Cretaceous Gardens Controller (CGC)

Software Requirement Specifications

SRS Version 3.0

Team #1
19 November 2019

CS 460 Software Engineering

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1 Introduction

The purpose of this document is to specify to the stakeholders and to the software engineers the functional and non-functional requirements that are needed to maintain and produce a viable and safe product.

The following sections will cover a variety of topics that will explain in detail our upcoming implementation of CGC. The topics are as follows: General Description which will discuss the CGC in a coordinated and cohesive manner which should give you an overall idea of the software being implemented. Specific Requirements talks about the components and the generalized action/behavior of said component. Design Constraints specifies the constraints of the overall design in which the system needs to operate within. Definition of Terms will list all the commonly used technical terms within the document for future reference.

2 General Description

The Cretaceous Gardens is to be a park in which visitors can safely view a living T-Rex, known as Alice. The software developed to enable a safe and efficient experience for visitors is laid out in this section.

2.1 Product Overall

CGC Overall design is to transport guests from one side of the island to the other to see the main attraction: Alice, the T-Rex. The parks consists of the Alice's enclosure, Safety features, Autonomous Transportation, and Automated Services. In detail our safety features are all based around all our other components

2.2 Product Functions

CGC has a multitude of products that must be maintained for continuous use.
The products in question are:
Automated Stations: These will have a UI so the guests can buy their tickets which will then dispense a receipt and a token
RFID: Used to transportation, see attractions and use automated services
RFID reader: Allows visitors to access the parks services.
Autonomous Vehicles: This will contain an RFID reader and multiple sensors, the vehicles will move when everyone is safely secured within the confines of their seats and will also not move until there are 10 or less people.
Electric Fence: The electric fence will keep the T-rex contained within the confines of his enclosure, there will be sensors and cameras checking for compromises around the enclosure.

Security System: The security system is made up of a manned control center, infrared cameras to detect a potentially missing T-Rex, a tranquilizer to aid in the recovery of potentially missing T-Rex, and speakers that allow security personnel both a way to communicate with island visitors, and a way to play alarms in case of emergency.

2.3 Product Constraints

Autonomous vehicle: Holds up to 10 people if we go beyond that limit the autonomous vehicle will not be operational and will stay in a stand still state,
Electric fence: If the electric fence becomes compromised an emergency state will be triggered and will notify all individuals in that vicinity.
Automated Station: The station can take one customer at a time and will take a credit/debit payment in exchange for a token which can be used within the park.
ID: Can only be used within the park and will have an expiration date determined by how much was paid to the automated station.

2.4 User Characteristics

Users will use a token to travel around the park which will be essential for their stay at the Cretaceous Gardens. You get one by buying a token from the parks Automated Stations. The Token will be used for park attractions, automated services, and transportation system. All of which should have an RFID reader.

3 Specific Requirements

The Specific Requirements section outlines the software requirements for the Cretaceous Garden Controller.

3.1 External Interfaces

The CGC interacts with multiple interfaces to control the overall behavior of the park. This section will detail these interfaces and how they interact with both the CGC as well as visitors. These interfaces include the physical interfaces, such as cameras as well as logical interfaces such as timers. In Figure 3.1, the overall picture of these interfaces is displayed.

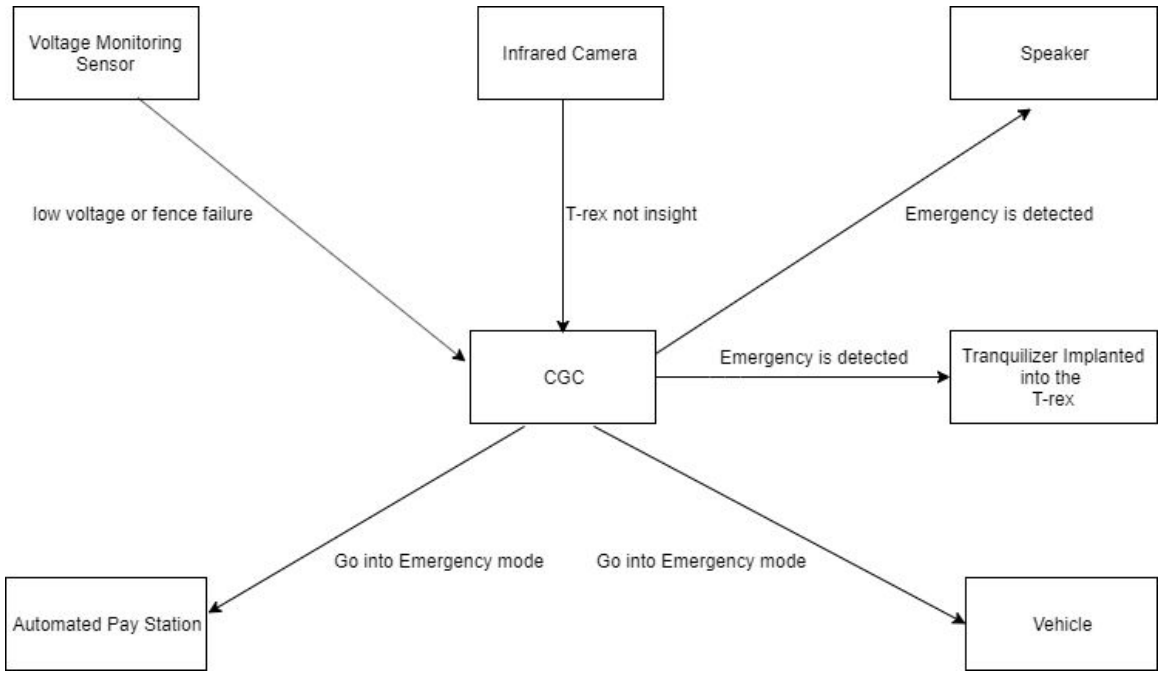

Fig. 3.1: Event flow diagram for CGC

3.1.1 Automated Pay station Interfaces

1. Touch Screen on the pay station

Input: Signed waiver.
Output: N/A

2. Camera

Input: Photo of the visitor.
Output: N/A

3. Credit card reader

Input: Credit card
Output: It verifies the payment. If it is a valid payment, it generates a unique token with a photo and a receipt. If it is an invalid payment, it will display a payment error on the touch screen.

4. Ticket dispenser

Input: No input
Output: Dispenses a unique ticket with a photo once the payment is verified as a valid payment.

5. Receipt Printer

Input: No input
Output: Prints a receipt once the payment is verified as a valid payment.

3.1.2 Car Interfaces

1. RFID reader

Input: Ticket with a photo and a unique number.
Output: It verifies the validity of the ticket using the photo and the unique number on the ticket. If it is a valid ticket, it open its open its door for the visitor. If it is an invalid ticket, it displays the "Invalid ticket" message on the display of the RFID reader.

2. Obstruction Door sensor

Input: Detection of obstruction on the door of the car
Output: Opens the door immediately. Alert the visitors about the obstruction through the speaker inside the car. Car will not move until the obstructions are out of the way.

3. Weight sensor

Input: Detection of overcapacity in terms of number of people
Output: Alerts the passengers about the overcapacity issue through the speaker inside the car. The Car will not move until the issue has been resolved.

4. GPS

Input: location of the car
Output: N/A

5. Speaker

Input to CGC: No input
Output from CGC: Alerts the passengers about different events.

6. Stop button

Input: Button pressed
Output: It will stop the timer from counting down.

3.1.3 Electric Fence Interface

1.Voltage monitoring Sensor

Input: Detection of low voltage or electric fence failure.
Output: If low voltage is detected, CGC will go into alert mode. If electric fence failure is detected, CGC will go into emergency mode.

2. Infrared Camera

Input: T-rex not insight
Output: CGC goes into alert state when the T-rex is not insight.

3.1.4 Security System Interface

1. Speaker

Input: No input
Output: Alerts the passenger about the emergency.

2. Tranquilizer device

Input: No input
Output: Gets triggered to incapacitate the T-rex when the emergency is detected.

3.1.5 Logical Interface

1. Timer object

Input: Start the timer when the car arrives at the north-end
Output: When the timer expires, car alerts the visitor that it is time to leave.

Input: Start the timer after the entry of the passenger.
Output: If the time expires and a new passenger does not get into the car since the entry of the last passenger, car will start heading to the north. If the timer has not expired and a new passenger gets into the car, the timer will restart.

3.1.6 Relation to physical devices

This section explains where each interface component is located in the theme park.

- **GPS -** is located on the top of the autonomous car.
- **Obstruction door sensor -** is located on the door
- **Ticket Scanner -** is located outside the car door.
- **Stop button:** is located in the middle of the car.
- **Infrared sensor -** is located on the door.
- **Automated pay station -** is located in the southern part of the island.
- **Electric fence** - is located in the north part of the island, around the perimeter of enclosure.
- **Infrared Cameras** - are posted around the electric fence.
- **Speaker** - is located in the north part of the island.
- **Control Center** - is located in the north part of the island.
- **Tranquilizer** - is located inside the T-rex

3.2 Control Logic

The following section covers the logic that governs components that have complex behavior.

3.2.1 Automated Station

Figure 3.1 depicts the control behavior of the Automated Station. The initial state is *Idle* which will be the state that starts any visitor interaction. Upon the visitor tapping the screen, the state transition to *Process Waiver* where the visitor can read and either cancel the transaction or sign the waiver. Upon signing the waiver the state will transition to *Take Photo* where the visitor will have a photo taken. After a photo is taken, the machine will request payment and once a card is inserted it will go to *Process Payment*. In this state it will communicate with the preferred third party payment system and start a payment transaction and transition to *Register User* where the station will communicate with the CGC to receive a unique identifier to assign to a token. Once the token has been retrieved go onto *Complete Transaction* where the payment transaction is completed Once completed and the token has been provided to the visitor the system transitions back to *Idle*.

For any of the previously mentioned states (besides *Idle*) if the transaction is canceled or times out (inactivity after 5 minutes) it will go to *Transaction Failed* which will notify the user of the failure and swap back to *Idle.* In the state *Register User* if the station is unable to communicate with the CGC it will transition to *Fail Transaction* where it will fail the payment transaction and go to *Transaction Failed*.

From any of the previously mentioned state, if the CGC signals to the station to transition to *Display Emergency* in which the station will display that the park is in a state of emergency and visitors should proceed to a safe area.

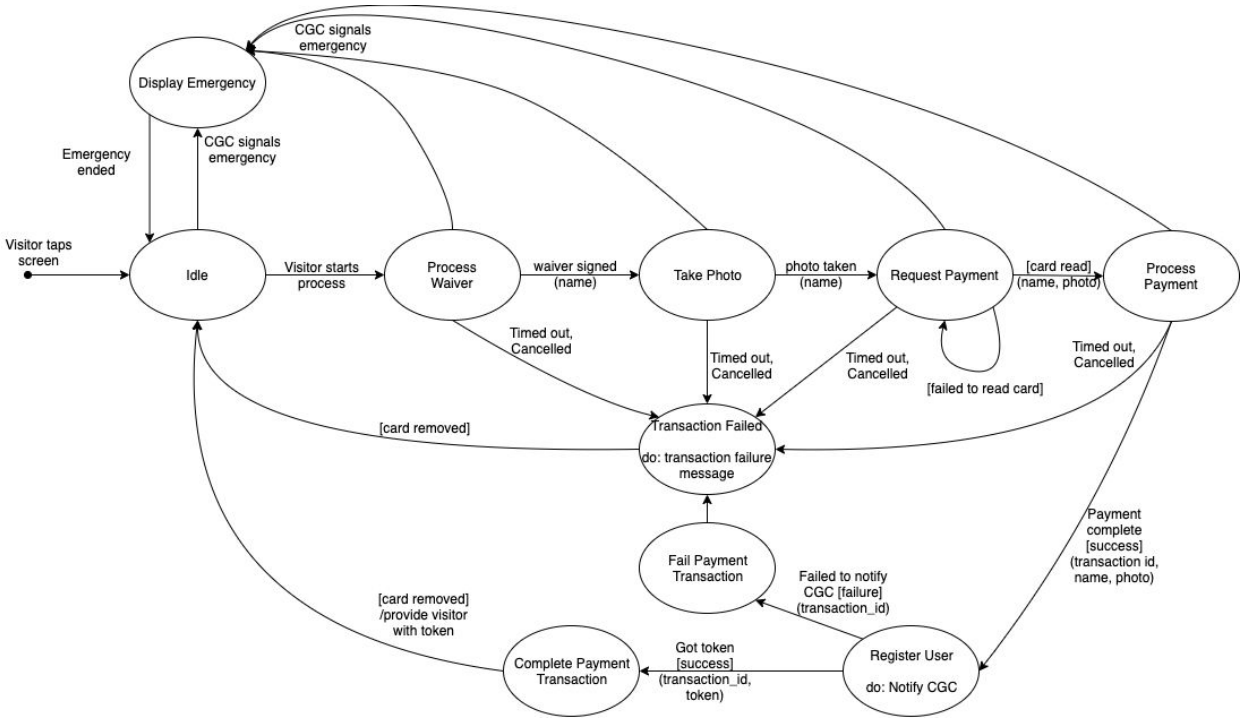

Figure 3.1: Automated Station Logic

3.2.2 Autonomous Vehicle

In figure 3.2, The autonomous vehicle will start off as idle. If the car senses a RFID nearby it will unlock the door and the engine will turn on. Depending on the temperature, it will either have the heat on or will have air conditioning on. When the car capacity is full or if the timeout of 60 seconds occurs, the car will start moving. It will get a message from the CGC that will give it the destination and the doors will get locked. If at any time it gets an Emergency message it will go into emergency mode which will trigger Figure 3.3. When the car stops moving it will send a message to the CGC that it has reached its destination, it will unlock its doors, and it will check the battery charge percentage which will all be sent in a message to the CGC. If the car battery is too low, the CGC will send it another message to set its destination to the recharge station. The car will start moving again and lock its doors. Once the car reaches the recharge station it will automatically start recharging until its battery is at a sufficient level to make another trip. The car will be sent somewhere needed in a message from the CGC and will sit idle until the next passengers arrive.

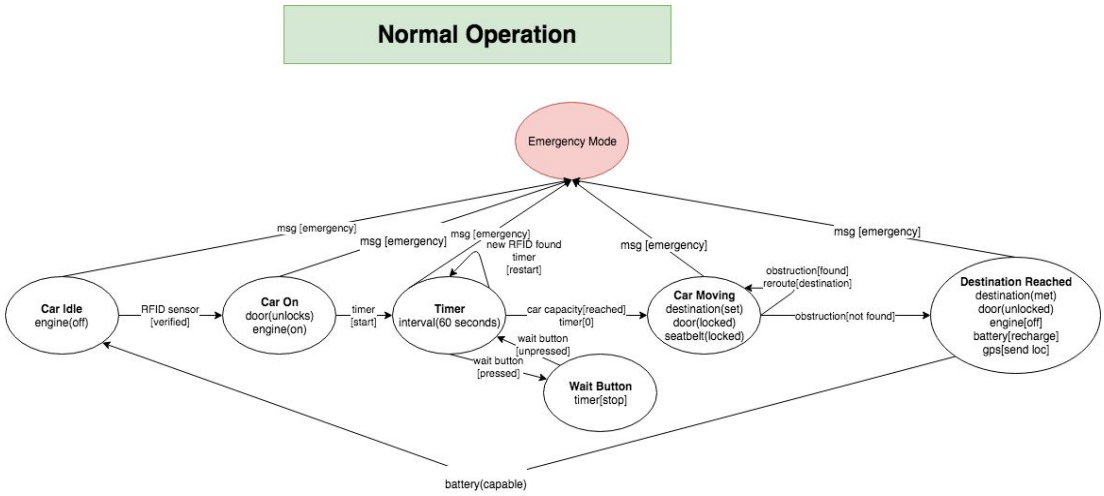

Figure 3.2 Autonomous Vehicle Normal Operation Diagram

In figure 3.3, the Vehicle has gotten an emergency message from the CGC. The autonomous vehicle does a quick sensor check to see if the vehicle is moving or not. If the vehicle is moving, it will reroute its current destination to the safety zone which is in the southern part of the island. It will keep at a safe speed until it reaches its destination. If the vehicle is idle it will be waiting for 10 passengers. The passengers can engage in a veto vote to start automatically moving the vehicle if there isn't 10 people nearby. When the car is moving it will engage its emergency sirens which will produce a loud noise. The touch screens that are available on the vehicle will also have an emergency message explaining the reason for the emergency. When the destination set by the CGC is reached, the doors will unlock and the car will go into an idle state until the emergency ends. The car will then go into normal operation mode.

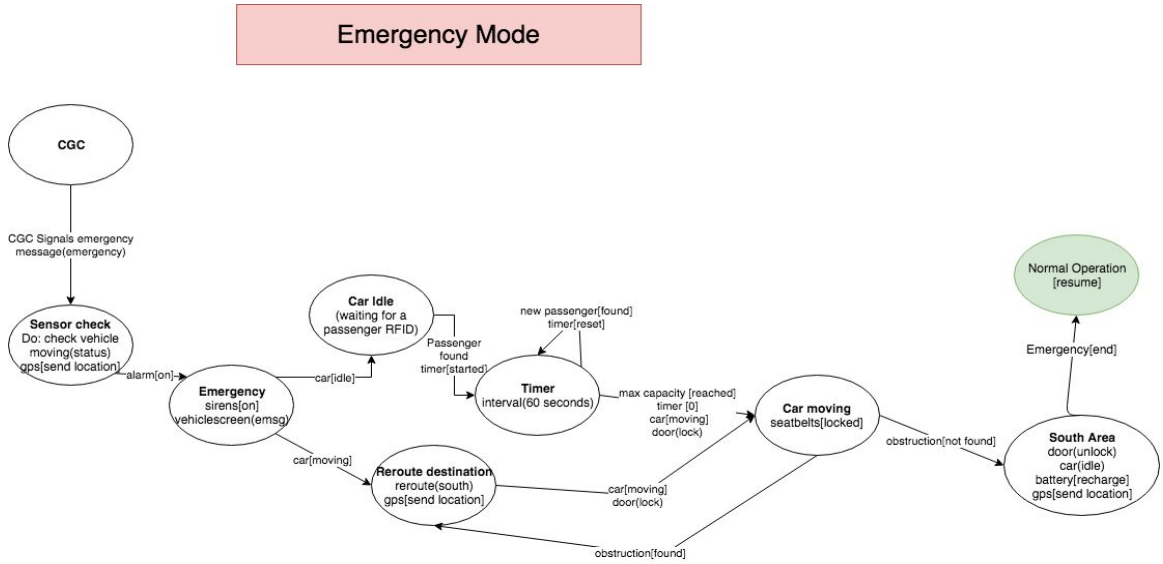

Figure 3.3 Autonomous Vehicle Emergency Operation Diagram

3.2.3 CGC

In Figure 3.4 the regular operation of the CGC is depicted. The CGC starts in the *Idle* state which will wait for input from an external resource. Upon any message from an external resource (Vehicle, Security System, Electric Fence, etc) the controller will transition to *Update Internal State* to update the state of the resource as last seen by the CGC. *Update Internal State* will use the information provided by an event to update the information that the controller knows about a resource, such as location or last action taken. Once the internal state has been updated, transition to *Check Event* which will evaluate the resource and event to determine the next action. If the resource is the electric fence and the event is that it has gone down the *Emergency Mode* will be triggered, refer to Figure 3.5 for the logic that governs the *Emergency Mode*. If the event and resource combination is low priority (to be defined by implementation) the controller returns to *Idle* and otherwise it will transition to *Send Alert* where the resource will be alerted to personnel so as to allow them to respond accordingly. Afterwards it returns back to *Idle*.

If *Emergency Mode* is triggered until personnel deactivate the emergency state, at which point it will go to *Signal Regular Operation* which will communicate with all resources. Once all resources have returned to regular operation then the CGC will return to *Idle*.

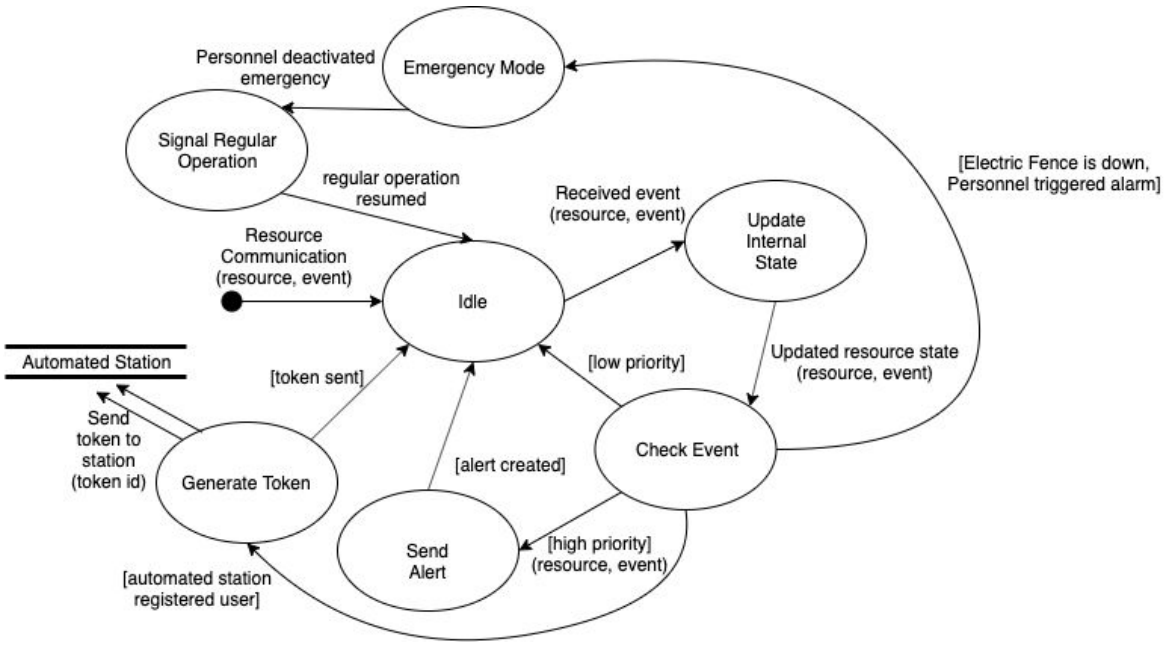

Figure 3.4 CGC Regular Operation

In figure 3.5 summarizes the emergency operation of the CGC. Once an emergency has been triggered, the CGC transitions into *Signal Resources* which will connect to all known resources anI d signals to them that it is an emergency and then transitions to *Query Resources* which will go through all of the resources and pass them through the following states. Upon querying a resource, if it fails to get a state it goes to *Set Resource Alert* to notify personnel that the resource is out of touch. If the resource is contacted, go to *Update Resource State* to ensure that the CGC has an updated state. It then will cycle back to *Query Resources*. This cycle will continue until the personnel mark the system as no longer operating under an emergency and transition back to *Regular Operation*.

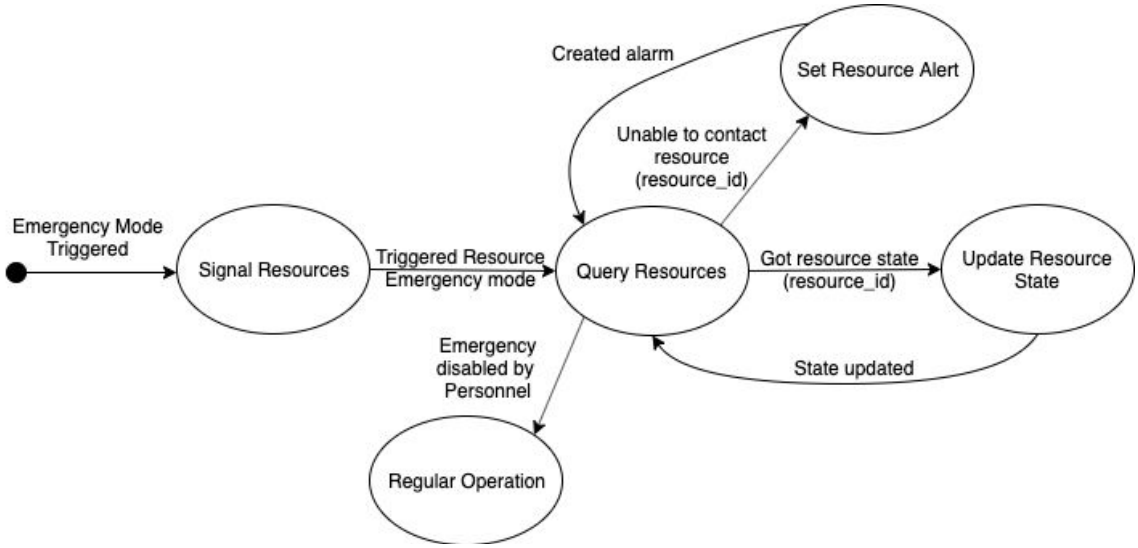

Figure 3.5 CGC Emergency Operation

3.2.4 Security System

The security system is a modular system made up of an arbitrary amount of infrared cameras, an implantable tranquilizer devices, the electric fence and speakers around the park. The infrared cameras will be continuously looking for the T-Rex and provide feedback to the control center, while the tranquilizer and speakers around the park can be operated by a user via the security system or will automatically operate in case of an emergency. In the case of an emergency, user input will be disabled. Figure 3.6 shows a diagram of the functionality of the security system. The system for the most part is in an idle state, and is triggered by alert or emergency events.

The security system will interface with the following components:

Electric Fence

- Modular, surrounds perimeter of T-Rex enclosure
- Arbitrary number of infrared cameras on top of fence

Infrared Cameras

- Placed on top of electric fence

Speakers

- Allows 1-way communication for park personnel from Security System to speakers
- Alerts visitors of an emergency

Tranquilizer

- One time use device implanted in T-Rex
- Prevent emergency from escalating

The security system will be triggered by two events: alert or emergency events.

Emergency

- Electric Fence Failure
  - CGC emergency mode will be triggered, tranquilizer device automatically triggered

Alert

- Electric Fence Malfunction
  - CGC will be alerted for maintenance on that segment of the fence (fence id)
- % Infrared Camera Doesn't Detect Dino
  - (Failed cameras / total # cameras) > max IR fail rate %

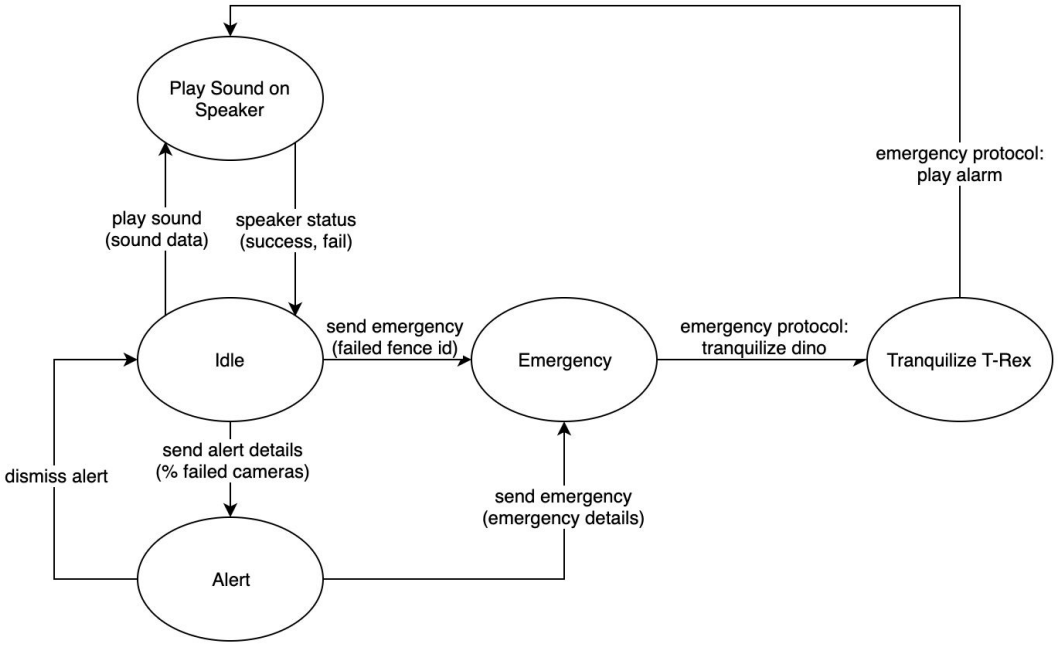

Figure 3.6 Security System Diagram

4 Design Constraints

The design constraints will go over what we have determined as potential constraints that we will have to look out for in this project.

4.1 Logical Constraints

- The electric fence will be using a predetermined voltage to keep the T-Rex safely inside of the exhibit.
- All software should be able to regulate itself without need of personnel.
- All software should be able to interact and communicate with each other in case of a failure.
- When the car arrives at the north end, timer should start and when the timer expires, it should alert the passenger that it is time to leave.
- When the visitor gets into the car at the south, a timer should start. If timer expires and no new visitors get into the car, the car should start heading to the North.

4.2 Vehicle Constraints

- The Autonomous vehicle will require at least one RFID ticket on board.
- The Autonomous vehicle will be travelling at safe speeds throughout its destination.
- The doors on the vehicle will require to be locked when the car is mobile.
- The doors on the vehicle will require to be unlocked when the car is immobile and there are passengers onboard.
- The autonomous vehicle can only be accessed after receiving a valid token, and is limited to a maximum of 10 people per vehicle or 4,650 lbs, rejecting entry and notifying visitors after exceeding this limit. When the limit is reached, the next idle car will be enroute to the location of the denied islander.
- The self-locking mechanism of the autonomous vehicle is to ensure the safety of the passengers. The vehicle will have a RFID reader which will activate if it senses a valid token nearby. The vehicle should also realize the range/distance it has before making a journey. The doors of the vehicle will be strictly locked throughout the journey and will be opened once the destination has been reached.

4.3 Safety Constraints

- Trees may fall on the vehicle track that may lead to potential hazards on the track. The vehicles should be able to track the obstruction and reroute to safely navigate around the tree.
- The siren that is sound by the Vehicles and outposts around the island will emit sounds upwards of 120dB which could incur hearing loss if repeatedly listened to for long periods of time.

- Electrical lines flow throughout the island which house high voltage currents for the electric fence. Islanders need to be wary around these lines. If high winds occur, the electrical lines could suddenly break. This is brought up in the waiver that is mandatory for visiting the exhibit.
- Given how complex the Cretaceous gardens will be, it is expected that the safety is top notch.
- There will be a high density of cameras situated at the T-Rex exhibit to provide the ability to respond quickly to dangerous situations.
- If the electric fence senses its own destruction, it will send out a signal to the CGC to issue the emergency protocol.
- When the emergency protocol is activated, it will communicate to the autonomous vehicles to set an evacuation route.
- A token must be purchased at the automated pay station before the passenger will be let onto the island.
- To maintain the safety and security of the island, every token will be sending out a GPS signal to the CGC.
- Tokens are automatically purged and programmed to be re-usable.

4.4 Physical Constraints

Automated Pay Station

- Can only handle one concurrent user at a time
    - Similar to ATM (single person booth)

Autonomous Vehicle

- Cannot exceed 10 person capacity or 4,650 lb. weight capacity
- Cannot exceed maximum speed of 60mph

T-Rex Enclosure

- Electric fence around perimeter
- Infrared Cameras to monitor enclosure

5 Use Cases

The following section covers the common use cases of the park and how the system is expected to behave under the stated scenario.

5.1 Security System

Use Case 1 (Standard):

Context: Dinosaur in sight, fence in tact, not in emergency mode, personnel able to stream audio to speakers to notify or alert visitors of non-emergency information.
Input: Microphone to ALL speakers to let audience know of park closing.
Output: Audio feed to ALL speakers with voice given as output.

Use Case 2 (Dino-Not-In-Sight):
Context: Dinosaur not in sight, fence in tact, not in emergency mode.
Input: Alert to Control Center notifying of inability to find T-Rex, system needs user to check if they can find T-Rex.
Output: CGC will switch to normal state if T-Rex was found, otherwise will go into emergency state if user input is not found.

Use Case 3 (Emergency Mode):
Context: Dinosaur not in sight, fence not in tact, in emergency mode
Input: Infrared Camera will alert Control Center and CGC of no T-Rex
Output:

- ALL alarms emergency sound (island + vehicle)
- CGC enter Emergency State

5.2 CGC

Use Case 1 (CGC Response)

Primary responsibility: Evacuate response team.

Goal in context: Evacuate and keep the guests and dinosaur safe by any means necessary.

Preconditions: System is not in maintenance, nor in emergency mode.

Trigger: The electric fence becomes compromised.

Scenario:

1. The Electric Fence starts to become compromised due to unforeseen circumstances.
2. Sensors connected to the fence will then signal an emergency response.
3. The emergency response will then signal the tranquilizer within the dinosaur.
4. The emergency response will in parallel also signal all necessary components into an emergency state.
5. Vehicles will go back and forth between the entrance and attraction to get guests.
6. Speakers will sound and repeat an emergency response.

7. Automated Stations will change UI to an emergency response.

Exceptions:

1. when an emergency response is triggered you will not be able to trigger the emergency mode again until the first response has been dealt with.

Priority: Essential, must be implemented.

When available: Always

Frequency of use: hopefully never.

Open Issues:

1. How do we handle tranquilizer failure?

2. How are we keeping the guests safe if tranquilizers fails?

5.3 Autonomous Vehicle

Use Case 1 - Autonomous Vehicle (Normal operation)

Context: The autonomous vehicle senses a ticket nearby. It will unlock the doors and let the passenger with the ticket inside of the vehicle. The vehicle will wait 1 minute since the entry of the latest passenger. If the time expires the CGC will communicate to the car to start moving or if the car capacity has been reached it will move automatically. It will lock its doors and set its destination. The autonomous vehicle will automatically start moving towards the destination with no interaction from the passengers. When the autonomous vehicle arrives at its destination it will unlock its doors and allow passengers to leave the vehicle. It will sit idle until it sense another ticket nearby or will recharge its battery if its battery is getting low.
Input: Passengers, RFID key (Ticket), Destination from CGC
Output: Passengers have moved locations, Car battery has been lowered.

Use Case 2 - Autonomous Vehicle (Emergency Mode):
Context: An emergency message from the CGC has been sent to the Autonomous Vehicles. The autonomous vehicle will check what state it is in (Moving or Idle). If it is moving then it will reroute its destination to the south side of the island. If the

vehicle is idle then it will wait for nearby ticket and follow protocol. Once the car capacity has been filled or if the capacity has been vetoed, the car will start moving towards its destination.
Input: Emergency Message from CGC
Output: Safety of passengers and set to destination provided from CGC

6 Definition of Terms

It is important to understand the terminology used throughout the rest of the document so as to fully understand what is being communicated.

Alice - See T-Rex

Automated Station - Similar to a touchscreen ATM, this machine accepts cash and card payments and will print a token on valid payment.

Cretaceous Gardens Controller (CGC) - A software system that controls the theme park and all of its activities.

Enclosure - Area in which the T-Rex is enclosed.

RFID - Radio Frequency Identification, used to read visitor's token

T-Rex - A living breathing, dinosaur: the infamous Tyrannosaurus Rex.

Tranquilizer Device - a device implanted into the dinosaur that allows personnel to remotely tranquilize the dinosaur in emergencies.

Token - A ticket equipped with a Radio Frequency Identification (RFID) chip that is monitored by the CGC and used to identify and validate the visitor for the length of their visit.