IoT Based Pet Tracker
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CONCEPT OF OPERATIONS

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FOR
IoT Based Pet Tracker

TEAM <17>

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1. Executive Summary

The purpose of this project is to address the problem of finding a pet whenever it is lost. The solution specified is to design and develop a GPS tracking system attached to the collar of a pet. On the collar there will be a GPS, camera, buzzer and LED. The GPS system and camera will communicate to a microprocessor which will then communicate to an android app. Through the app, the user will have the ability to set the dimensions of a safe area for the pet, request video streaming from the collar, and receive notifications when the pet is out of the specified safe zone. The buzzer and LED will be activated whenever the GPS detects that the pet has left the safe zone. Then the user will be notified via alert notifications from the app that their pet has escaped. By using the IoT Based Pet Tracker, the user should be able to locate and return their pet home safely.

2. Introduction

The Internet of Things (IoT) based pet tracker will perform a variety of features to enhance pet safety and monitoring. Many scenarios arise where pets compromise their safety by escaping or going into unsafe areas. By using the IoT based pet tracker, users can find the location of their pets whenever and wherever with the use of an Android app.

2.1. Background

Common measures for pet safety in place today include chipping—a practice where a chip containing the owner's information is inserted into a pet—and using pet collars that may have GPS capabilities. While these methods are effective, they are limited in their ability to efficiently locate pets. For example, chips only work by relying on the person who found the pet to take them to the pound and many GPS trackers do not report the exact location of the pet.

The IoT based pet tracker aims to improve the user's ability to find precious pets with the touch of an app. This can be used in tandem with chipping so users can find their pets while it's on the run or even after someone has brought it in to check the chip at a pound. It will also be helpful to be used along with a normal label and phone number on a dog collar. A bystander may notice your pet with the device lighting up and making sound and decide to call the number so you can get them back. This system will be able to replace other dog GPS trackers that have less features and overall usefulness than our tracker.
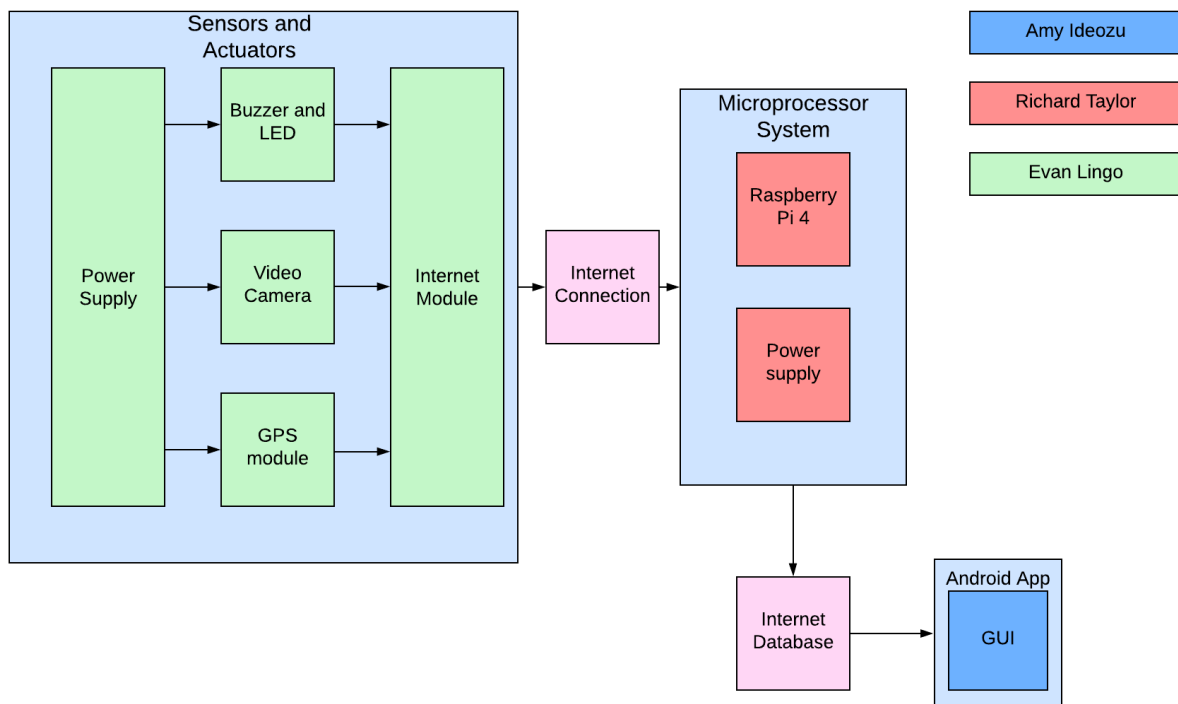
2.2. Overview

Figure 1: IoT Based Pet Tracker System Block Diagram

This system will be used to track the activities of a user's pet as it goes about its day to day life. There are three main subsystems involved in the IoT based pet tracker. The first subsystem is the system of sensors and actuators which will read input from the environment and send it to the microprocessor. By detecting GPS signals, the sensors will be able to send data as well as accept inputs from the microprocessor to actuate the camera, LEDs, and buzzer. The second subsystem will be the microprocessor system which will act as the middleman between the Android app and the first subsystem for the project. The microprocessor will contain all the code to accept and send input to the graphical user interface (GUI) via an online database as well as accepting and sending input to the sensors to ensure the whole project runs smoothly. The last subsystem is the Android app which will enable the user to monitor the activity of the tracker from their phone. It will have a variety of features including daily and weekly reports on pet activity, an option to check the video stream of the camera on the tracker, and an ability to set the bounds of the safety net for the pet.

2.3. Referenced Documents and Standards

- Raspberry Pi Instruction video:
  https://www.linkedin.com/learning/raspberry-pi-essential-training/welcome?autoAdvance=true&autoSkip=false&autoplay=true&resume=true&u=74650722
- Instructables Raspberry Pi and Android App Communication:
  https://www.instructables.com/Raspberry-Pi-Android-App-communication/
- Using GPS/Location Services: https://developer.android.com/training/location

3. Operating Concept

3.1. Scope

This project would affect the market of dog and cat owners that are concerned about the safety and behaviors of their pets. The IoT based pet tracker will be able to interface with multiple users through an internet database which will communicate with the Android app. As long as the consumer has an android phone, a pet, and stable internet connection in their house, they will be able to set up the IoT based pet tracker.

3.2. Operational Description and Constraints

The project will be used for the recreational purpose of security of pets. By checking daily and weekly activities users can be sure that their pet is staying within the bounds of its designated safe zone most of if not all of the time. By ensuring the location of the pet through the GPS system as well as additional security methods such as the video camera, LEDs, and buzzer sounds, you will be reassured that their pet is out of harm's way. Checking up on your pet will only require checking the easy to use phone app.

The constraints of the system are as follows
- The GPS, LED, buzzer, video camera, and power supply will be attached to the collar of the pet on a PCB with a Wi-Fi module to connect it to the Raspberry Pi 4.
- The Raspberry Pi will remain stationary in the user's house.
- The Android app will run on your phone.
- Both the microprocessor and phone app will be connected to the internet database and thus will be able to communicate with each other.

3.3. System Description
- Android App: will act as the user interface for the device, enabling the user to set the safe area, request video streaming for the collar, and receive notifications when the pet is out of the safe zone.
- Camera: takes video input to send through the microprocessor to the user's phone app via the internet.
- Buzzer: Will activate and remain active as long as the pet is outside of the safe zone.
- LED: Will activate and remain active as long as the pet is outside of the safe zone.
- Microprocessor: Raspberry Pi 4 will be used as the main functioning unit between the sensors and the android app.
- GPS module: will record the location of the pet through GPS and provide feedback to the app via the microprocessor.

3.4. Modes of Operations

The IoT based pet tracker will have two modes as well as an extra function that can be activated in either mode. The first mode will be INACTIVE in which the pet is inside the safe zone and thus the LED and buzzer will not be activated. In this mode , users will still be able to check the GPS location of their pet through the Android app. The second mode will be ACTIVE in which the pet is outside the safe zone and thus the LED and buzzer will be activated. In this mode, the user will receive notifications about their pet being outside the safe zone once every 30 minutes or so. In either mode the user will be able to use the Android app to check the video feed from the pet's collar.

3.5. Users

The IoT based pet tracker will be marketed to pet owners of dogs and cats of age 18 and above. It requires a basic understanding of replacing batteries for the system, setting up the Raspberry Pi, as well as basic knowledge about using the Android app. Many pet owners who are worried about where their pet may be at any given point in the day will benefit from using the pet tracker.

3.6. Support

Support for the IoT based pet tracker will come in a troubleshooting guide as well as a user manual. The user manual will encompass all the basic guidelines for using the system such as setting up the Raspberry Pi, replacing the batteries, and the basics for downloading and using the Android app.

4. Scenario(s)

4.1. Pet outside safe area

Once the pet is outside the safe area, the user will be notified via alerts on their phone. These alerts have to be manually turned off to ensure that the user is aware that their pet is outside of the defined safe area. At that point the user can choose to activate the video camera located on the collar. Additionally, the buzzer and LED on the collar will automatically be activated once the pet has left the safe area.

4.2. User request video camera

The user can request video whenever needed. It is not limited to only when the pet is outside of the safe area. However, the video will not always be streaming; the user must request the video stream via the app.

4.3. Redefining safe area

The user has the option to redefine the dimensions of the safe area for the pet. In the scenario where the user wants to take their pet to the park, they will be able to set the dimensions of the safe area to the park they are at. This ensures that the user is not limited to only one safe area.

4.4. GPS Malfunction

In the case that the GPS malfunctions or is not transmitting data to the user, the user can still request video feed from the collar. It is not an ideal situation, but there are still ways that the pet can be found. The buzzer and LED will not be activated as there will be no way to determine whether the pet is inside or outside of the safe zone.

4.5. Wear and Tear

In the event that the collar experiences any sort of wear and tear, including, but not limited to: exposure of the PCB boards, exposure of the battery, internal water damage, and/or physical damage inflicted on the collar, the user should remove the collar and dispose of it to protect their pet from any harm.

5. Analysis

5.1. Summary of Proposed Improvements
- Allow users to track and see the location of their pet at all times via phone app.
- Application will allow users to use geofencing to set "safe zones" for the pet.
- Provide visual and aural cues to alert user that pet is out of bounds and help user to locate their pet:
    - Video camera streams by user request.
    - LED and buzzer are activated when the pet leaves the area.

5.2. Disadvantages and Limitations
- No theft protection; the collar can be removed from the pet by anybody at any time
- App failure due to:
    - Slow/no network connection.
    - Blocking bugs in the program.
    - Disconnection from collar.

5.3. Alternatives
- Chipping pet, but requires the person who found the pet to go to a Veterinarian's office.
- Pet trackers that are already out in the market (but do not have video streaming capabilities):
    - Standard trackers: allows GPS signal only.
    - Hunting trackers: GPS tracking and buzzer to have.

5.4. Impact
- Because the pet tracker collects video footage, there may be privacy concerns.