[Detecting Disease Contact]

[Circuit Breakers]

Version 1.0

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Jared Beyers, Tarod Anderson, Ronil Doshi, Isaiah Maberry,
Jennifer Tapia
[TeamCircuitBreakers@groups.unt.edu]

Preliminary Design Document

Version 1.0

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A. Project Overview

The rapid spread of and efforts to combat the COVID-19 pandemic in recent years laid bare how essential contact tracing and disease vector tracking are to epidemiology. The global public and national medical establishments alike were brimming with questions, concerns, and speculation about the chain of transmission.

In order for medical researchers to collect data and trace contact, maintain exposure standards, and provide improved insights to medical institutions and policymakers, it would be very beneficial for field researchers and other professionals to be able to exactly track the number of people they come into contact with and the frequency of contact.

B. Current Problems and Proposed Solutions

We are proposing a camera-equipped vest to accurately track the number of people that come into a two meter radius of the wearer, paired with a mobile app that allows the user to easily view the data. The cameras will work in tandem with algorithms running in the cloud to create a “snapshot” of every instance of a new individual entering and leaving the two meter radius, providing data points for further analysis, such as creating heatmaps, tracing spread, and reporting potential transmission.

Previous implementation is still not accurate in detecting disease contacts. Probably, we need more sensors and background processing to accurately detect contacts. The data from the sensors needs to be computed on the vest and sent to the cloud. The processed data can then be used to make decisions about the contacts. A simple smartphone application can also analyze the data and provide statistics about the contacts.

C. Requirements

1. Functional Requirements

ID	Functional Requirements	Team Member Responsible	Effort (in %)	Verification
FR1	The system should operate in both day and night conditions.	Jared Beyers	20%	Testing
FR2	The system should trigger the camera system when it detects possible human presence.	Jared Beyers	30%	Testing
FR3	The system should use computer vision to determine if a possible presence is a human.	Ronil Doshi	25%	Testing
FR4	The system should algorithmically determine and record the closest distance for each contact.	Ronil Doshi	30%	Analysis

FR5	The system should detect all humans exiting 2 meter radius.	Jared Beyers	30%	Testing
FR6	The system should track all human subjects so long as they remain in the 2 meter radius.	Ronil Doshi	35%	Testing
FR7	The system should record GPS location for all encounters.	Isaiah Maberry	25%	Testing
FR8	The cloud should calculate and store data based on frequency of contacts.	Tarod Anderson	15%	Demonstration
FR9	The system should send data to the cloud for storing and access.	Tarod Anderson	25%	Demonstration
FR10	The smartphone app should access data from the cloud.	Tarod Anderson	25%	Demonstration
FR11	The smartphone app should display all contacts with their respective timestamps and locations on a map, along with the total number of contacts.	Jennifer Tapia	25%	Demonstration
FR12	The smartphone app should have a searchable list of contacts. With each contact showing data on duration, distance, timestamp, and location.	Jennifer Tapia	30%	Demonstration
FR13	The smartphone app should display frequency of contacts, with filters such as per hour, per day, and per week.	Jennifer Tapia	20%	Demonstration
FR14	The smartphone app shall interact with cloud database to secure user logins and protect access to contact data.	Isaiah Maberry	25%	Testing
FR15	The system should delete all user video after processing is complete.	Ronil Doshi	10%	Demonstration

FR16	The smartphone app should display power levels of each subsystem and the central system.	Isaiah Maberry	15%	Inspection

2. Non-Functional Requirements

ID	Non-Functional Requirements	Team Member Responsible	Effort (in %)	Verification
NFR1	The system should be embedded into a wearable vest.	Tarod Anderson	25%	Inspection
NFR2	The system should be discrete.	Tarod Anderson	10%	Inspection
NFR3	The system should use a battery for 12-hour operation.	Isaiah Maberry	15%	Analysis
NFR4	The system should be under 1 KG.	Ronil Doshi	10%	Inspection
NFR5	The system shall be implemented on a PCB that ensures compact size and reliable signal routing.	Isaiah Maberry	20%	Inspection
NFR6	All components shall be housed in enclosures to ensure protection and user comfort.	Jared Beyers	20%	Inspection
NFR7	The smartphone app should be professional, elegant, and user friendly.	Jennifer Tapia	25%	Inspection

3. Constraints

a. *Money is a constraint as there is a budget for the product.*

b. *Time is a constraint as there are 32 weeks to complete the product.*

c. *The system must use commercial components, as it is a proof of concept prototype.*

d. *The product’s packaging and size should allow for comfortable wear through everyday activities.*

D. Specifications

1. Functional Requirements Specifications

[List the specifications for functional requirements. Please refer to the functional requirements above.]

ID	Functional Requirement Specification	Team Member Responsible
FR1	The system will use a light sensor in order to measure the light in the environment. If the sensor measures low light conditions, an infrared specialized camera will be used to capture images. In proper lighting conditions, camera will be used.	Jared Beyers
FR2	The system will use 4 time flight sensors to gauge the closest object in radius. Once an object enters the 2 meter radius, the system will use an infrared camera to capture a heat map. An algorithm will be run on this heatmap to help predict if the heat captured is from a human. If the heatmap shows promise of human detection, the cameras will be triggered to capture 4 frames, one in each quadrant.	Jared Beyers
FR3	The system will receive four video streams from the camera system at 5 frames per second. Using computer vision algorithms, the system will determine whether what it is looking at is a person, and if so it will begin tracking them.	Ronil Doshi
FR4	Using computer vision algorithms, the system will analyze the video stream it receives from the cameras to precisely determine the distance of individuals being tracked from the vest. It will pair each instance of tracking with the tracked individual's closest calculated approach.	Ronil Doshi
FR5	The distance sensor will work with the camera system in order to properly categorize subjects and record the time they exit the 2 meter radius.	Jared Beyers
FR6	The system will use computer vision to keep track of the position of all persons in the two meter radius until they exit. As people move in between the fields of view of the different camera, the system will seamlessly transition the tracking object between camera streams to ensure that all persons are accurately counted across cameras.	Ronil Doshi

FR 7	For every confirmed human contact case, the system should record the GPS location. This location data will be sent to the cloud as part of the contact data, which can be used in future cases.	Isaiah Maberry
FR 8	The system will have a data array to keep track of the number of people the system has come in contact with. Every time that someone comes within the 2 meter threshold, the array will increment.	Tarod Anderson
FR 9	The system will send data to the cloud to be stored in a data array. The data sent to the cloud will include the number of times a human comes within 2 meters of the vest, how long each encounter lasts, what time the encounter starts and ends, the location of the contact, as well as the closest recorded point of contact between that human and the vest wearer.	Tarod Anderson
FR 10	The mobile phone app will access the data array from the cloud to display the information in the data array to the end user.	Tarod Anderson
FR 11	The smartphone app should have a live map showing contacts as dots on the map, each dot should be clickable, and display stats such as: time of contact, duration of contact, location of contact, and closest distance.	Jennifer Tapia
FR 12	The mobile app should offer a searchable list of contact instances received from the cloud. This including the time of contact, distance , and duration. The list should support various filtering options. The data should remain anonymous and be displayed in an easy-to-read and understandable format.	Jennifer Tapia
FR 13	The mobile app should show how often contacts occur, and allow users to view this information by the hour, by the day, or by the week. The information should be retrieved from the cloud and will be displayed in an easy to read format. Users should be able to quickly shift between the various viewing options.	Jennifer Tapia
FR 14	The smartphone app will have a login page, which is able to verify the user’s login information with the logins stored in the cloud database.	Isaiah Maberry

FR 15	The system will process video and sensor data in 5 second chunks. No identifying data or images of individuals will be retained by the system for longer than a 2 chunk duration (a current chunk to process and a previous chunk to check continuity). After that duration all chunks of video and private user data will be deleted.	Ronil Doshi
FR 16	The system will use current sensors to detect how much current has been pulled from the battery. Using this data, the battery percentage can be calculated. After that, the data will be sent to the cloud where the smartphone app can then pull the data and display it to the user.	Isaiah Maberry

2. Non-Functional Requirements Specifications

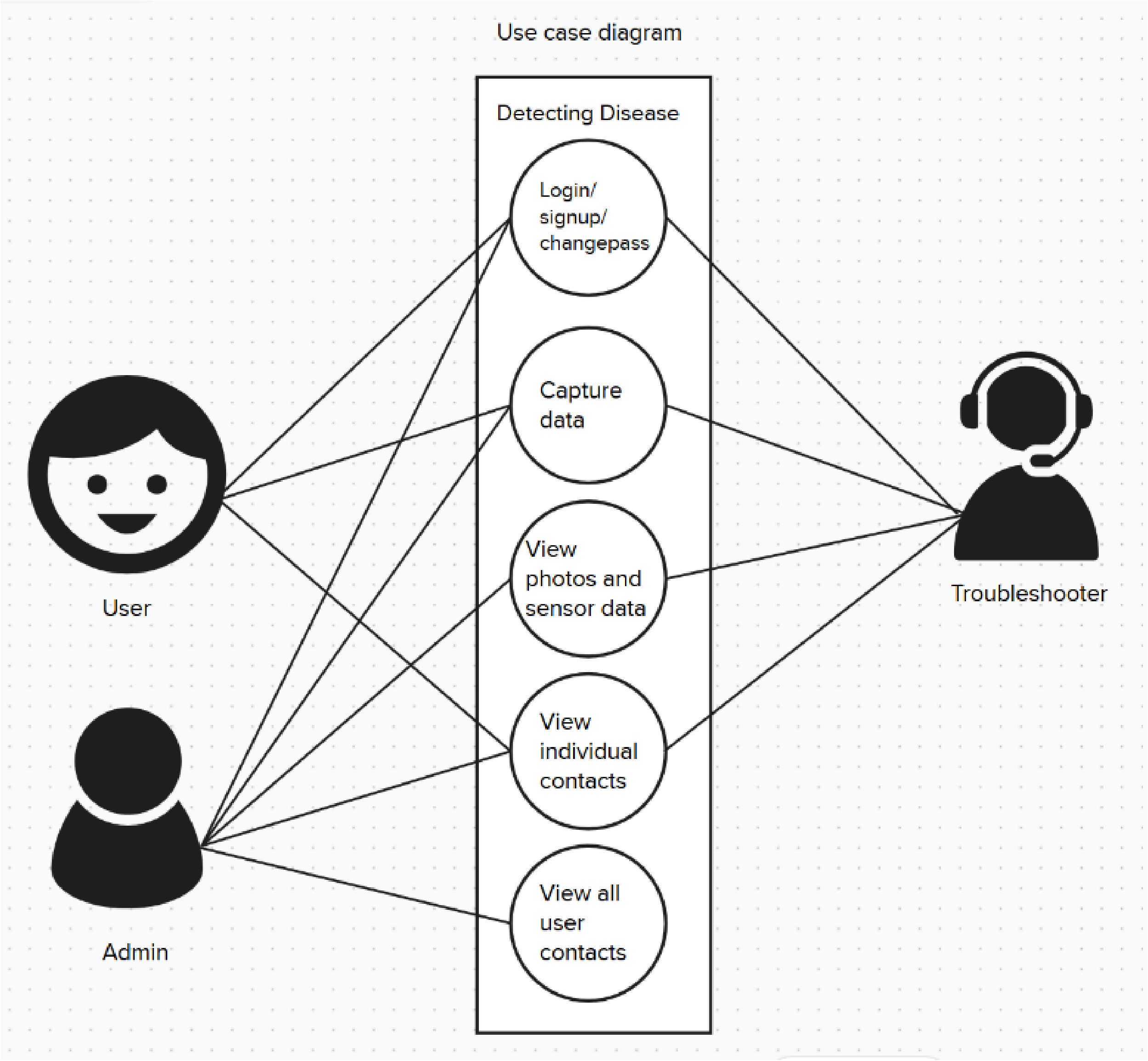
[List the specifications for non-functional requirements. Please refer to the non-functional requirements above.]

ID	Non-Functional Requirement Specification	Team Member Responsible
NFR 1	The system should consist of a series of sensors (IR cameras/ ultrasonic sensors) which will be used to detect people within a 2 meter radius of the wearer. The sensors should be integrated into a vest that will look like a normal item of clothing.	Tarod Anderson
NFR 2	All components will be placed within the wearable vest and not protrude outwards.	Tarod Anderson
NFR 3	The system will consist of multiple power banks, one for each of the subsystems, and one for the central system, for a total of 5 power banks. Each needs a minimum capacity of 36000mAh, enough to run the system for a minimum of 12 hours.	Isaiah Maberry
NFR 4	the system will be integrated into an unobtrusive vest, less than 5 kg in weight, and allow the user full maneuverability without creating errors in detection	Ronil Doshi
NFR 5	The system will have five PCBs, one for each subsystem and one for the main system. Each PCB will route the signals and components needed to implement the system.	Isaiah Maberry

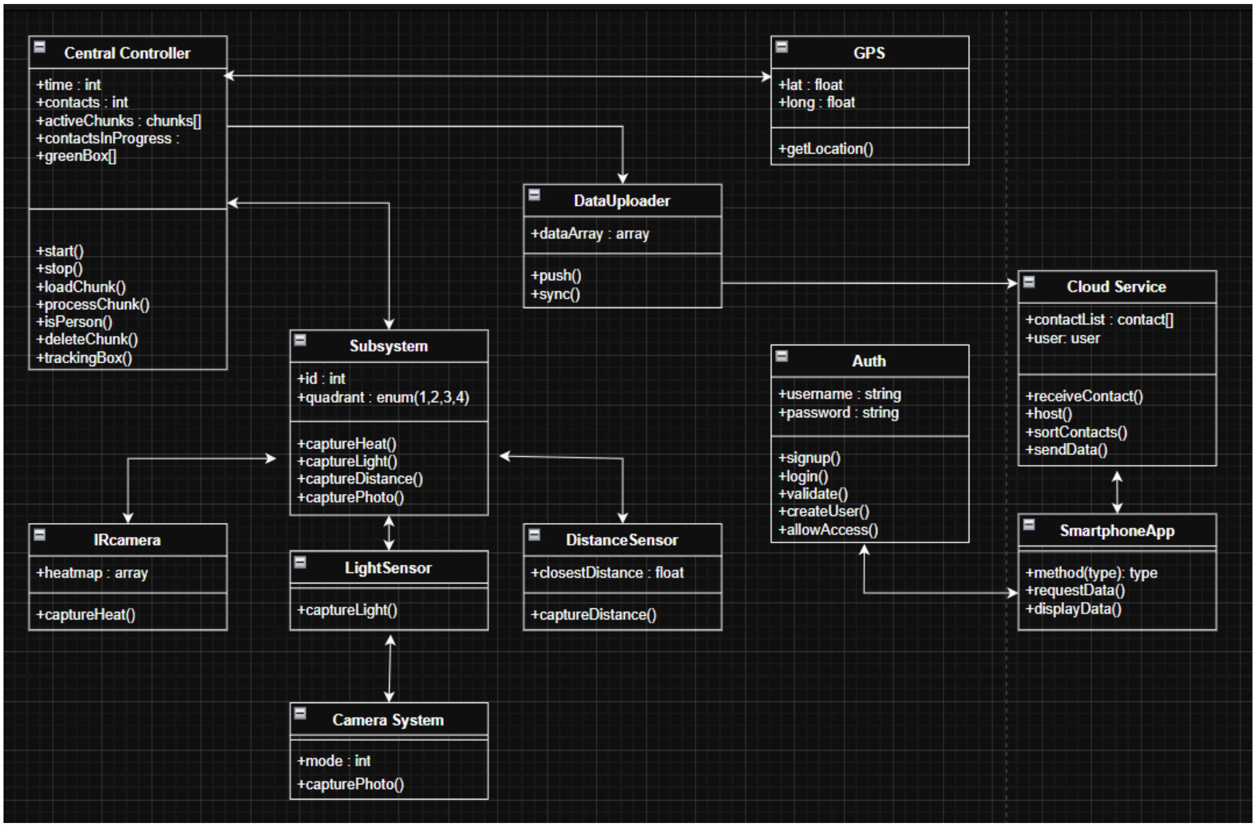
NFR 6	The system should consist of one central system, powered by a controller, to send data to the cloud. The system will have four subsystems with components: controller, camera, night camera, and ToF sensor. The 4 subsystems and the central system should be housed in a 3D printed enclosure to protect the components and the user.	Jared Beyers
NFR 7	The mobile app should provide a simple and user-friendly interface which allows the users to view the daily summaries as well as the contact lists. There will be visual elements such as clear icons, colors, and clear labeling so the information is easy to digest.	Jennifer Tapia

E. Preliminary Design

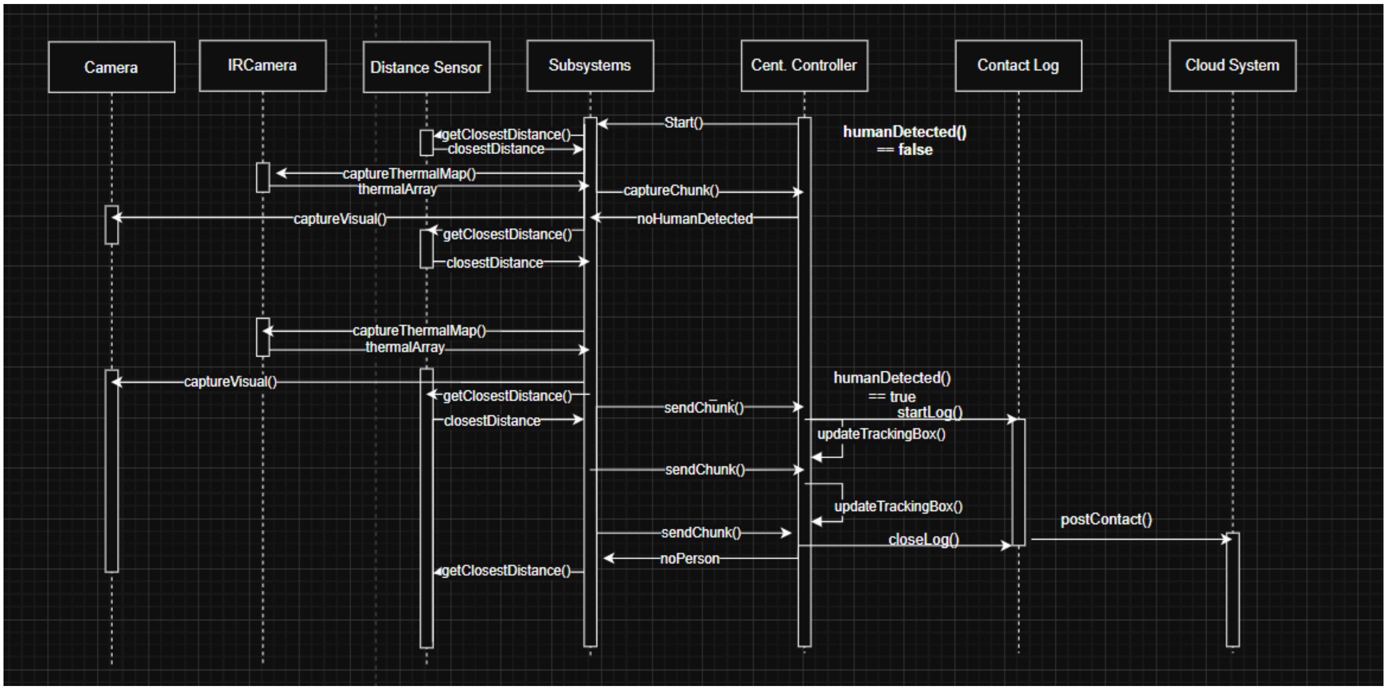
1. Use Case Diagrams



2. Class Diagram



3. Sequence Diagrams


Camera
IRCamera
Distance Sensor
Subsystems
Cent. Controller
Contact Log
Cloud System
Start()
humanDetected() == false
getClosestDistance()
closestDistance
captureThermalMap()
thermalArray
captureChunk()
captureVisual()
noHumanDetected
getClosestDistance()
closestDistance
captureThermalMap()
thermalArray
captureVisual()
getClosestDistance()
humanDetected() == true
sendChunk()
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closestDistance
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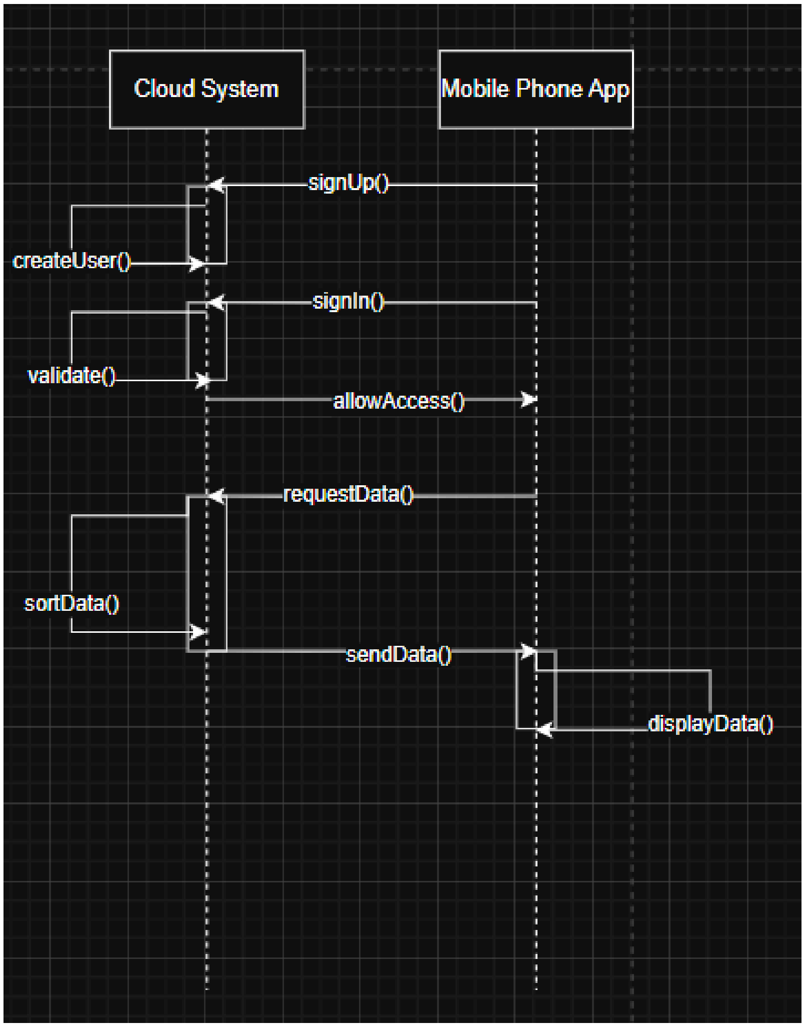
sendChunk()
closeLog()
noPerson
getClosestDistance()


Cloud System
Mobile Phone App
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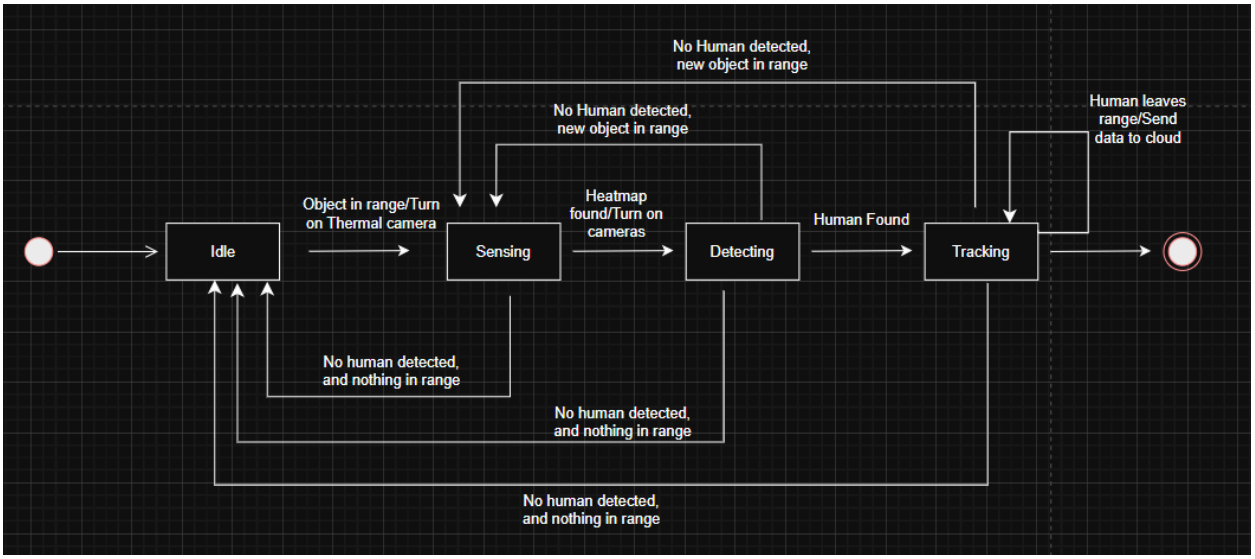
createUser()
signIn()
validate()
allowAccess()
requestData()
sortData()
sendData()
displayData()

4. State Diagrams



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