High Level Design (HLD)

¡Neuron

High Level Design (HLD)

UGV (Unmanned Ground Vehicle) based

**Surveillance**

Revision Number**: 2.0**

Last date **of** revision: 23/06/2021

**UGV** SURVEILLANCE 1

High Level Design (HLD)

**Document Version Control**

**Date Issued Version**

**Description**

¡Neuron

**Author**

**8/06/2021**

**1**

**Initial** HLD **-** V1.0

**P Sairam**

**23/06/2021**

**2**

Updated KPI - V1.1

P **Sairam**

**Priti**

UGV **SURVEILLANCE**

**2**

High Level Design (HLD)

**Contents**

**Document Version Control**.

**Abstract**....

¡Neuron

**.2**

**4**

1

**Introduction**

...5

1.1

Why this High-Level Design **Document**?.

.......5

1.2

**Scope.....**

**5**

**1.3**

Definitions**......**

...5

**2**

General Description**........**

**...6**

**2.1**

Product Perspective**.....**

**..6**

**2.2 Problem** statement

..6

**2.3**

PROPOSED SOLUTION.......

**2.4**

FURTHER IMPROVEMENTS

**2.5**

Technical Requirements.

2.6

Data Requirements

2.7

Tools **used**.**..............................**.

.6

.6

**.6**

...7

**.8**

**2.8**

2.7.1

Hardware Requirements**.....**

**2.7.2 ROS(**Robotic Operating System)..

**Constraints.......**

**8**

.9

.9

**2.9**

**Assumptions...**

.9

3

Design Details

**.10**

3.1

**Process Flow**......

**.....** *10*

3.1.1

Model Training and Evaluation

**.10**

**3.1.2**

Deployment Process

11

**3.2**

Event log..

.11

**3.3**

**Error** Handling

11

**3.4**

Performance**..**

**.12**

3.5

Reusability**.....**

3.6 Application Compatibility

**.12**

**.12**

**3.7**

**Resource Utilization**

3.8

**4**

**.12**

**5**

**Deployment....**

**Dashboards....**

4.1 **KPIs (**Key Performance Indicators**)**.

**Conclusion**

**.12**

**13**

**.13**

**14**

**UGV SURVEILLANCE 3**

High Level Design (HLD)

¡Neuron

**Abstract**

**Recent trends are** to build tall **buildings in** big **cities as a way out of the current housing overpopulation** problem**.** These new structures unveil problems that if not addressed **in** time **could cause** catastrophes **of** unimaginable impact. Some **of** those problems **is** the incidence **of a fire** threat happening **upstairs** in one **of those buildings**, **medical emergencies** due **to any** road accidents **or** mob that **may cause threat** to the **human** kind. **This work discusses** the implementation of the **unmanned ground** vehicles to spot **the** real location of **the** medical **emergencies** due to road mishap, mob or **illegal activities such** as **hooliganism**, **snatching**, robbery and the **fire** emergency and accordingly **channelize or** route them **to the concerned** helpline for quick mitigation and avoid disaster.

**UGV** SURVEILLANCE 4

High Level Design (HLD)

¡Neuron

**1 Introduction**

**1.1 Why this High-Level Design Document**?

**The** purpose of this High**-Level Design** (HLD) Document **is** to add the necessary detail to the **current project description** to **represent a suitable model for** coding. **This document is also** intended to help detect **contradictions prior to** coding, and **can** be used as **a reference** manual **for** how the **modules** interact at **a** high **level**.

**The HLD will:**

**Present all of** the design aspects and define **them** in **detail** Describe the user interface **being** implemented

**Describe** the **hardware and software interfaces**

Describe the performance requirements

Include design **features** and the architecture **of the** project **List and describe the non-functional attributes like:**

о

Security

**Reliability**

**Maintainability**

о Portability

o **Reusability**

o Application **compatibility**

о

**Resource utilization** O **Serviceability**

**1.2 Scope**

The HLD documentation **presents the structure of the** system, **such as** the database architecture, application architecture **(layers),** application **flow** (Navigation), and **technology architecture**. The **HLD uses** non-technical **to mildly-**technical terms **which should be understandable to** the **administrators of the system**.

1.3 **Definitions**

*Term*

*UGV*

***Database***

*IDE*

***AWS***

*Description*

Unmanned **Ground Vehicle**

**Collection** of all the information monitored by **this system**

Integrated Development Environment

**Amazon Web Services**

UGV **SURVEILLANCE**

LO

**5**

High Level Design (HLD)

¡Neuron

2 **General Description**

**2.1 Product Perspective**

**The UGV** based Surveillance **solution system is** a **deep** learning-based object detection model which **will help us** to detect the anomalies in the **society** and take the **necessary** action.

2.2 **Problem statement**

**To** create an Al solution for **surveillance** using **rover or** UGV and to implement the following **use cases**.

2.3

**To** detect mob **(illegal**) activities and inform police.

To detect disasters **(like fire**, **smoke**, **etc..)** and send **details to** concerned **authorities**. To detect a medical emergency (**accident,** etc..**) and take** emergency action (call **ambulance** and **raise** an **alarm** to the **nearest hospital) for help**.

**PROPOSED SOLUTION**

**The** solution proposed here **is an** UGV (Unmanned Ground Vehicle) based Surveillance (**Unmanned** Ground Vehicle) can be **implemented to** perform above **mention use** cases **.In** first case, **if UGV** detects **any mob(illegal**) **activities** at a **particular location** it **will** take photos **or** video for the evidence and send the police the current location where the mob activities are **taking place, further in the** second **use** case, **if** UGV detects **any natural or human** made disasters **(fire, smoke, etc..)** the **UGV detects** with **its sensors and will** send **details** to concerned **authorities** and lastly in the **final use case** of UGV, **if it finds any** medical **emergency (accident**, **etc..)itwill take** rapid action (call ambulance and **alert** the nearest hospital **)for swift** help.

2.4 **FURTHER IMPROVEMENTS**

**UGV** can be **added with more use cases like weather** detection**, live temperature to** detect and **record the** temperature **of that locality**. **UGV can also be synchronized with** UAV (**Unmanned** Aerial **Vehicle) for** better **and** fast **response or action, with** help **of** UGV and UAV synchronized it can be implemented in the **other** domains like **mining**, agriculture.

2.5 **Technical Requirements**

**This** document **addresses** the requirements for detecting the **anomalies** in the **society at** early stages and recommending the necessary and rapid action to **avoid** imbalance in the **harmony of** the **society**. **Mobile platforms** like Ground **robots** should be **used for this purpose.** Ground Robots **can** be **based** on wheels**, tracks, or legs**.

UGV should be able to **move on** steps and various **terrains. Wheel robots or**

Wheel-Legged robots **would** better fit kind of **tasks**.

These **UGVs' should include** many **sensors like stereo vision** cameras,

panoramic camera**, thermal** and infrared **detecting systems**.

UGV **SURVEILLANCE** 6

¡Neuron

High Level Design **(HLD)**

These can be **battery** powered or **solar** powered.

UGVs**' should** be equipped **with** proper computing **power to** process the

**images** or **video** of anomalies it had detected.

**2.6 Data Requirements**

Data requirement completely depend on **our problem** statement.

**We** need images data that is balanced and must have at least **1000 images**.

We **require** at **least 30-40** images for each class label with annotation.

An image **is** nothing more **than a two-**dimensional **array** of numbers**(pixels)**

Pixel value ranging between 0 to 255

**It is defined by the mathematical** function **(x**, **y**), the **value of f (x, y**) **at any point**

**is** giving the pixel value at that point of an **image**

Original image **is** in the format of **(width**, height, no of RGB channels**)**.

There **are numerous** image file formats **out** there **so it** can be hard to **know** which

**file** type best suits **your** image needs (on your **requirement**).

**TIFF** - Tagged **image** file **format**

о

**BMP** - Bitmap image file **form**

о

**JPEG -** Joint photographic **experts**' groups

GIF **-** graphics interchange **format**

о

**PNG - portable network** graphics

O

**RAW image files**

**EPS-**encapsulated post **script**

**• Tiffs are** great **for** printing. These are **lossless image files** meaning **they don't**

need to compress or **lose** any image quality or information. These format

images are high **quality images**.

**bmp** format developed by **Microsoft for windows**. **There is** no **compression or**

**information loss; this format is generally recommended** for high **quality scans**.

JPEG is **a lossy format** meaning that **the** image **is** compressed to make a

**smaller file but this loss is** not **noticeable**.

JPEG **is a very** popular **format for digital** cameras.

**GIFs are widely used** for web graphics **because they** are limited to **only** 256

**colours**, can **allow** for transparency and can be animated. These types **of files**

**are typically small** in **size** and very portable.

PNG **are a lossless image format**; **these files are able to** handle up **to 16 million**

colours unlike the 256 colours supported by **GIF**.

EPS **is a common vector type file**.

UGV **SURVEILLANCE** 7

High Level Design **(HLD)**

•

¡Neuron

**RAW** images that **are** unprocessed that have been **created** by a camera or

scanner**.** Digital cameras can shoot in raw, **mostly used in** photography.

**If the** data **is** in video format **like (MP4) convert** into images based on FPS (**no. of** frames displayed **per** second**) in real time** processing**.** There **are** number **of** tools to **convert** videos into images. Using **cv** we can convert video **into** images

2.7 **Tools** used

Python **programming** language and **frameworks such as** NumPy, **Pandas, Scikit-learn**, **TensorFlow**, **Keras** and **Roboflow are used** to **build** the **whole model**.

SN NumPy **K**

+

pandas

scikit

**learn**

TensorFlow

**PC**

**django**

**AWS**

**git:::**ROS

GAZEBO

PyCharm is used **as** IDE.

**For visualization of the** plots**, Matplotlib, Seaborn** and **Plotly are used**. **AWS is** used for deployment of the **model**.

**Tableau/Power** BI **is used for dashboard creation**.

MySQL/MongoDB **is used to** retrieve**, insert**, **delete,** and update the database. **Front** end **development is** done using HTML**/CSS** Python Django **is used for** backend **development**. GitHub is used **as** version **control system**.

**UGV SURVEILLANCE** 8

High Level Design (HLD)

¡Neuron

2.7.1 Hardware Requirements

**USB** Camera for object Detection

**LM35** temperature **sensor**

**MQ Smoke Detector Sensor**

PC (check **you** are system supports: https://7dfps.com/ros-system-

**requirements/)**

HC**-SR04 Ultrasonic sensor**

**Ground** vehicle

Raspberry Pi

**3**

Vec **(**SV)

LM

35

DZ

Analog Out 10mV/C

**Ground**

**DAT**

DOUT

**AOUT**

GND

UCC

PUR

**Gas Sensor**

Transmitter for Ultrasonic Waves

Ver**(**+5V)

Crystal Oscillator (4 MHz)

Receiver for

Ultrasonic Waves

Trig **(Input** Pin)

HC-SRO41

GND

Echo (Output Pin)

GP to J\*\*

Rospberry Pi 3-Model 8+ Raspberry Pi 2017

BNGAROOM

HOMI

ΑΛΛΑ

2.7.2 ROS (Robotic Operating System)

Robot Operating System **is** an **open-source** robotics **middleware suite.** Although **ROS is** not an operating **system** but **a** collection of **software** frameworks for robot **software** development, it **provides services** designed **for a heterogeneous computer cluster such as hardware** abstraction, **low-**level device control, **implementation of commonly used** functionality, **message-passing** between **processes,** and package management.

**UGV** SURVEILLANCE 9

High **Level** Design

¡Neuron

**2.8**

**Constraints**

**The** UGV based **Surveillance solution system must be user friendly, as automated as possible** and **users** should **not be required to know any of the workings**.

2.9 **Assumptions**

**The** main objective **of** the project **is** to implement **the use cases as previously mentioned** (2.2 Problem Statement) **for new dataset that** comes through UGV vehicle which has camera **installed** for capturing the live videos**.** Deep **Learning based** object **detection model is used for** detecting the above**-**mentioned **use** cases **based** on **the input** data. **It is also assumed** that **all** aspects **of this project** have **the ability** to **work together in thewaythe designer** is expecting.

UGV **SURVEILLANCE**

**10**

High Level Design (HLD)

3 **Design Details**

3.1 **Process Flow**

¡Neuron

For **identifying** the different types of anomalies**, we will use a** deep **learning** base model. Below **is** the **process flow** diagram **is as** shown below.

**Proposed** methodology

Captured Images from UGV

Training/Validation

on Dataset

3.1.1 Model Training and Evaluation

Take

necessary action

DL Model for Object Detection

Predicition of anomalies (usecases)in the area

(7) Prediction

(3) Data augmentation

aining set

New images

(5) Training

(1)

Annotated

Dataset

(2)

dataset

annotation

(4) split

Test set

(6) Evaluation

Model

Result of the evaluation

Prediction

**UGV** SURVEILLANCE 11

High Level Design (HLD)

3.1.2 Deployment Process

Start

Load Model

¡Neuron

Get Frames from ROS

CVBridge

Predicted Result

Make

Prediction

Preprocess

Image

**3.2 Event log**

The **system** should **log** every **event so that** the **user will know** what **process is** running internally.

**Initial Step-By-Step Description**:

1. The System identifies **at** what step logging required

2. The System should be able to log **each** and every **system flow**.

3. Developer can choose **logging** method. You **can** choose database logging**/** File

logging as **well**.

4. System **should** not hang even **after using so many** loggings. Logging **just because**

we can easily debug issues so logging **is** mandatory to do.

3.3 **Error Handling**

Should **errors** be **encountered,** an **explanation will** be **displayed as to what** went **wrong**? An **error will** be defined **as** anything **that falls** outside the **normal** and intended usage.

UGV SURVEILLANCE 12

¡Neuron

High Level Design (HLD)

**4 Performance**

**The UGV** based **surveillance** solution **is used for detection** of **anomalies in the** society whenever UGV detects **any anomalies (mob**, medical **emergency, fire, smoke**, **etc.......) it will inform concern** authorities **and takes necessary** action**, so** it **should be as accurate as possible.** So that it **will** not mislead the concern **authorities (like** hospitals, cops, **etc..)**. Also, **model** retraining **is very important** to **improve the performance**.

**4.1 Reusability**

The **code** written **and** the components **used** should have the **ability** to be **reused with** no **problems**.

**4.2 Application Compatibility**

The different components **for this project will** be using Python **as** an interface between **them**. Each **component will** have **its** own **task** to perform, and it **is** the job **of the** Python to ensure proper transfer of information.

4.3 **Resource Utilization**

When any **task is performed**, it **will likely use all the** processing **power available until** that **function is** finished.

**4.4 Deployment**

**Microsoft**

**Azure**

Google Cloud

**Tamazon**

web servicesTM

UGV **SURVEILLANCE 13**

High Level Design (HLD)

5 **Dashboards**

¡Neuron

**Dashboards will be** implemented to **display and indicate certain** KPIs and **relevant** indicators **for** the unveiled problems that if not addressed in **time** could cause **catastrophes of unimaginable** impact.

tableau

Power **BI**

**As** and **when, the system starts to** capture the historical**/**periodic **data for a user**, the dashboards **will be** included **to display** charts **over** time with **progress on various** indicators **or factors**.

5.1 **KPIs (Key Performance Indicators)**

1. Key indicators **displaying a** summary **of** the **anomaly** detection in the **society/**area.

2. Time and workload reduction **using the** UGV based **surveillance**.

3. To detect mob **(illegal**) **activities** and inform police.

4. On **time** alert **to** nearest hospital on medical emergency (accident).

5. Taking adequate evidence **of** mob.

6. **Send disaster details to concerned authorities**.

7. **Display** of **battery** life and percentage of **UGV**.

8. **Distance** travelled by UGV.

9. **Get** the **exact location of UGV**.

UGV SURVEILLANCE 14

High Level Design (HLD)

6 **Conclusion**

¡Neuron

The Designed UGV (Unmanned Ground Vehicle**) will** detect **an anomaly in the** locality **based on** various **anomalies data used** to train **our algorithm**, **so we** can identify the imbalance in the **society** in early **stages and can take necessary** action to stop **them** immediately, **so we** can have a pleasant environment in that area or location.

UGV **SURVEILLANCE** 15

High Level Design (HLD)

7 **References**

**1. https://en.wikipedia.org/wiki/Unmanned ground vehicle** 2. Google.com for images **of** UGV hardware.

3. **https://www.ros.org/**

¡Neuron

**UGV SURVEILLANCE** 16