Robotic Convoy SRS

Project VarunMittal_CSCI568 Project (Requirements Management)

Printed by Varun Mittal

May 8, 2017, 1:10:50 AM EDT

Configuration VarunMittal_CSCI568 Project Initial Stream

Configuration Type Local Configuration

Component VarunMittal_CSCI568 Project

Table of Contents

Robotic Convoy SRS

Overview

Name:	Robotic Convoy SRS
Type:	Requirements Specification
Format:	Module
Project:	VarunMittal_CSCI568 Project (Requirements Management)
Created On:	2017-03-20T02:03:57.787+0000
Creator:	Varun Mittal
Last Modified:	2017-05-08T04:47:13.161+0000

Attributes

Name	Value
Identifier	67706
Status	Under Review

1 Introduction

ID 67707

Understanding high-level characteristics and functions of a proposed robotic convoy system called RoboCon paving way for development of autonomous cars.

ID 67699

1.1 Purpose

ID 67708

The purpose of this document is to record the decisions agreed to by RoboCon stakeholders and serve as a basis for detailed system requirements specification and documentation.This document will also include software design requirements and also serve as preliminary documentation for end users.

ID 76364

1.2 Product Scope

ID 67709

This type of autonomous convoy is a common use-case for CS568 Systems algorithms, having applications in transportation, inventory management, automated farming, and other areas. For example, a set of trucks could be placed in a convoy to transport goods.

A human driver could drive the leader truck, and the follower trucks could be driven automatically. Similarly, farming equipment could be made to automatically drive over fields to harvest crops without a human driver.

ID 76366

1.3 Intended Audience and Reading Suggestions

ID 100502

This project is being undertaken by the technology company named CS568 Systems, Inc. CS568 Systems owns several patents for image processing and artificial intelligence algorithms. CS568 Systems business model is to license their algorithms, and software components that implement those algorithms, to third-party companies for inclusion in those companies' products.

This SRS serves a common purpose for the RoboCon Developers, CS568 Algorithm Developers and customers who want to understand the the true purpose and the specification that goes into the development of the RoboCon System

ID 100503

1.4 References

ID 93466

http://www.scilit.net/article/10.3390/robotics5030012https://www.osti.gov/scitech/servlets/purl/492007

https://courses.uscden.net/d2l/le/content/10796/viewContent/134682/View

https://link.springer.com/chapter/10.1007/978-3-319-07230-2_63

https://www.scribd.com/document/130736497/A-Line-Follower-Robot-From-Design-to-Implementation-Technical-Issues-and-Problems

http://www.ri.cmu.edu/pub_files/pub4/steinfeld_aaron_m_2006_1/steinfeld_aaron_m_2006_1.pdf

ID 100362

2 Overall Description

ID 67711

This section will give an overview of the whole system. The system will be explained in its context to show how the system interacts with other systems and introduce the basic functionality of it.

It also includes a description of the type of stakeholders that are involved in the system and also tells about their primary goals and desires.

ID 94863

2.1 Product Perspective

ID 94817

RoboCon consists of a variable number of robots that form a convoy and follow a leader robot to a specified destination. In most usage scenarios, the convoy will include at least four robots, but at least two robots are required:

• One robot in the convoy is designated as the leader robot. The leader robot is provided with a path to follow in the form of a series of spatial coordinates called waypoints.
• All other robots in the convoy are follower robots. Each follower robot uses on-board sensors to track the robot immediately ahead of it in the convoy and follow it.

ID 94868

2.2 Product Functions

ID 94872

RoboCon will provide a demonstration and experimentation platform for CS568 Systems image processing and artificial intelligence algorithms.

ID 94873

RoboCon System will allow CS568 Systems to conduct internal evaluation of alternative algorithms in different operational scenarios.

ID 102822

RoboCon System will provide a platform for CS568 Systems to showcase the performance of new algorithms to customers.

ID 102824

2.3 User Classes

ID 94819

The different types of stakeholders involved in the Robocon System development , testing and deliverance to the final intended audience and customers are :

1. The RoboCon development team
2. CS568 Systems algorithm developers (RoboCon users)
3. CS568 Systems management
4. CS568 Systems customers

ID 94848

2.3.1 Stakeholder Goals

ID 94820

2.3.1.1 The RoboCon development team

ID 94855

They are responsible for building the RoboCon System. The development team has indicated that their primary goals are:

a) Exhaustive cost estimation so that the project is completed on-budget

b) Strict adherence to project time-line and milestone deliverables to ensure the project is completed on-time

ID 94849

2.3.1.2 CS568 Systems algorithm developers

ID 94856

They are the primary users of RoboCon. The developers have indicated that their primary goals are:

a) Scaling and extending the system to incorporate new image processing and artificial intelligence algorithms

b) Making the system versatile to make it easy to provide configurations for different experiments

c) provide rich and meaningful metrics of algorithm performance thriugh algorithm visualizer tools

ID 94851

2.3.1.3 CS568 Systems management team

ID 94857

They are going to oversee the planning and funding of the RoboCon System development. The management team have indicated that their primary goals are:

a) The system has low maintenance costs over time specified according to the service level agreements with the different vendors

b) The system can be used to provide compelling demonstrations to customers of the value of RoboCon algorithms.

ID 94852

2.3.1.4 CS568 Systems customers

ID 94858

Thy are going to view RoboCon demonstrations that showcase the performance of CS568 Systems algorithms. The customers have indicated that their primary goals are:

a) Comparing performance metrics of different CS568 Systems algorithms and select the best one that adapts and satisfies their needs

b) Incorporation of selected CS568 Systems algorithms into their own products to provide their customers with more value and increase the profitability of the product

ID 94854

2.3.2 Stakeholder Requirements

ID 99493

The RoboCon development shall allow the RoboCon system to be developed with a proposed timeline of 2 years and a fixed budget of 100,000$.

ID 99549

The CS568 Systems algorithm developers shall provide an algorithm visualizer tool which will help in giving rich, meaningful and intelligent performance metrics for comparing the various AI and Image processing algorithms and selecting the best algorithm to be implemented in the RoboCon System and comparing it with the competitor's algorithm.

ID 99550

The CS568 Systems Management team shall allow the RoboCon system to have downtime of at most 100ms specified in the service level agreements with different customers and provide maintenance cost amounting to 2000$ over a duration of every 3 months.

ID 99551

The CS568 Systems Customers shall have the option to buy the RoboCon System license for incorporating it with their own companies' products.

ID 99552

2.4 Operating Environment

ID 100504

2.4.1 RCU Hardware Specification

ID 100508

RCU HARDWARE SPECIFICATION

S/N	Description	Qty (per Team)
Electronics		
1	DFR0305 Romeo BLE	1
2	DFR COMB0003 DFRduino Mega Kit for 4 motor robot	1
3	Turnigy 9X 9Ch Transmitterw/Module & 8Ch Receiver	1
4	LiPo Battery	2
5	Micro USB cable	1
6	Printer port USB cable	1
Actuators		
1	SRC SM-S4303R Continuous RotationServo	2
2	HXT 900 Micro Servo	3
3	Turnigy metal gear micro servo TSS-10MG	2
4	Turnigy TGY-R5180MG 180 Degree MetalMini Servo	2
5	VSD-11Y 360 Degree Large Servo	1
6	Geared DC Motor, 133 rpm, 75:1, 6 V	1
7	HXT 12K 10 kg Servo	2
8	28BYJ-48-5V 4-Phase 5-Wire Stepper Motor Kit	1
9	SW5513-4MA Sailwinch Servo 10.63 kg/55 g/0.9	1
Wheels		
1	POL226-5/8 inch plastic black wheel for continuous servo	2
Accessories		
1	4WD Vehicle Kit (4 DC motors)	1

ID 100510

2.4.2 ACU System Specification

ID 100518

ACU SYSTEM SPECIFICATION

Component	Operating system architecture	
	32-bit	64-bit
Processor	1 GHz IA-32 processor	1 GHz x86-64 processor
Memory (RAM)	1 GB	2 GB
Graphics card	DirectX 9 graphics processor with WDDM driver model 1.0	
Free hard drive space	16 GB	20 GB
Optical drive	DVD-ROM drive[100] (Only to install from DVD-ROM media)	

ID 103046

2.4.3 eBox3854 Specification

ID 100513

EBOX 3854 SPECIFICATION

eBox-3854

- Fanless design
- VIA Eden Nano 800MHz
- 256MB DDR2 onboard
- 6 x USB 2.0 ports
- 10/100Mbps LAN
- PXE diskless boot
- Compact Flash slot
- Mini PCI socket
- Wireless IEEE 802.11 b/g (optional)

www.compactpc.com.tw

Specification	*eBox-3854*
system	
Processor	VIA EDEN Nano processor
BIOS	AMI BIOS
System Chipset	VIA CLE266 / VT8235
I/O Chip	VIA VT1211
System Memory	Onboard 256MB DDR2
I/O	
MIO	1 x EIDE (UltraDMA 133, 44Pin 2.0 Pitch), 1 x PS/2 K/B, 1 x PS/2 Mouse
USB	6 x USB 2.0 Ports (one in front)
Compact Flash	Type I/II Compact Flash slot
Mini PCI	124-pin Mini-PCI connector
Display	
Chipset	Integrated VIA UniChrome 2D/3D Graphics with MPEG2 Accelerator
Display Memory	8/16/32/64 MB share system memory
Resolution	Up to 1280 x 1024
Audio	
AC97 2.2(Codec)	VIA VT1612A
Audio Interface	Line out, Mic in
Ethernet	
Chipset	VIA VT6103 10/100 Base-T Ethernet PHY
Remote Boot ROM	built-in boot ROM function
Mechanical & Environment	
Power Requirement	+5V @ 4.5A
Operating Temperature	0 ~ 60℃ (32 - 140 ℉)
Operating Humidity	0% - 90% relative humidity, non-condensing
Size (W x H x D)	170 x 123 x 56 mm
Weight	970 g
Certification	CE, FCC, VCCI

Note:the specifications are subject to change without prior notice

ID 100514

2.5 Design and Implementation Constraints

ID 94837

There are a limited number of resources that can be bought with the proposed budget set by the RoboCon Development Team including fixing the number of robots, buying GPS devices, IR sensors, setting up charging stations etc.

ID 100522

The artificial intelligence and image processing algorithms will be developed in Java using standard libraries and they should run on all JDK complaint platforms providing platform independency and hardware independency.

ID 101235

The design of the project should not rule out providing a web interface capability for ACU as that will help in remotely controlling and providing proper management for the RoboCon system.

ID 101234

There has to be a central repository large enough to store multiple redundant databases which should be capable of storing error logs, log entries for storing the number of messages exchanged between ACU and RCU so as to provide fault-tolerance, encapsulation and isolation so as to make the system more robust and increase the overall productivity and efficiency.

ID 101233

3 Specific Requirements

ID 94815

This section contains all the functional and quality requirements of the system. It gives a detailed description of the system and all its features.

ID 94874

3.1 External Interface Requirements

ID 94822

This section provides a detailed description of all inputs and outputs of the system. It also gives a description of the hardware and software interfaces and provides a detailed description of the usage

scenarios of the RoboCon System.

ID 94875

3.2 User Interfaces

ID 94823

The RoboCon system has two high-level usage scenarios: experimentation and demonstration.

ID 94878

3.2.1 Experimentation

ID 94876

RoboCon will be used internally by CS568 Systems algorithm developers to experiment with different image processing and artificial intelligence algorithms. In this usage scenario, the algorithm under test will be implemented in a component that plugs into the RoboCon software.

The RoboCon system will then be configured for a particular experiment (e.g., the number of robots, the starting and destination locations, the lighting conditions, etc.). As the experiment executes, the RoboCon system will record performance metrics such as battery usage, total travel time, number of messages exchanged, etc.

After the experiment completes, the algorithm developers will analyze the recorded data to evaluate the algorithm’s performance.

ID 94879

3.2.2 Demonstration

ID 94877

RoboCon will be used to demonstrate CS568 Systems algorithms to external customers. In this usage scenario, RoboCon’s best-performing algorithms will be plugged into the RoboCon software and the system will be configured for a demonstration that illustrates how CS568 Systems algorithms outperform the competitors’ algorithms.

For example, a demonstration might illustrate how a CS568 Systems image processing algorithm is able to function in a low-light environment.

ID 94880

3.2.3 Usage Scenarios Requirements

ID 96172

The IR sensor shall be placed at bottom of the chassis of the RCU while the GPS device has to be placed on top of the RCU.

ID 100543

The robocon system shall have the functionality to check the battery usage automatically every 10 min and record it in a separate log file to be sent to the ACU.

ID 100535

There shall be a predetermined assignment of the positions of robots in the convoy during the initialization process in the staging area.

ID 100548

The system shall also be able to function properly in a low-light environment in which the system shall ask all the RCUs to switch to GPS or IR sensor tracking and switch off their respective video camera.

ID 100540

The robocon system shall have the capability to record performance metrics -total travel time,total number of messages exchanged and store it in a central repository which is shared with the ACU and the RoboCon developers

ID 100537

Each follower robot shall not follow that guide robot RCU which is not preceding it in the predetermined order of assignment during the convoy formation operation mode

ID 100550

The robocon system shall provide a plugin for the RCU software which can be provided with initial configuration parameters - number of robots, starting and destination locations, lighting conditions for a particular experiment scenario

ID 100536

The follower RCU in the RoboCon System shall not incorrectly identify the guide RCU even in low-light environment.

ID 100541

The robocon system shall provide functionalities for demonstration and experimentation which can be configured configured for testing out and deploying various artificial intelligence and image processing algorithms developed by the robocon developers

ID 100534

The final recorded data elements should have an accuracy with a threshold value defined by the system developers for evaluating the algorithms on the basis of the performance metrics mentioned above.

ID 100538

The leader RCU robot in the RoboCon Convoy shall be provided a route to follow having a finite number of waypoints including the starting and destination locations

ID 100545

The route provided to the RoboCon Convoy shall contain finite number of spatial co-ordinates called waypoints and charging stations which help in recharging the RCU battery and include at least one obstacle.

ID 100546

The robocon system shall provide the user with shall have to provide a measurement and analytical tool for conducting internal evaluation of image processing algorithms as an alternative to artificial intelligence algorithms or vice versa in different operational modes.

ID 100551

The robocon system shall work identically for all algorithms and every operational mode will be an atomic operation which will either result in a success or failure and every execution (transaction) operation will be recorded in a log file along with all the errors which will be shared with the ACU or the developers

ID 100542

The robocon convoy shall have each and every follower robot RCU uses on-board sensor tracking system to track and follow the guide robot RCU which is immediately in front of the follower robot RCU

ID 100547

The follower robot shall not move on its own in random direction as it has been pre-programmed track and follow only the guide RCU

ID 100549

The robocon convoy shall include at least 2 RCU robots i.e. one leader RCU and follower RCU for which the leader RCU acts as the guide and ACU software for proper functioning and application.

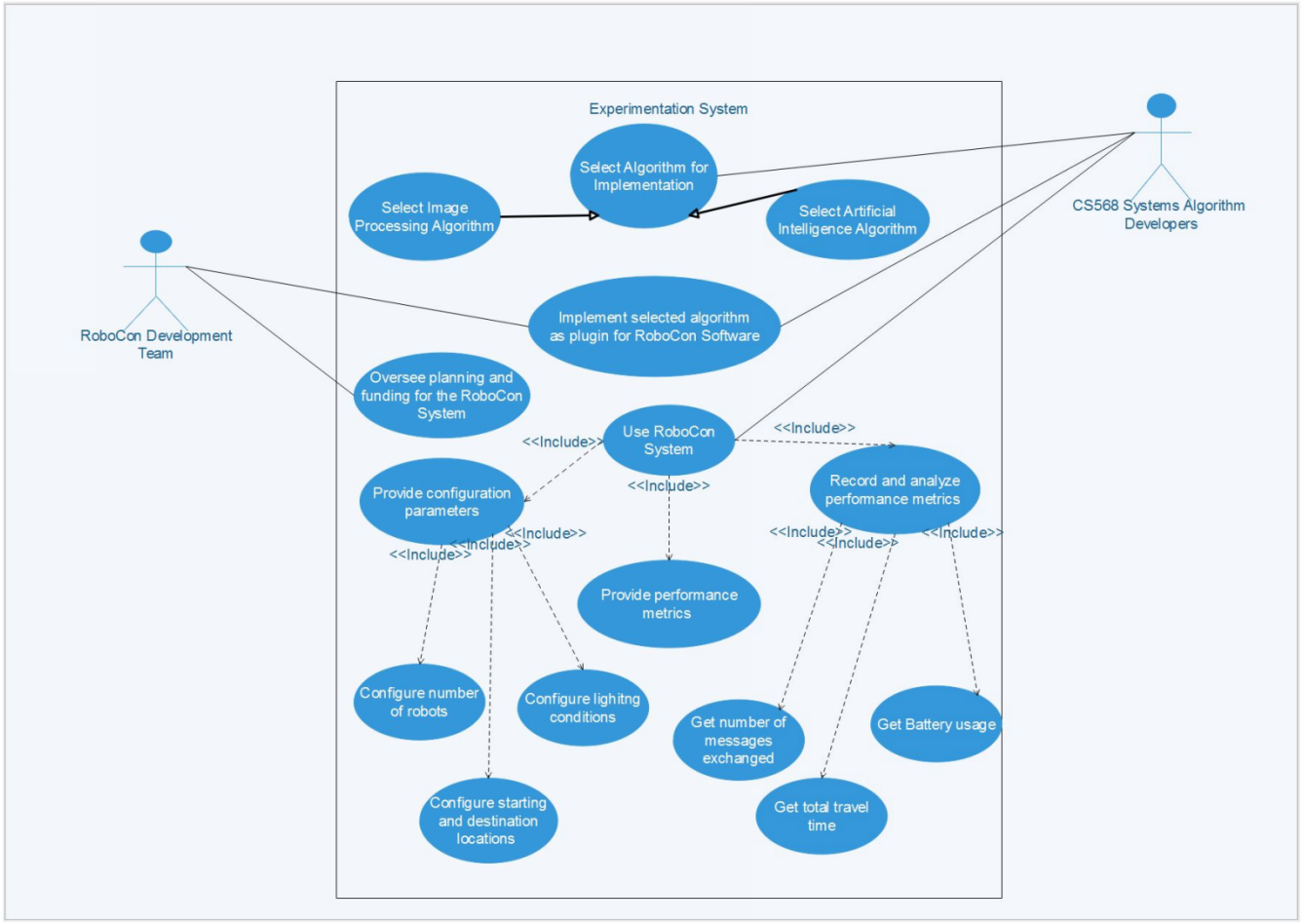
ID 100544

The robocon system shall operate in a highly available and fault-tolerant manner.

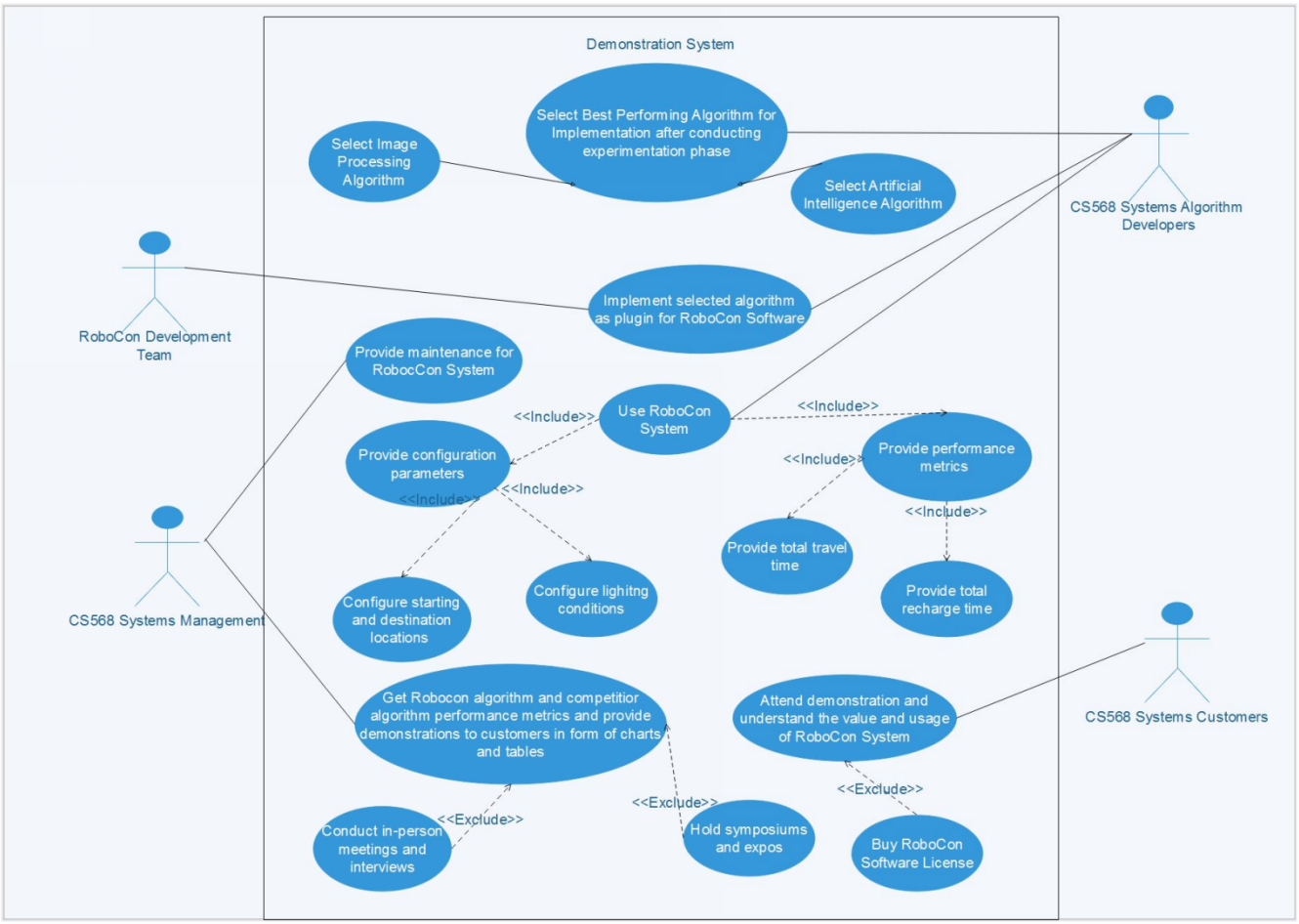
ID 100539

3.2.4 Use Case Diagrams

ID 94824



ID 95110



ID 95094

3.3 Hardware Interfaces

ID 94825

3.3.1 RCU Hardware Platform

ID 94826

3.3.1.1 RCU Hardware Requirements

ID 97888

The RCU hardware shall operate on a system having a processor which is capable of multiprocessing and provides capabilities of deadlock prevention, context switching and preemption of resources for running multithreading applications.

ID 100560

Every RCU hardware will have a hardware id which will help in distinguishing between the leader RCU, follower RCU and guide RCU.

ID 100556

The RCU hardware shall support video camera, GPS receiver and IR receiver and transmitter components for providing the tracking capabilities used during convoy formation , movement mode and recharge mode operation modes.

ID 100565

The RCU hardware shall also support 802.11 wireless local area network (LAN) adapter which will provide the WiFi connecting for inter process communication between different RCUs of the convoy and the ACU

ID 100564

Each and every RCU hardware shall have 4 wheels with each having rotation per minute 135 RPM and 4 motors each having 24VDC that help in moving and turning the robot along the specified direction

ID 100557

The manufacturing of the RCU hardware shall not be done by any external sources including third party hardware vendors.

ID 100554

The RoboCon System shall have a processor that is capable of doing accurate GPS calculations at rate of 100 transactions per route

ID 100561

The RoboCon System shall have a reported uptime of 99.9%

ID 100562

The RCU hardware shall operate on a system capable of performing near real-time execution of instructions running in Fedora Linux.

ID 100559

The RCU hardware shall have a front bumper sensor that helps in obstacle detection so that the obstacle avoidance algorithm can be invoked accordingly.

ID 100558

The RCU hardware may contain separate SAN (flash storage) device for storage flexibility for plugging in separate USB pen drives etc.

ID 100563

The manufacturing of the RCU hardware shall be done internally at CSCI 586 Systems by using off-the-shelf components

ID 100555

3.4 Software Interfaces

ID 94827

3.4.1 RCU Software Controller

ID 94828

3.4.1.1 RCU Software Controller Requirements

ID 99554

The RCU software shall receive sensor data from the RCU sensors and store sensor data streams in a database designed in MySQL that can handle transaction processing at a rate of 500 transactions per minute

ID 100598

The RCU software shall support for analyzing sensor data that help in determining actions that need to be taken by the RCU by using RCU sensors and actuators like moving RCU , increasing speed of the RCU , stopping RCU etc.

ID 100570

The RCU software shall have the functionality where in one RCU controller instance communicates with other Controller instances via an ad-hoc WiFi network to coordinate activities.

ID 100573

The RCU software shall perform periodical offsite and onsite backups of all configurations and reporting data and can be replicated on any other RCU software controller or ACU for providing backup in cases like power failure, signal loss etc.

ID 100569

The RCU software shall support wireless encryption protocols WPA [1-2] and WEP.

ID 100571

The RCU software shall have a tool that helps in recording performance metrics for analysis and

also transmits metrics to the Admin component.

ID 100574

The RCU software shall have multiple redundant databases for fail-over purposes

ID 100568

The RCU software shall support communication mode using Linux drivers to communicate with WiFi, GPS, IR receiver and IR transmitter

ID 100572

3.4.2 Administrative Control Unit

ID 94829

3.4.2.1 Administrative Control Unit Requirements

ID 99578

The ACU shall allow feature modeling support that helps in a tabular representation of the performance metrics data via charts and tables which are to be presented in the RoboCon demonstration procedure conducted in various symposiums and exhibitions held by RoboCon System Management Team

ID 100578

The ACU shall allow a user to specify experiment and demonstration configuration parameters like number of robots, starting and destination locations, lighting conditions and uploading the configurations to the RCU controllers

ID 100577

The ACU shall support a customizable Windows Graphical User Interface software application for

performing various RoboCon management functions like providing a route to the RoboCon convoy, adding waypoints in the route , setting starting and final locations .

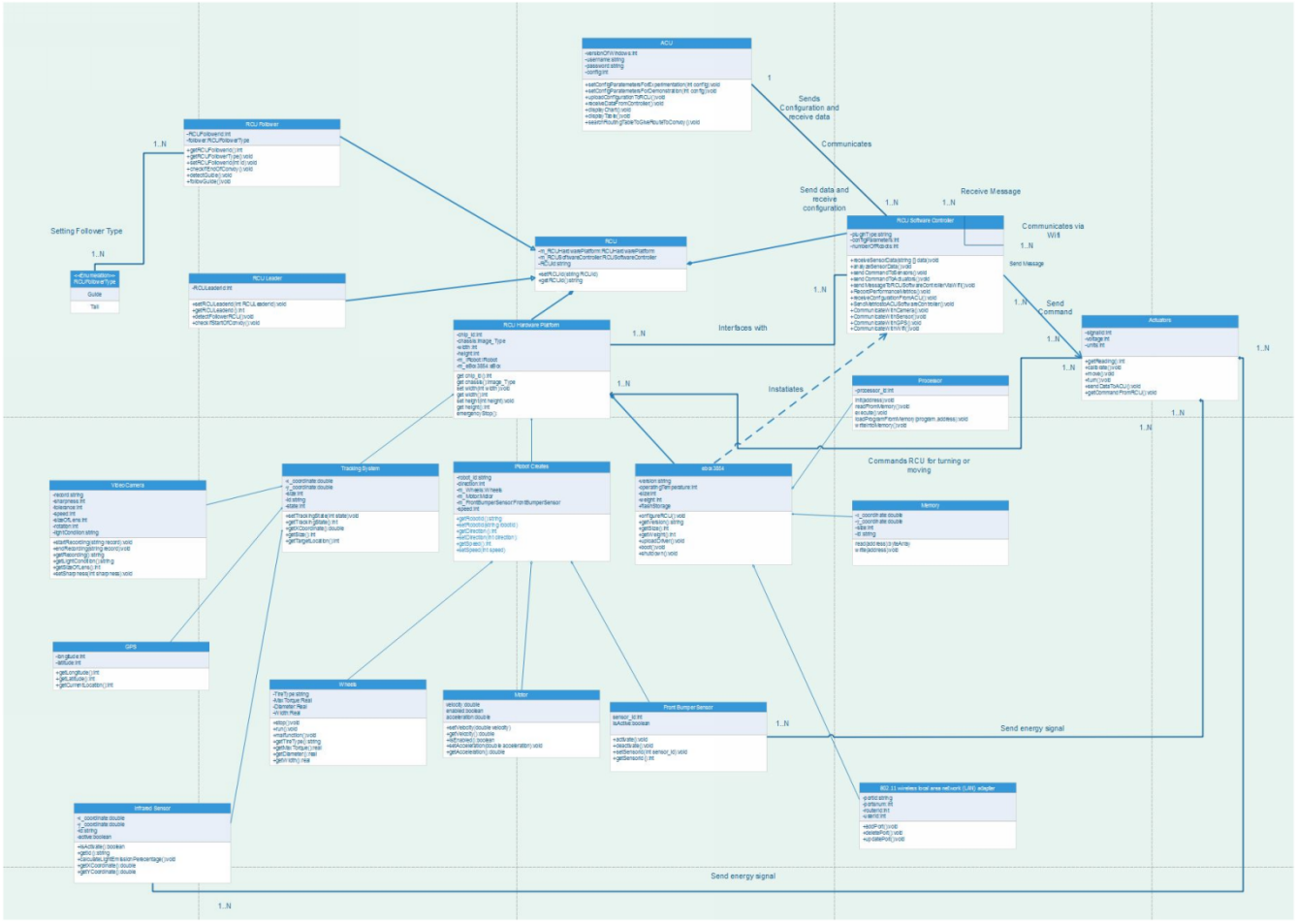
ID 100576

The ACU shall support an operating system running Microsoft Windows 7 capable of multi-processing and provides capabilities of deadlock prevention, context switching and preemption of resources for running multithreading applications.

ID 100575

3.5 Architecture Class Diagram

ID 94839



ID 100788

4 System Features

ID 94830

4.1 Operational Modes

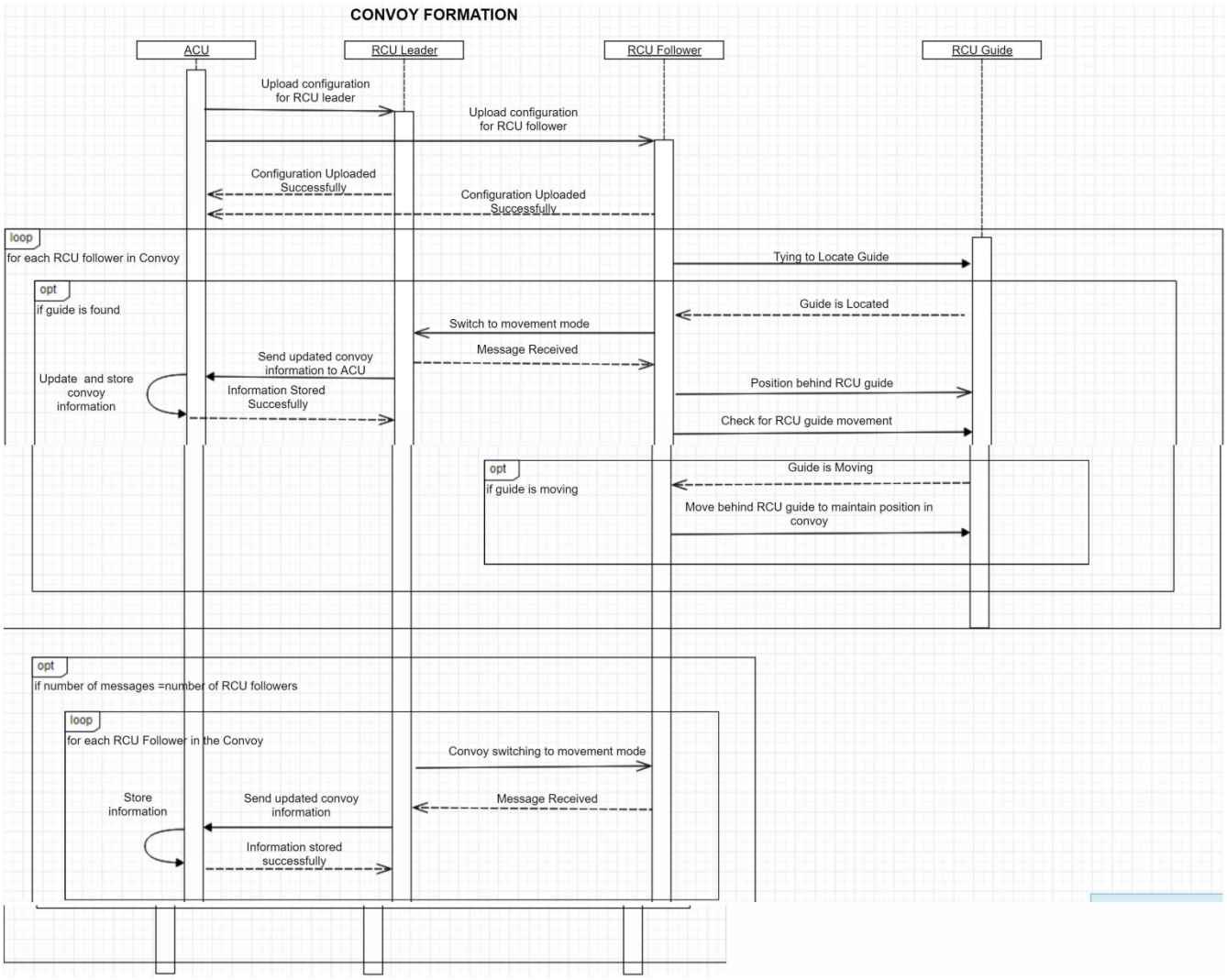
ID 94831

4.1.1 Convoy Formation

ID 94832

4.1.1.1 Convoy Formation Sequence Diagram

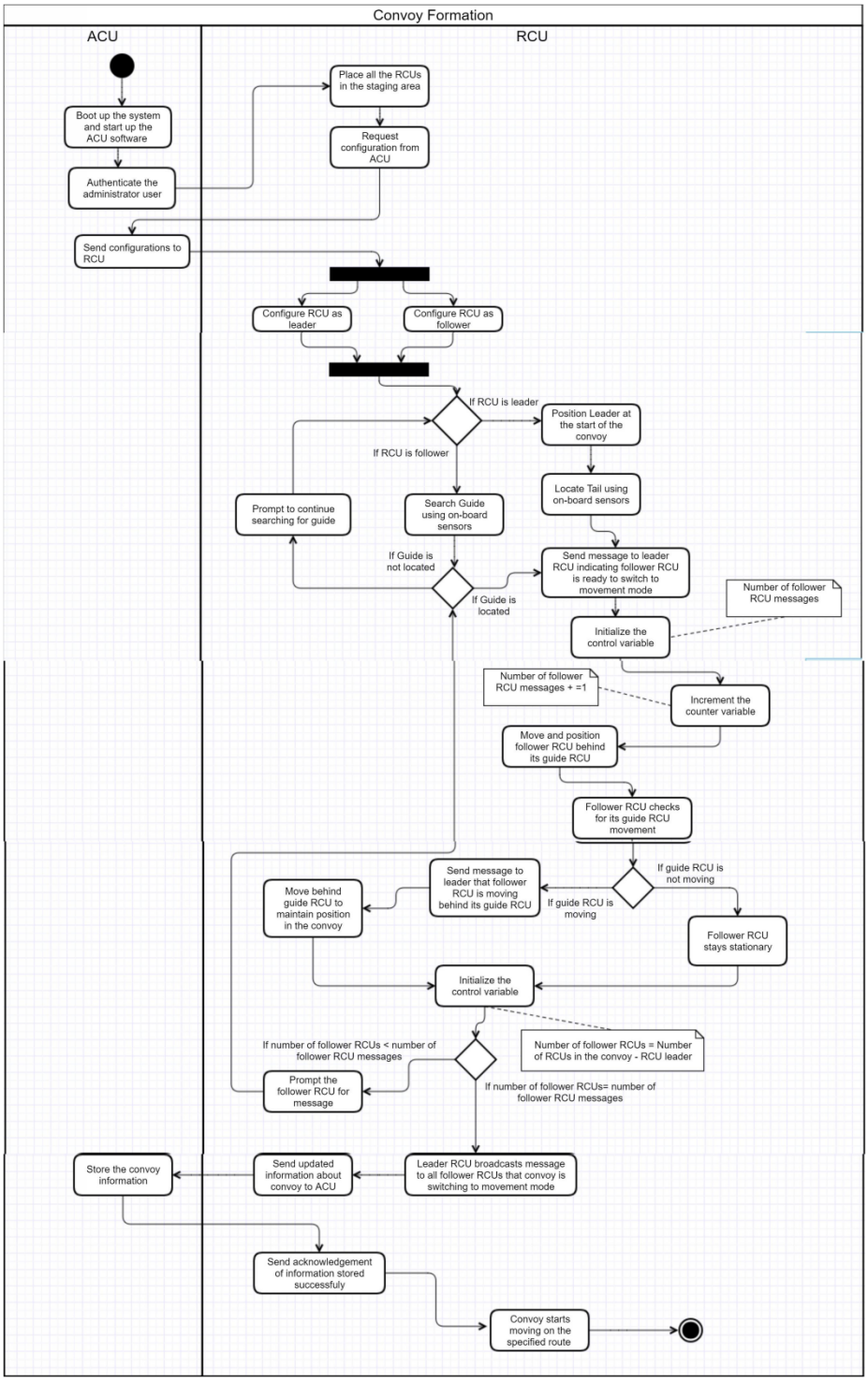
ID 99921



ID 99923

4.1.1.2 Convoy Formation Activity Diagram

ID 99938


Convoy Formation
ACU
RCU
Boot up the system and start up the ACU software
Authenticate the administrator user
Send configurations to RCU
Place all the RCUs in the staging area
Request configuration from ACU
Configure RCU as leader
Configure RCU as follower
If RCU is leader
If RCU is follower
Position Leader at the start of the convoy
Locate Tail using on-board sensors
Search Guide using on-board sensors
Prompt to continue searching for guide
If Guide is not located
If Guide is located
Send message to leader RCU indicating follower RCU is ready to switch to movement mode
Number of follower RCU messages
Initialize the control variable
Number of follower RCU messages + =1
Increment the counter variable
Move and position follower RCU behind its guide RCU
Follower RCU checks for its guide RCU movement
If guide RCU is not moving
If guide RCU is moving
Send message to leader that follower RCU is moving behind its guide RCU
Move behind guide RCU to maintain position in the convoy
Follower RCU stays stationary
Initialize the control variable
If number of follower RCUs < number of follower RCU messages
Number of follower RCUs = Number of RCUs in the convoy - RCU leader
If number of follower RCUs= number of follower RCU messages
Prompt the follower RCU for message
Store the convoy information
Send updated information about convoy to ACU
Leader RCU broadcasts message to all follower RCUs that convoy is switching to movement mode
Send acknowledgement of information stored successfuly
Convoy starts moving on the specified route

ID 99926

4.1.1.3 Convoy Formation Requirements

ID 99579

The system shall allow each follower RCU to have exactly one guide RCU which it will track using on-board sensors including GPS, IR sensor and video camera

ID 100602

The system shall allow the follower RCU to switch to movement mode after the follower RCU has located its guide RCU and broadcasted the message to the leader RCU.

ID 100604

The system requires that the leader RCU shall receive a message from the follower RCUs when they are ready to switch to the movement mode.

ID 100606

The system shall impose a constraint that the RoboCon convoy will be a straight single file line.

ID 100601

The system requires the follower to maintain its position behind the guide, once the guide starts moving so as to maintain the relative position of the follower RCU behind its guide RCU without having to redo the whole process from the beginning.

ID 100605

The system shall allow a convoy in which each RCU has exactly one tail and the last RCU in the convoy line has zero tails which helps in identifying the end of the convoy and the leader RCU is positioned at the start of the convoy indicating the start of the convoy.

ID 100603

The system shall have a set of RCUs positioned in a staging area after booting up ACU and completing the initialization procedure for configuring each and every RCU.

ID 100599

The system requires that the whole convoy starts moving along the route provided by the ACU when all the followers are ready to switch to the movement mode and the leader shall broadcast a message to all the followers indicating that the convoy is switching to the movement mode.

ID 100607

The system shall allow every RCU participating in the convoy to be configured either as a leader or follower by assigning a unique identifier to every RCU

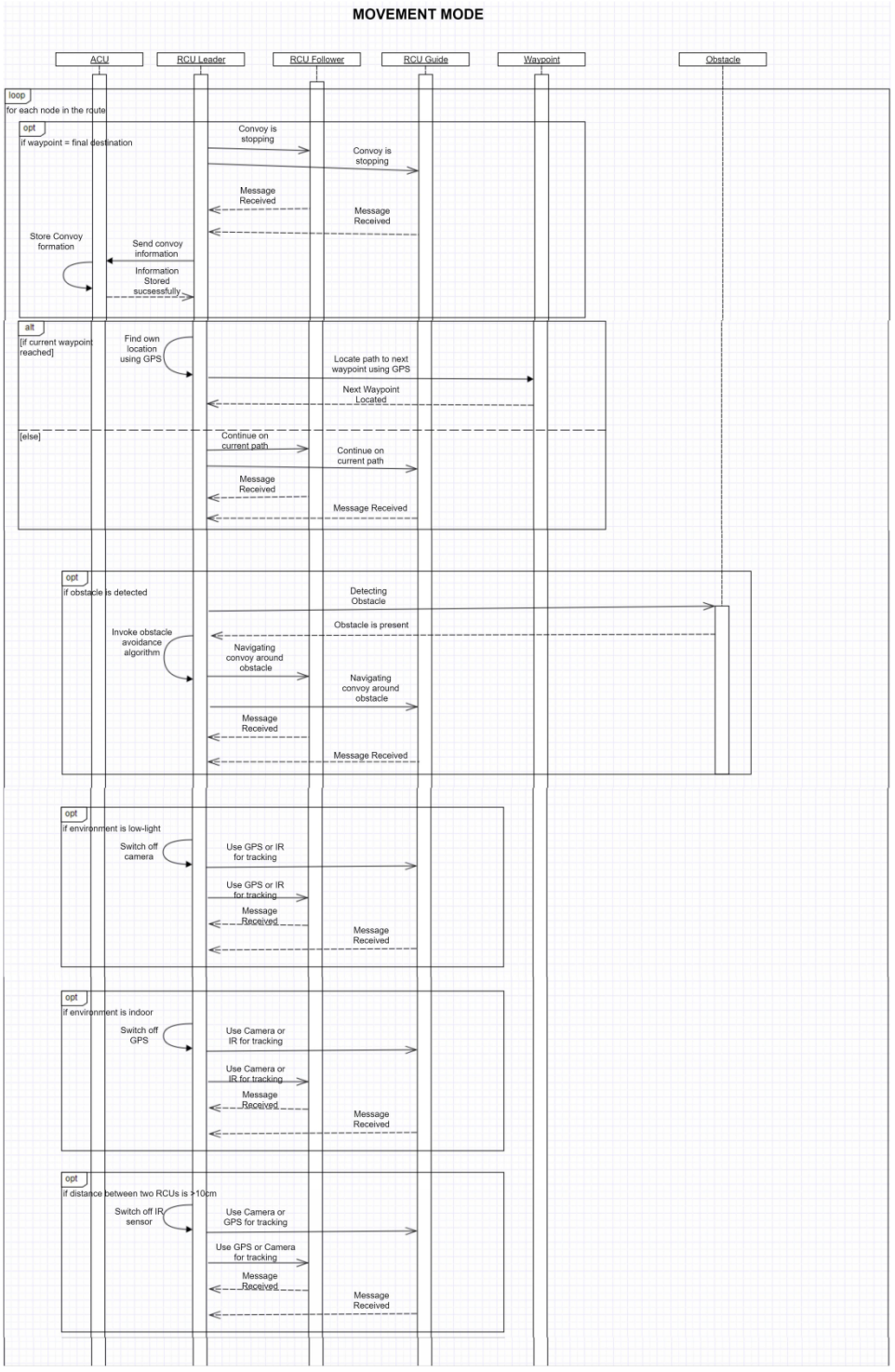
ID 100600

4.1.2 Movement Mode

ID 94833

4.1.2.1 Movement Mode Sequence Diagram

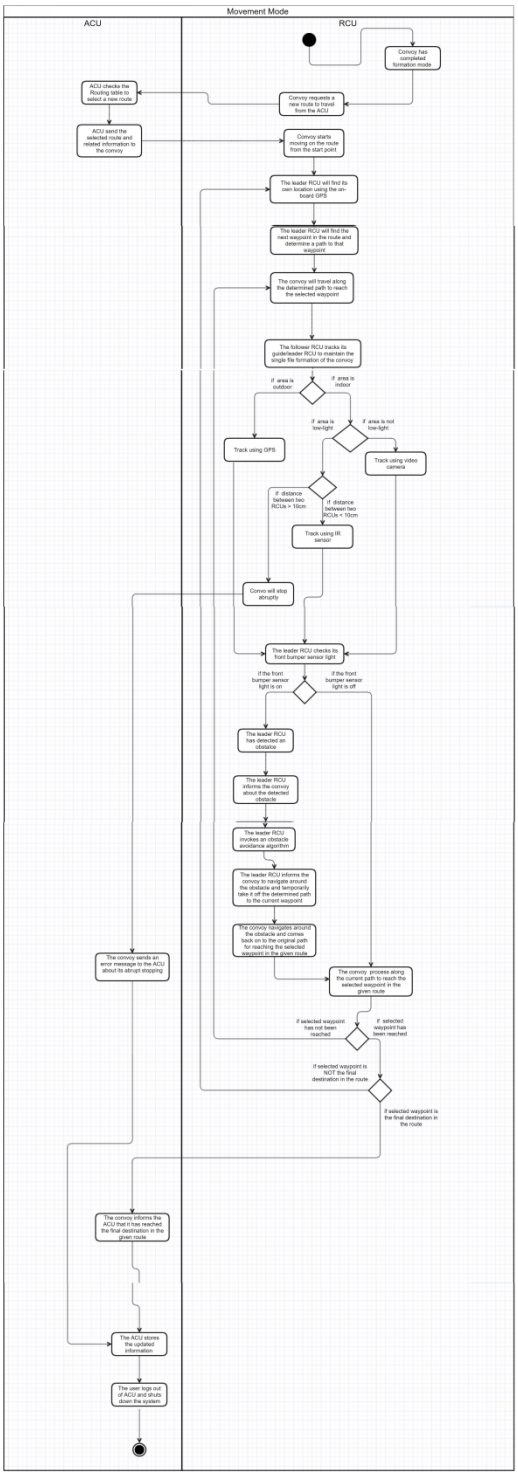
ID 99919


MOVEMENT MODE
ACU
RCU Leader
RCU Follower
RCU Guide
Waypoint
Obstacle
loop
for each node in the route
opt
if waypoint = final destination
Convoy is stopping
Convoy is stopping
Message Received
Message Received
Store Convoy formation
Send convoy information
Information Stored sucsessfully
alt
[if current waypoint reached]
Find own location using GPS
Locate path to next waypoint using GPS
Next Waypoint Located
[else]
Continue on current path
Continue on current path
Message Received
Message Received
opt
if obstacle is detected
Detecting Obstacle
Obstacle is present
Invoke obstacle avoidance algorithm
Navigating convoy around obstacle
Navigating convoy around obstacle
Message Received
Message Received
opt
if environment is low-light
Switch off camera
Use GPS or IR for tracking
Use GPS or IR for tracking
Message Received
Message Received
opt
if environment is indoor
Switch off GPS
Use Camera or IR for tracking
Use Camera or IR for tracking
Message Received
Message Received
opt
if distance between two RCUs is >10cm
Switch off IR sensor
Use Camera or GPS for tracking
Use GPS or Camera for tracking
Message Received
Message Received

ID 99924

4.1.2.2 Movement Mode Activity Diagram

ID 99936



ID 99927

4.1.2.3 Movement Mode Requirements

ID 99581

The RoboCon convoy will come to an abrupt halt along the route which will happen due to sudden malfunctioning of the entire tracking system or sudden change of the environment conditions and send an error message log to the ACU.

ID 100590

The RoboCon convoy shall check at every waypoint if it has reached the final destination so the the convoy can complete and terminate the movement mode operation.

ID 100588

The system shall support the functionality of the leader RCU using an on-board GPS device to find its current location and determine a path to the next waypoint.

ID 100580

The system requires that if the environment around the convoy is a low-light environment then the follower RCU cannot use camera tracking and automatically switches to GPS or IR following.

ID 100585

The robocon system shall request a new route for traversal from the ACU which it does so by recursively searching its routing table stored in the ACU database and sending the same to RoboCon Convoy after successfully completing the convoy formation operation mode.

ID 100579

The system shall allow the follower to track the guide RCU either through camera or IR sensor in case of network connection problems between the RCU and WiFi

ID 100583

The system requires that when the convoy reaches a waypoint, the leader should compute a path to the next waypoint in the route and simultaneously check whether the next waypoint is the final destination.

ID 100581

The system shall allow the follower to track the guide's location by using a WiFi link, followed by using the GPS to get its own location and compute a path to the guide's location.

ID 100584

The system requires that the leader should invoke an obstacle avoidance algorithm and temporarily take the convoy off the path and do a navigation maneuver depending on the shape and type of the obstacle if the leader encounters an obstacle in the path to the waypoint.

ID 100582

The RoboCon convoy will never move along the route if the movement mode operation is carried out with starting location present in an indoor environment having low-light environment with the distance between any to RCUs in the convoy more than 8m

ID 100589

The safe distance shall have a threshold value of 5 m to avoid any collisions between the RCUs with proper speed synchronization

ID 100591

The system requires that if the convoy is moving in an indoor environment then the follower RCU

cannot use GPS tracking and automatically switches to IR sensor or camera tracking

ID 100587

The system requires that if the distance between any two RCUs in the convoy is greater than 8m then the follower RCU cannot use IR sensor tracking and automatically switches to GPS or video camera tracking.

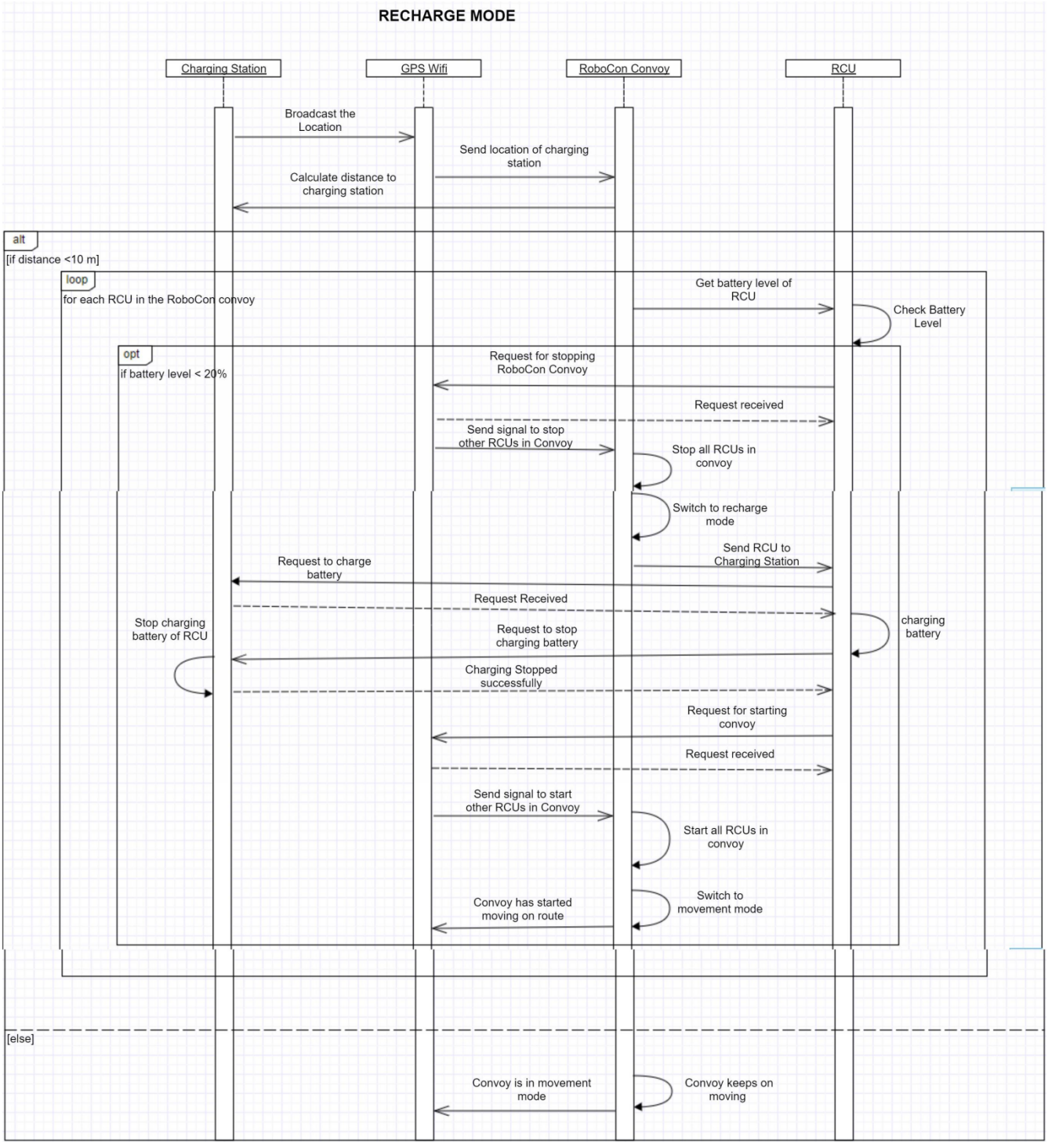
ID 100586

4.1.3 Recharge Mode

ID 94834

4.1.3.1 Recharge Mode Sequence Diagram

ID 99920


RECHARGE MODE
Charging Station
GPS Wifi
RoboCon Convoy
RCU
Broadcast the Location
Send location of charging station
Calculate distance to charging station
alt
[if distance <10 m]
loop
for each RCU in the RoboCon convoy
Get battery level of RCU
Check Battery Level
opt
if battery level < 20%
Request for stopping RoboCon Convoy
Request received
Send signal to stop other RCUs in Convoy
Stop all RCUs in convoy
Switch to recharge mode
Send RCU to Charging Station
Request to charge battery
Request Received
Stop charging battery of RCU
Request to stop charging battery
charging battery
Charging Stopped successfully
Request for starting convoy
Request received
Send signal to start other RCUs in Convoy
Start all RCUs in convoy
Switch to movement mode
Convoy has started moving on route
[else]
Convoy is in movement mode
Convoy keeps on moving

ID 99925

4.1.3.2 Recharge Mode Activity Diagram

ID 99935

ID 99928

4.1.3.3 Recharge Mode Requirements

ID 99583

The system allows the RCU to assume its original position in the convoy and switch the convoy back to movement mode, once that particular RCU has finished fully charging the battery.

ID 100596

The system supports that all the RCUs having battery remaining less than 20% can go to the charging station one-by-one and recharge themselves.

ID 100595

The system requires that if any RCU has battery remaining less than 20% , it will send a message to all the other RCUs via WiFi to stop the convoy temporarily and switch the convoy to recharge mode.

ID 100594

The system allows the convoy to switch to movement mode from recharge mode when all the RCUs with battery remaining less than 20% have finished charging thus terminating the recharge mode.

ID 100597

The system allows the charging stations in the route diagram to broadcast their location over WiFi to the convoy can store the information and mark it accordingly on the route.

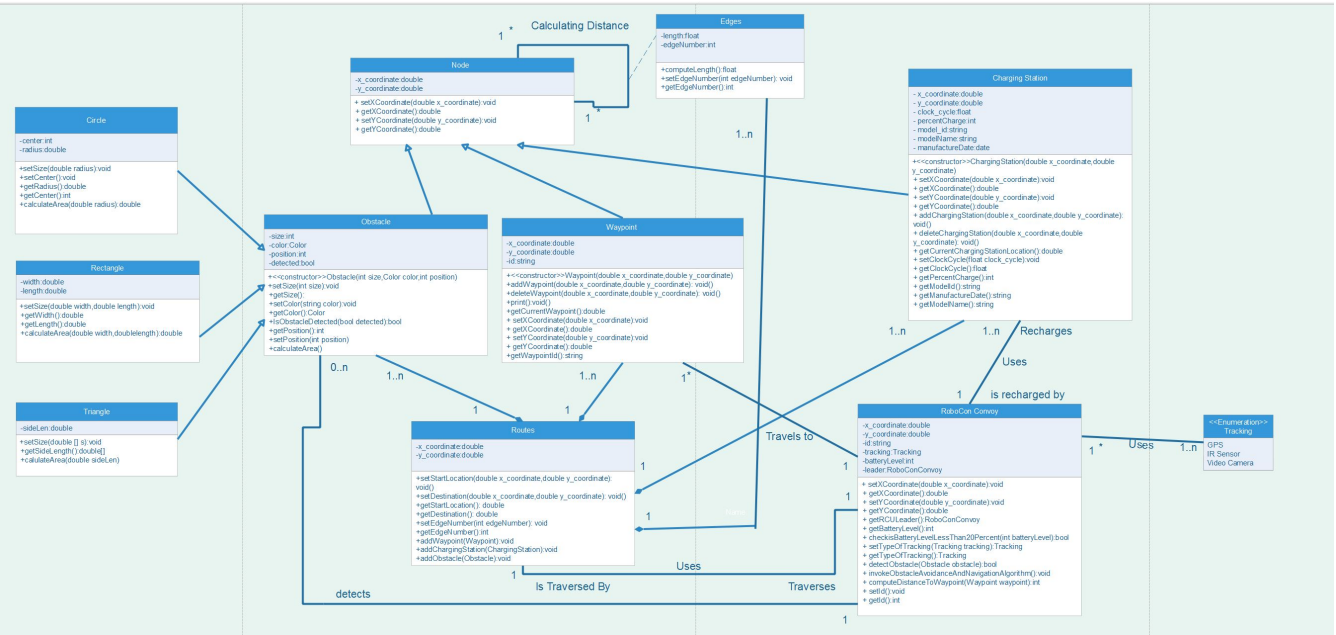
ID 100592

The system requires if the distance between charging station and the convoy is less than 10 m then each RCU in the convoy has to check the remaining battery power.

ID 100593

4.2 Routes Class Diagram

ID 94840



ID 100741

5 Non - Functional Requirements

ID 94838

5.1 Security Requirements

ID 100626

Authentication: ACU application shall verify the identity of their users and provide two factor authentication against intruder and man-in-the-middle attacks.Robot programming and maintenance operations are prohibited for persons other than those who have received adequate training in controlling of the robots

ID 100684

Non Repudiation: Every message has a unique id associated with it and RCU has a proof of proof of delivery and the ACU is assured of the RCU's identity.This means neither can subsequently refute their participation in the message exchange.

ID 100691

Integrity: The Robocon system shall report its performance metrics and error logs to the admin users of the system only after validating them through multifactor validation and also detect any interception of the signals from an enemy or competitor so as to ensure that the contents of the message of are not changed

ID 100690

Encryption: The video recording and the images of the route through the camera shall be encrypted and then send to the ACU for further performance evaluation and route determination purposes.

ID 100687

Authorization: Admin users have pre defined access rights to the resources of the system for carrying out management functions of the RoboCon System

ID 100685

5.2 Performance Requirements

ID 100628

The Robocon system shall optimise the utilisation of the hardware and software components to provide maximum throughput

ID 100702

The Robocon system shall also report the deviation from the planned route to the stakeholders

ID 100705

For each RCU the Robocon system shall record the distance travelled from one waypoint to another as well as the total distance travelled during the route

ID 100701

The Robocon system shall optimise the number of messages exhanged between the ACU and the RCUs for better performance

ID 100703

For each RCU the Robocon system shall record the total time of recharging, movement from one waypoint to another, navigationg around the obstacle

ID 100700

The Robocon system shall constantly report the battery levels of each RCU to the ACU as well as to the admin users

ID 100699

The Robocon system shall check the efficiency of the obstacle avoidance algorithm and should report the locations of the obstacles reported by each RCU in their route

ID 100706

The Robocon system shall be able to measure and report the accuracy of the waypoints and path determination from video camera, GPS and IR

ID 100704

5.3 Software Quality Attributes

ID 100627

5.3.1 Readability

ID 100631

Readability: The source code for the applications will be written with readability being highly emphasized. This includes the commenting of major functions and any artificial intelligence and image processing algorithms used. This will allow future evolutions of the product to be implemented with less time wasted on understanding the current implementation.

ID 100639

5.3.2 Robustness

ID 100630

Robustness: The RoboCon Convoy application will attempt to compensate for any network lag experienced by switching to alternate modes of tracking – IR sensor and video camera

ID 100678

Robustness: The ACU software admin application will run smoothly and avoid memory leaks and errors.

ID 100681

5.3.3 Scalability

ID 100632

Scalability: The RoboCon System will be easy to extend to other artificial intelligence and image processing algorithms by providing meaningful metrics

ID 100644

5.3.4 Availability

ID 100633

Availability: The RoboCon Convoy should be available on the specified date and specified time for experimentation so as to meet the project budget and deadline and meet demands of customers have made reservations for attending the demonstration to be held during symposiums and exhibitions.

ID 100649

5.3.5 Correctness

ID 100634

Correctness: The RoboCon Convoy should reach start from correct starting point and should reach correct destination in the route so as to successfully with minimum deviation from the specified route.

ID 100652

5.3.6 Portability

ID 100636

Portability: The ACU software admin application which can support both Apache and Java 1.5

ID 100670

5.3.7 Usability

ID 100635

Usability: The RoboCon System must be user-friendly and easy to learn so that a new user can master how to use the system after their first use. This will be accomplished by having easy to understand User Interfaces, help files, and clearly defined user documentation.

ID 100671

5.3.8 Reliability

ID 100637

Reliability: The RoboCon System will be highly fault tolerant with a mean time between failure (MTBF) of 1 hour

ID 101795

5.3.9 Maintainability

ID 100673

Maintainability: The ACU and RCU should maintain correct logs and carry out the tracking of robots properly so as to have low maintenance costs over time.

ID 100674

6 Glossary

ID 88517

6.1 Definitions

ID 100708

Convoy: A group, traveling together with a protective escort or for safety or convenience towards the same destination.

ID 101289

Route: It is a way to get from one place to another place

ID 101288

Algorithm: It is a process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer.

ID 101287

Obstacle: It is something that blocks your way so that movement or progress is prevented or made more difficult:

ID 101285

Charging Station: Charging area or charging stations are places where people charge their electric equipment or vehicles.These stations provide electric power at a high voltage and a high current which are not available at residential complexes, to facilitate quick charging.

ID 101286

Video Camera: is a camera used for electronic motion picture acquisition

ID 100736

IR sensor: The infrared sensors are the sensors that detect/measure infrared radiation or change in the radiation from outer source source or inbuilt source to detect the changes in surrounding

ID 100735

GPS: It is a radio navigation system that allows land, sea, and airborne users to determine their exact location, velocity, and time 24 hours a day, in all weather conditions, anywhere in the world.

ID 100734

Wifi: It is a facility allowing computers, smartphones, or other devices to connect to the Internet or communicate with one another wirelessly within a particular area.

ID 100733

Throughput: It is the maximum rate of production or the maximum rate at which something can be processed.

ID 100732

Mean time between failures (MTBF): It is the predicted elapsed time between inherent failures of a system during operation. MTBF can be calculated as the arithmetic mean (average) time between failures of a system.

ID 100731

Robot: It is a re-programmable, multifunctional manipulator designed to move material, parts, tools, or specified devices through variable programmed motions for the performance of a variety of tasks.

ID 100730

Logfile: It is a file that records either events that occur in an operating system or other software runs, or messages between different users of a communication software.

ID 100729

Actuator: It is a component of a machine that is responsible for moving or controlling a mechanism or system. It requires a control signal and a source of energy. The control signal is relatively low energy and may be electric voltage or current, pneumatic or hydraulic pressure, or even human power. The supplied main energy source may be electric current, hydraulic fluid pressure, or pneumatic pressure. When the control signal is received, the actuator responds by converting the energy into mechanical motion.

ID 100728

Waypoint: A set of spatial coordinates indicating a position that the convoy must pass through on its way to the destination of the route.

ID 88519

Tail: The RCU immediately behind a given RCU in the convoy. An RCU is the guide of its tail.

ID 88518

Leader: The RCU that is provided with the route waypoints and proceeds first in the convoy.

ID 67705

Guide: The RCU tracked and followed by a follower and can either be the convoy leader or a follower. All followers have exactly one guide.

ID 67704

Follower: An RCU that does not know the waypoints of the route and uses on-board sensors to follow another RCU immediately preceding it in the convoy.

ID 67703

6.2 Abbreviations

ID 100710

MTBF: Mean Time Between Failure

ID 100737

ACU: Administrative Control Unit

ID 88530

GPS: Global Positioning System

ID 88529

GUI: Graphical User Interface

ID 88528

IR: Infrared

ID 88527

LAN: Local Area Network

ID 88526

OS: Operating Systems

ID 88525

OTS: Off - the - Shelf

ID 88524

PC: Personal Computer

ID 88523

RCU: RoboCon Unit

ID 88522