

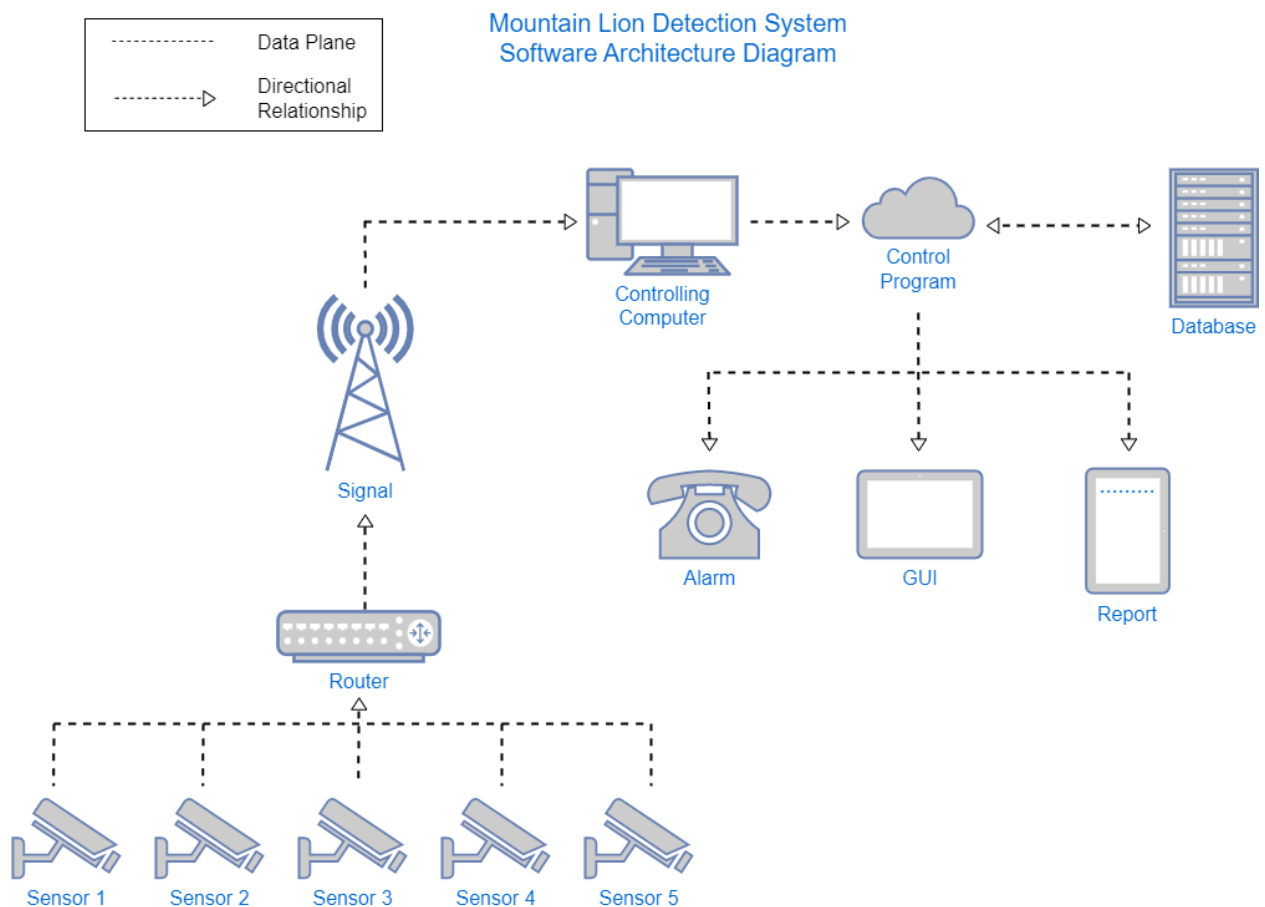
Mountain Lion Detection System

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1. System Description

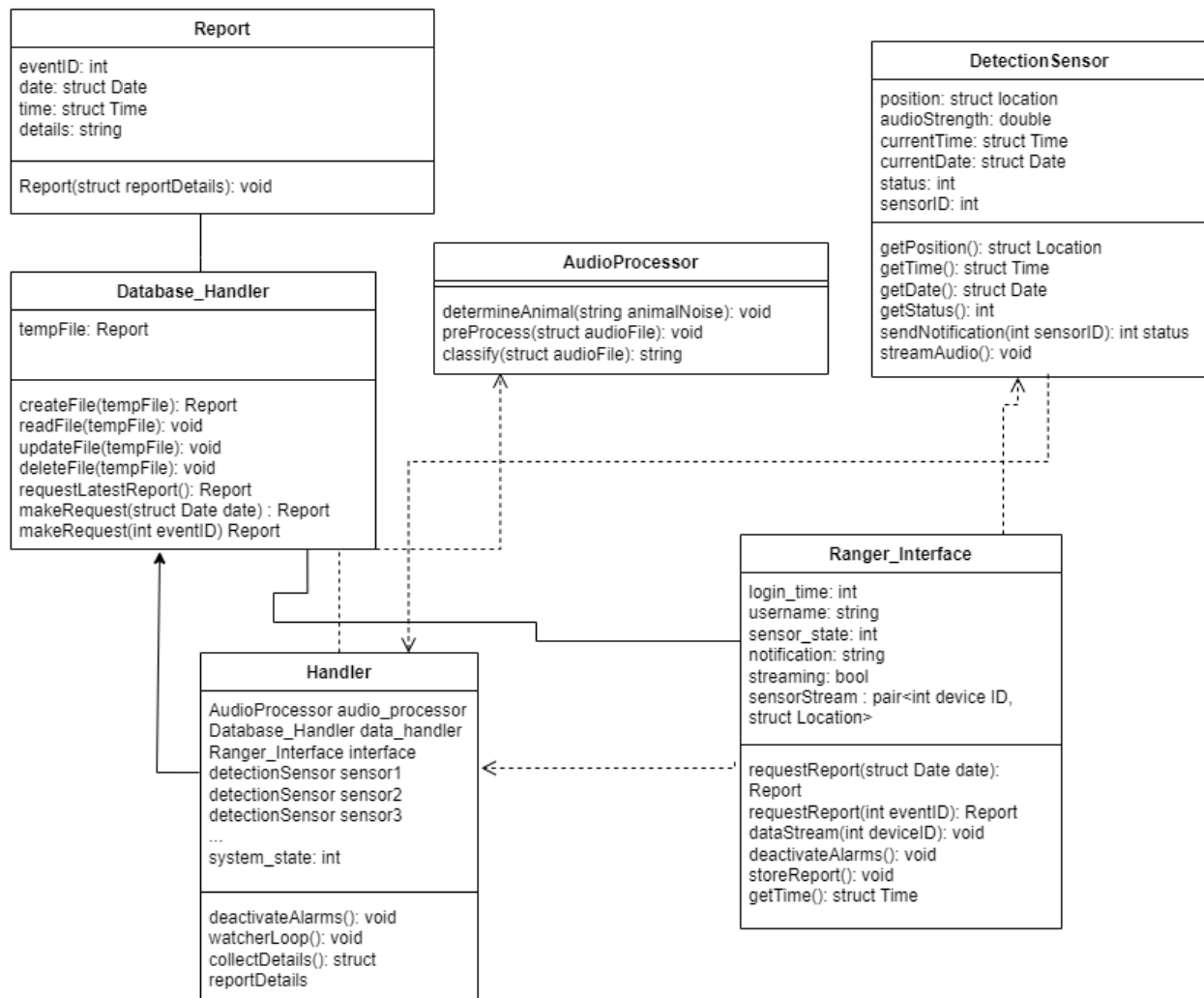
This is a mountain lion detection system, where the purpose is to detect any mountain lions nearby and if detected an alarm is sounded. This is needed to protect our civilians in parks all over California and allow our rangers to be more aware of what can possibly be out there in the parks. Though this system is for mountain lions it will also be able to detect different types of noises and animals that will directly notify the rangers to do what they need to do. This document will discuss precisely what requirements this system will need and how this system will be able to run smoothly.

2. Software Architecture Overview



The software system includes two main components which are the animal detection system and the controlling computer system. The animal detection system consists of five noise detection sensors. The sensors detect the strength, type, and location of the noise within a 3-meter radius. This information is sent to the controlling computer to be processed into a structured alert message. The Controlling Computer receives the alert message from the sensors based on both the type of animal noise and strength. The control program which is on the controlling computer has multiple functions for the ranges. Once an alert has been received from the animal detection system the control program will initialize the alarm to sound off. The alarm must be turned off manually by a ranger, otherwise it will continue to sound. The control program allows for the ranger to review and classify each alert message as definite, suspected, or false. The controlling computer saves all mountain lion alerts along with a summary of alert information to the database. Because the control program has access to the database it allows the rangers to request several types of reports, and display information with a graphical interface. Note that the control program will display any information such as the GUI and reports in the controlling computer.

UML Diagram



The handler will be the entry point of the program that runs the main watcher loop. This watcher loop will use an interrupt system to wait for notifications from the sensors (instead of something like polling) so that the rangers can also interact with the terminal while the server is waiting for a notification. These interactions may include things like generating reports. When an interrupt occurs, the program flow will be given to the appropriate function. The handler will have instances of the other classes as attributes so that it can call the necessary functions. It will have a state attribute that will change as the system goes through different stages such as all clear, warning, and emergency. It will also be in charge of giving the official notification to sound the alarm.

When the `detection_sensor` senses strange activity, it will send a flag to the main server along with its sensor id (this will be an integer that identifies which sensor is which). This causes the main server to query the sensor and record a brief audio. The sensor can give back information from its attributes such as the approximate position of the animal, the intensity of the sound recorded, and the time during recording.

The handler will pass the audio information from the sensor to an `audio_processor` class which will then perform a variety of functions to prepare the audio for classification of the animal. It will have a `preprocess()` function for cleaning up noise and then a `classify()` method which will return the believed animal type using a deep learning algorithm. For testing, a known animal noise can be passed to show that it is classifying animals correctly.

The `Ranger_Interface` class will have the functions that are tied to the buttons of the graphical interface. It will keep track of information on the ranger's login session through its attributes like the `login_time`, username of the ranger, sensor state (all of which to be shown on screen), and any notification to be displayed. It will provide a graphical link to the database functions for rangers to be able to request reports using a few different parameters, for example one could request reports based on the date it happened or by an event id (each event will have an id attached). There will also be a `dataStream(int deviceId)` method that allows the ranger to watch a certain sensor on screen at will by clicking the desired sensor.

The `Database_Handler` class will simply define CRUD operations for interacting with the database and functions that wrap specific SQL commands to easily get specific information without having to design requests. Each report will be an object defined by the File class, this way the reports will have a consistent format. These files in the database can be created, read, updated, and deleted. These may be expanded to perform more specific and useful functions like SQL requests that get all the events for a certain day or to get the most recent event, etc.

3. Development Plan and Timeline

PROJECT TIMELINE

Approximate Budget: 3 million USD

APRIL 2023 - JULY 2023

Month of April (Starting April 3)

The engineers will first have to install all the appropriate hardware to support the system. We'll have one person for field setup such as the sensor and alarm devices, with a group of three for the mainframe server and network setup. The equipment will take about two weeks to configure to a basic level but will also need to be fortified to withstand various weather conditions such as rain, snow, and heavy winds, so we can expect hardware setup to take about three weeks.

(ETA April 24 - May 1)

Month of May

Before starting with the higher-level development, we will give developers three weeks to get the most basic functionality running and do robust testing to ensure that our interfaces are working. The developers will set up unit tests to make sure devices have basic capabilities such as having the server successfully recognize a sensor message (without location), having dummy entries successfully saved to the database, and having the main server accept login information from rangers. With these foundations in place, higher-level development should be started by the beginning of June (June 1 - June 8).

Months of June and July

Developers will be able to use existing infrastructure and low-level capabilities to start plugging in higher-level functionality. This will include creating the classes and functions that will perform the needed functionality instead of using dummy data. The major aspects to work on will be the ranger interface, the main loop/sensor interrupt functionality, the CRUD operations to perform on the database using different querying parameters (event id, date, etc.), and the audio processing functionality which will involve extensive training to classify animals correctly. Expect 8 - 10 weeks to have the system working to an acceptable level for deployment (Delivery: August 5 - August 12)

Maintenance

We'll have to put measures into place to keep the system updated and add features as needed without complications. The system will be designed to accept new sensors or alarms with no changes to the existing infrastructure. Hardware checks on the devices will have to be performed every week to check for cracks or damage to devices as well as electrical issues. The audio processing will have to be fine-tuned to accommodate unforeseen circumstances and improve accuracy.

4. Verification Test Plan

Unit Testing

- Unit: Test Set 1

determineAnimal(string Animal)

Input: Roar

Expected Output: AudioProcessor.determineAnimal = Mountain Lion

The function determine Animal() will be passed a string from the Database_Handler which the Ranger_Interface can establish the animal data categorized in relation to the sound identified.

- Unit: Test Set 2

void updateFile(tempFile)

Input: Input of the temporary file created from an instance of the class, Report

Expected Output: Output does not return anything but the file is has new material in the file that was set with the parameter

Functional/Integration Testing

- Integration: Test Set 1

Classes: Ranger_Interface/Database_Handler

Feature Description: Ranger interface report request should make request for a report with the database handler and display the data on

Test 1:

Input: Date 03/22/2021

Feature: Ranger_Interface.requestReport(03222021)

Expected Output:

Database_Handler -> tempFile = Report

Database_Handler.readFile(Report)

Test 2:

Input: Invalid Date 05/32/2070

Feature: Ranger_Interface.requestReport(05322070)

Expected Output:

Database_Handler -> tempFile = null

Database_Handler.readFile(Report) = null

Description: tempFile will be null if there is no Report to read that has an ID of the Date specified in requestReport(), otherwise if there is a valid ID with a Report in Database_Handler then tempFile : Report and the Ranger_Interface has access to read file.

- **Integration: Test Set 2** -> Detection_Sensor/Ranger_Interface Integration
Feature: Detection sensor activation should prompt data stream from respective sensor to Ranger Interface

Test 1: Existent Sensor

- Input:
 - integer 2
- Feature:
 - Detection_Sensor.sendNotification(2)
- Expected Output:
 - Ranger_Interface -> sensor_state = 1
 - Ranger_Interface -> streaming = True
 - Ranger_Interface -> sensor_stream = 2, (50,100,50)

Description: Sensor_state should be set to 1 to signify warning state (0 all clear, 1 is warning, 2 is emergency). Because Detection_Sensor.sendNotification() occurs, Ranger_Interface.dataStream() should be called with the appropriate deviceID to stream the current audio data to the ranger interface for the sensor with suspicious activity. This should cause the sensorStream attribute to change to signify the streaming sensor (2 in this case) as well as that sensor's x,y,z location (sensor 2 located at 50,100,50).

Test 2: Non-Existent Sensor Edge Case

- Input:
 - Integer 0
- Feature:

- Detection_Sensor.sendNotification(0)
- Expected Output:
 - Ranger_Interface -> sensor_state = 0
 - Ranger_Interface -> streaming = False
 - Ranger_Interface -> sensor_stream = 0, (0,0,0)

Sensor 0 is nonexistent / invalid input

Description: Sensor_state should still be 0 to signify all clear state. Because Detection_Sensor.sendNotification() was called, with a non-existent sensor. Ranger_Interface.dataStream() will not be called and streaming will stay as False (default), sensorStream attributes should remain at defaults since no sensor is streaming.

System/Acceptance Testing

- System: Test Set 1

When an audio is detected from the detection sensor an alarm is set off the rangers then have to be able to turn off the sensor and then handle the information to what they need to do.

Input:

- login_time
 - 1401
- username
 - ranger101
- sensor_state
 - 1
- notification
 - "audio detected"
- streaming
 - true

Feature:

- Ranger_Interface.requestReport(eventID) -> struct Report tempfile
- DetectionSensor.dataStream(sensorID)
- DetectionSensor.getStatus() -> 1
- Handler.deactivateAlarms()

- Ranger_Interface.storeReport()
- DetectionSensor.getTime() -> struct Time time

Expected Output:

- tempfile -> eventID = 1234
- login_time = 1401
- username = ranger101
- sensor_state = 0
- streaming = false

DetectionSensor.getStatus is a method that gets the status of the detection sensor 0 being off and 1 being on.

Handler.deactivateAlarms() is called to deactivate the alarms that have been set off this would change the sensor state to off this case being 0, this would also save the username of and login time of who accessed this and when did they.

Ranger_Interface.requestReport(eventID) is a method that is able to request access to the report that was generated from this instance of the detection sensor going off.

- **System: Test Set 2**

Audio files of dangerous animals should cause a report to be generated for rangers to view at a later time with the correct details of the event.

Input:

- Audio file of known mountain lion roar
- Mock Detection_Sensor
 - currentTime
 - Year: 2020
 - Month: 10
 - Day: 10
 - currentDate
 - Hour: 10
 - Minute: 10
 - Second: 10
 - ID
 - 10
 - Location

- [10,10,10]
- eventID -> 99999

Feature:

- Audio_Processor.classify(processedAudioFile) -> string "Mountain Lion"
- Detection_Sensor.getPosition -> [0,0,0]
- Detection_Sensor.getDate -> struct Date date
- Detection_Sensor.getTime -> struct Time time
- Handler.collectDetails() -> struct ReportDetails reportDetails
- Constructor Report(reportDetails)
- Database_Handler.createFile(tempFile)
- Ranger_Interface.generateReport(99999+1) -> struct Report report

Expected Output:

- report -> eventID = 100000
- report -> date.year = 2020
- report -> date.month = 10
- report -> date.day = 10
- report -> time.hour = 10
- report -> time.minute = 10
- report -> time.second = 10
- report -> location = [10,10,10]
- report -> details = "Mountain Lion"

Normally Database_Handler.requestLatestReport().eventID would be called to find the most recent eventID. This number would be incremented to be passed as the next report's ID. In this case we pass in 99999 as a dummy theoretical return value from this function (high number to not overwrite other reports), meaning the next report should be generated using ID 100000.

A mock sensor Object will be created as input to see if its details are displayed accurately in the report.

The audio_processor will be passed a known mountain lion audio file; this should be classified correctly as a mountain lion

The handler.collectDetails() method should get details returned from the audio_processor and detection_sensor objects as well as the incremented eventID and place them all into one struct. This will be passed to the Report constructor which will create a report ready to be stored in the database

The Database_Handler.createFile() method will be called and passed in the tempFile attribute which will be set as the Report that was generated. This will store the file to the database.

Finally The Ranger_Interface.generateReport(100000) should now return the report that was just saved to the database and should hold all the correct dummy details about the event.