC converter utilizing a boost converter topology. The chip that was used for the boost converter was the Texas Instruments' TPS613222ADBVR integrated circuit.

B. ESP32-CAM

The primary component of the receiver is the Ai-Thinker ESP32-CAM Wi-Fi SoC Module V1.0. This module serves as the microcontroller, camera module, and Wi-Fi module all in one package. For the purpose of the microcontroller, the ESP-32S chip handles all of the internal logic of the receiver device and controls the camera and the buzzer components of the system. With regards to the camera module element, an OV2640 camera is inserted into the module to allow the controller to take pictures when the controller receives a message to do so. Finally, the Wi-Fi element is also controlled by the ESP-32S chip on the module and an antenna that is on the PCB for the module. The Wi-Fi module accepts messages from the transmitter to determine when the controller should activate the peripheral components and sends pictures to Firebase when they are taken.

C. Active Piezoelectric Buzzer

The final main component of the receiver is the buzzer. An active piezoelectric buzzer was determined to be the best option for this project because of its maximum sound pressure level and its active nature. As for the maximum sound pressure level, a piezoelectric buzzer can deliver a higher sound pressure due to the linear relationship between its input drive signal and the output audio power, as opposed to magnetic buzzers. This was deemed an important aspect of the design, so as to be as alerting as possible.

A buzzer that is active was chosen because of its lower current draw and simpler operating principle since active buzzers have built-in oscillation sources and do not require an external driving circuit, unlike passive buzzers. This lends well to ensuring that the circuit is not unnecessarily complex or power hungry.

VII. Pool-AID Design

Pool-AID is a two-part device that consists of a transmitter and receiver. The transmitter is be the central part of the device and contains all the sensor modules embedded within it. The receiver part of the device will only consist of a buzzer, camera, and a power supply source. The two parts will be connected wirelessly, to allow the alarm to be closer to the user but still close enough to the pool so that the person in distress knows that the adults have been alerted.

The housing for the transmitter of the Pool-AID device had to meet two basic requirements. First, it needed to float and, secondly, it could not restrict the ability of our device to perform its various functions. As the housing unit is the main portion of the Pool-AID that the user will see and interact with daily as it floats in their pool, it is important to have an aesthetic design to increase the potential marketability of the device. Therefore, we decided that a sphere like container would provide us with the most efficient and aesthetic look for a tool that will be visible on any pool surface. The sphere container will be of the same shade of blue of pools and thick enough to provide protection to the hardware in the interior from sunlight. The container was designed, and 3D printed from resin material to help us meet the two requirements mentioned above, maintaining a waterproof system, and not interrupting the visibility scope of the sensors underwater. Provide protection to the hardware in the interior from sunlight. To aid with the stability of its flotation, a ring encircles the main housing and there is additionally an inner ring inside the housing with counterbalancing weight that keeps the device stable as the solar panel at the top of the housing would cause it to tip in the water otherwise.

FIGURE V. – Pool-AID Design

VIII. Mobile Application

The purpose behind our mobile application is to allow the user to interact with the collected data and information received from the transmitter. Building a functional application allowed us to increase the chances of alerting a parent that is not so close to the pool. The app features multiple options to make the app as interactive as possible. Once authenticated, the user is able to access a gallery of their image captures, details of the event captured, and an alarm on-off button that directly controls the receiver's buzzer. When designing the application, there were two parts that needed to be built and integrated within one another in order to make the features mentioned above happen. We will discuss both, the backend and frontend, design process.

A. Backend Setup of the Application

The backend design choices play a crucial role in making sure the mobile application is able to deliver images and notifications under the requirement specifications discussed on *page 1*. As the data received from the hardware is raw and hence unstructured, the database managing and storing the users' images and related information had to be nonrelational. Google's Firestore is used to ensure that the authenticated user is able to access their content. One section of the database is dedicated to storing users with access to the application that have registered using their email and assigned password. The security rules for authentication were first set to test mode for the alpha version of the app so the team could test accordingly. These settings were then changed for the beta version of the application to locked mode to ensure that only registered users could access their data.

The first field of the collection is the time the alarm was triggered. Firestore features an option to create a timestamp object, which takes the date and the exact time the data was inserted to the collection in the database. In the scenario where the alarm gets triggered on Monday at noon, the capture time field will now include the current date and the exact hour and seconds the data was added, such as April 4^{th}, 2022, 12:00:00 PM. The second field of the database includes the image capture that was sent to firebase from the ESP32-CAM module. The image field in our collection will be of type string, and the string will correspond to the link of the bucket storage that contains the picture. A third field is included to store the ID of the owner of the Pool-AID system, which in our case would still be the user. When a user was created using authentication, an ID for that user was also generated, which we use to trace data back to them whenever messages are received, and images are captured.

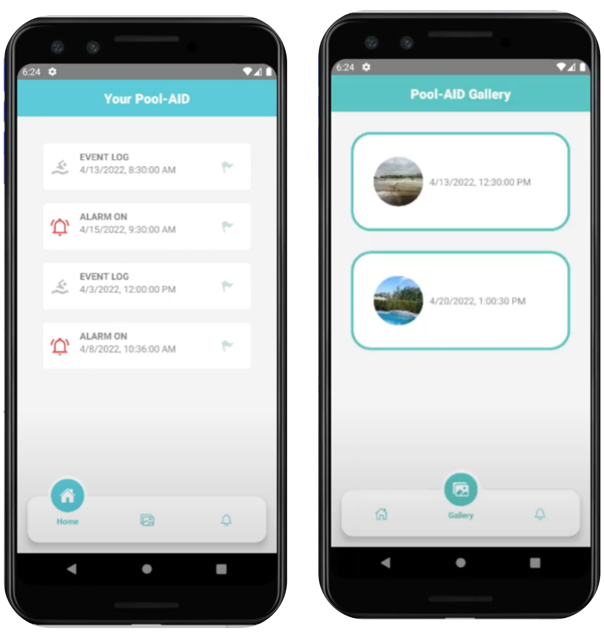


FIGURE VI. – Pool-AID Mobile Application

B. *Frontend Design of the Application*

We want the Pool-AID application to enhance the way our user interacts with the device. The goal of the application is to provide access to the activity captured by the camera and time-stamped logs. The stretch-goal of developing this app is to integrate a series of settings to remotely disarm the alarm, authenticate users, and accessing the real-time image captures by the camera. The application will be built simply for the user's convenience and will not affect the performance of the system in any way in case of failure. *Fig. VI*, highlights the navigation between the different pages of the mobile app. The home page will show the most recent activity detected by the sensors.

For simplicity of the project, each component was built separate from the main app file to have the option to integrate each component and pass the needed props. This made the process easier than having a single file where all the components were overwriting each other. The application follows a structure similar to that of React's component lifecycle methods of updating the child components when some changes are made by some event occurring in the parent component. It was mentioned previously that the mobile application will need to have some communication with the database, so the data can be acquired from the database and be displayed on the mobile application. If our selection from the database is Firestore, there will be some component from the application that acts as a bucket storage to store the pictures taken by the camera module from the system.

This feature allows the user to communicate with the system itself, to either monitor the incoming alerts or turn off the device when the buzzer goes off. For the design of the application, pure CSS can be used or even styled components for the application to look professional and responsive to any type of screen. The main screen of the applications will include some widgets that will be beneficial for the user to navigate through the apps features and make it user friendly.

IX. COMMUNICATION

With two wireless parts to our device, the way they communicated required the use of multiple protocols. First, the transmitter's controller communicates with the passive infrared sensor and the GY-87 module. Secondly, it transmits the received data over to the receiver through Wi-Fi's HTTP protocol. Once received, the ESP32 communicates with the buzzer and the embedded camera module. The receiver is also configured to communicate with Firebase to log all the collected data.

A. *I^2C Serial Communication*

The GY-87 utilizes the I^2C serial communication protocol to write data to the MCU. I^2C, short for inter-integrated circuits, is the main way the peripherals within the GY-87 module use to communicate. In our case, only readings from the gyroscope and accelerometer are used to determine the degree of tilting, while the barometer and magnetometer do not provide us with any useful information to determine drowning-related activities. The SCL and SDA pins from the

GY-87 module are wired directly with the ATmega328's pins 27 and 28, which support SCL and SDA. SCL is short for synchronous clock line and is controlled by the master to drive the clock signal. SDA is short for serial data and is used to transmit over data between the master and the slave. The setup between the MCU and the module is relatively simple. Given the module's unique address, the sensor is able to send readings which are used in the calculations to determine the significance of tilting detected.

B. UART Serial Communication

UART Serial communication is used to interface between the transmitter microcontroller and Wi-Fi module. It will send a string over the RX and TX pins using UART from the transmitter to the receiver based on the readings from the GY87 module and the PIR sensor. Based on the values collected from either the GY-87 module or the PIR motion sensor, the ATmega328 is programmed to reflect a two-step check to ensure that the device is not triggering the buzzer for any simple and irrelevant activity detected. For instance, when an object contacts the water that is inanimate, the GY87 module will trigger an event and the microcontroller with send a string through UART to the Wi-Fi module however, as the PIR will detect nothing, the buzzer will not be triggered and only a picture will be taken.

C. Hypertext Transfer Protocol

Once the transmitter's microcontroller has prompted the Wi-Fi module to send a command to the receiver, the Wi-Fi module will send the commands to the receiver's Wi-Fi module using standard hypertext transfer protocol GET requests. This communication is possible between he Wi-Fi modules because the receiver's Wi-Fi module is set up as a server that is awaiting HTTP requests and the transmitter's Wi-Fi module is set up as a client that will connect to this server and send requests. Once the transmitter Wi-Fi module client has connected to the receiver Wi-Fi module server, the client can continue making requests to the server for as long as is needed. This allows for higher speed communication between the devices, as a connection and disconnection process is not necessary after every request, but only when the transmitter no longer needs to send information to the receiver for an extended period of time. The use of the hypertext transfer protocol allows for accurate and secure transfer of data over the server-client connection.

The hypertext transfer protocol is also used when connecting the receiver to a secure server on the cloud to avoid storage limitations and allow for easy remote access of images taken by the camera. With this, the receiver can add photos captured by the camera and store them on to a remote Firebase storage and create a document on a Firestore repository for interfacing with the mobile application.

X. Power

A. Solar Panel

Since the Pool-AID transmitter is intended to be left in a pool for an indefinite time frame, the power source for the system was determined to need to be self-generating. For this reason, a solar panel mounted on the top of the enclosure for the transmitter is the primary source of power that is to be inputted into the system. The two biggest constraints for the choice of solar panel are the size and power output, which are two constraints that are generally inversely proportional to each other.

As for the size constraint, the solar panel had to be small enough to fit onto the top of the enclosure while also not shifting the center of mass enough to lead to the enclosure rotating on the water. The power output was generally controlled by two constraints: the size of the solar panel and the silicon structure. The size has already been discussed and polycrystalline silicon structured solar panels were determined to be the better option for the project because, while being of lower efficiency, offer better efficiency per unit price than their monocrystalline silicon counterparts. With these considerations in mind, a polycrystalline solar panel was chosen that could provide 583mA at 6V for a power output of 3.5W was selected. This solar panel was also of appropriate dimensions, at 6.2 x 5.1 x 0.2 inches.

B. Lithium-Polymer Battery

While the solar panel is the primary source of power into the system, it cannot offer power constantly due to the varying nature of when there is sunlight necessary for its operation. Because of this, a secondary battery was needs, to store the power generated from the battery for later use.

Secondary batteries come in many possible chemistries that offer various price to power ratios and size to power ratios. For the purpose of the Pool-AID, a battery of optimal power to size ratio was determined to be paramount, as size and weight are of important consideration for the buoyancy of the device. For this reason, it was determined that a battery of lithium-ion type chemistry would be needed, as they offer exceptional power output for their size. Specifically, the lithium-polymer (LiPo) battery chemistry was chosen because, despite their higher propensity to damage with improper operation, they offer a very appealing power output for their size which was deemed optimal for this project. To ensure that the Pool-AID could run for a long enough time to operate continuously without the need of sun for many hours, a 3000mAh LiPo battery was chosen.

The 3.3-volt regulator that was chosen for the transmitter utilizes the Texas Instruments TPS63051RMW buck-boost converter chip. A buck-boost converter chip was necessary for this application as the lithium polymer battery typically outputs 3.7 volts which is above the 3.3 volts of the converter but can drop to 2.75 volts which is lower than the 3.3 volts of the converter. For preliminary testing, a prebuilt battery charger module, the Icstation 03962A, was utilized to gain an early understanding of the principles of lithium polymer battery charging and the ensure that the chosen battery and solar panels could be properly utilized for the circuits power elements. While this method was useful and convenient for testing purposes, it seems necessary to design a battery charging circuit specifically for the Pool-AID to ensure proper satisfaction of all characteristics can be met.

C. Power Consumption

Due to the Pool-AID transmitter being disconnected from any power source besides a solar panel and battery, power consumption is of primary concern so that the device does not power down unexpectedly. While the receiver is more easily accessible than the transmitter to the user for battery replacement, power consumption is still of concern so that the device can be ready to alert the user whenever an incident is to occur. To accomplish adequate power consumption performance, the maximum possible current draw for each device was tabulated and calculated to ensure that the devices would be able to provide for this current draw for a reasonable amount of time. While this current draw is not likely to occur for extended periods, it is a good baseline for determining a worst-case scenario, allowing certainty that the device can, at the very least, provide power for a determined amount of time.

TABLE II. – Transmitter Power Requirements

Transmitter	Voltage Requirement	Current Requirement
MCU	5 V	200 mA
Wi-Fi Module	3.3 V	170 mA
PIR Sensor	5 V	0.3 mA
Gyroscope Module	5 V	3.7 mA
Total	3.3 – 5 V	374 mA

TABLE III. – Receiver Power Requirements

Receiver	Voltage Requirement	Current Requirement
Camera Module	5 V	310 mA
Active Buzzer	5 V	20 mA
Total	5 V	330 mA

XI. Conclusion

The purpose of Pool-AID is to provide parents of adventurous toddlers a device that can save their little ones from a life-threatening, if not deadly, accident. With a number of established requirements before the design process, the team was able to successfully build a two-part device that delivers results to meet the specifications. This paper focuses on the technical design and implementation of a low-maintenance alarm system. Our drowning prevention system includes a wide range of features to help minimize drowning accidents in private pools. The main objective of this device was to provide parents with a reliable surveillance system to alert them when suspicious pool activity has been detected, and this paper highlights the design choices that were made to achieve that goal.

Acknowledgment

The authors of this thank Dr. Lei Wei and Dr. Samuel Richie for their insightful thoughts and feedback that were used to make this design project the best version of itself. We would also like to extend our gratitude to the University of Central Florida for giving us access to the Senior Design lab and trusting us with valuable equipment. Finally, we would like to extend our thanks to Drs. Zakhia Abichar, Edward Amoruso, and Zhishan Guo for accepting to be a part of our review committee.

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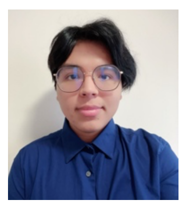
Biography



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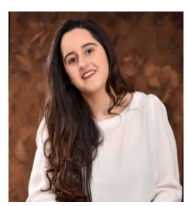

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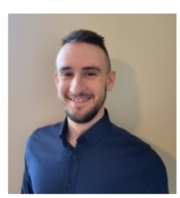

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