Automatic Recognition of Fish Diseases in Fish Farms

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1 Introduction

1.1 Purpose of this document

The purpose of this Software Requirements Specification document is to outline our system requirements for Automatic Recognition of Fish Diseases in Fish Farms. The main requirements for this system are identify and diagnose some fish diseases before spreading, and Analyzing fish behavior as it helps in Prediction and detection of fish disease. the system is proposed to automatically recognize and identify three different types of fish diseases. These diseases are Epizootic ulcerative syndrome (EUS), Ichthyophthirius (Ich) and Columnaris. This document will provide a fulfilled illustration about each single stage and algorithms used in this stage. Along with a full description of what the system will do. This software requirements specification document defines how our audience see the product and its functionality.

1.2 Scope of this document

This Software Requirements Specification targets owners of fish farms and experts in the fish farm domain. Our Application will help them in saving much more time rather than manual detection. It will also be beneficial for the government in increasing fish production. This document will provide details about user characteristics and problems that user face that our project will solve it. Fish disease is a substantial source of loss to the owner of fish farm. Production costs are increased by fish disease outbreaks because of the investment lost in dead fish, cost of treatment. Therefore, Our automatic identification system for diseased fish is necessary to prevent fish diseases before huge loss occur.

1.3 Overview

Our proposed approach aims to detect and diagnose fish diseases in fish farms automatically. Raspberry Pi kit is used and connected to sensors, camera and a

personal computer(PC). The proposed system is presented in three consequent stages. During the first stage, water quality is examined by measuring water temperature and rate of pH, while fish captures are acquired by the camera. The kit gets the sensor's measurements and acquired fish captures. In the second stage, all inputs are passed to the PC for processing. This processing concerns detecting any abnormal behavior in farm environment and fish infections. Infection detection starts by pre-processing, then segmentation of infected areas and finally classification. In pre-processing phase, different color spaces were applied on input images which are RGB, Ycbcr and XYZ. For segmentation, we built a Gaussian distribution in the XYZ color space. The XYZ color space was used in the phases of classification by convolution neural networks (CNN). In behavior classification, Histogram of gradient (HOG) feature is applied on videos of fish trajectories to detect fish and displays bounding boxes around the detected fishes. Then, we randomly crop the detected fish and then we applied AlexNet for fish disease classification. Finally in the third Stage, the kit is responsible for sending notification to farm owner's mobile phones through an application, In case that mobile is not connected to the internet, GSM800 component, sends message to mobile to notify them of any improper changes in farm environment or detected infections. The overview of our proposed approach is shown in Fig. 1.

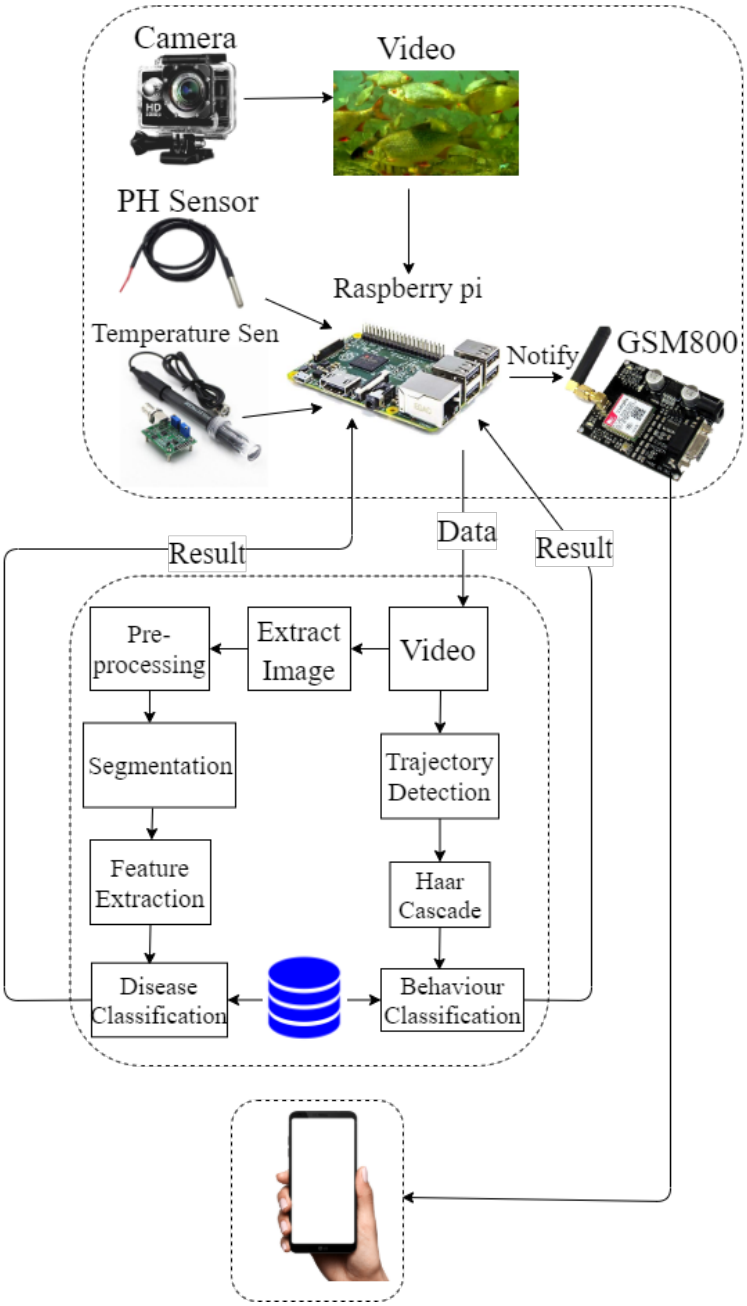

Figure 1: Proposed System Overview

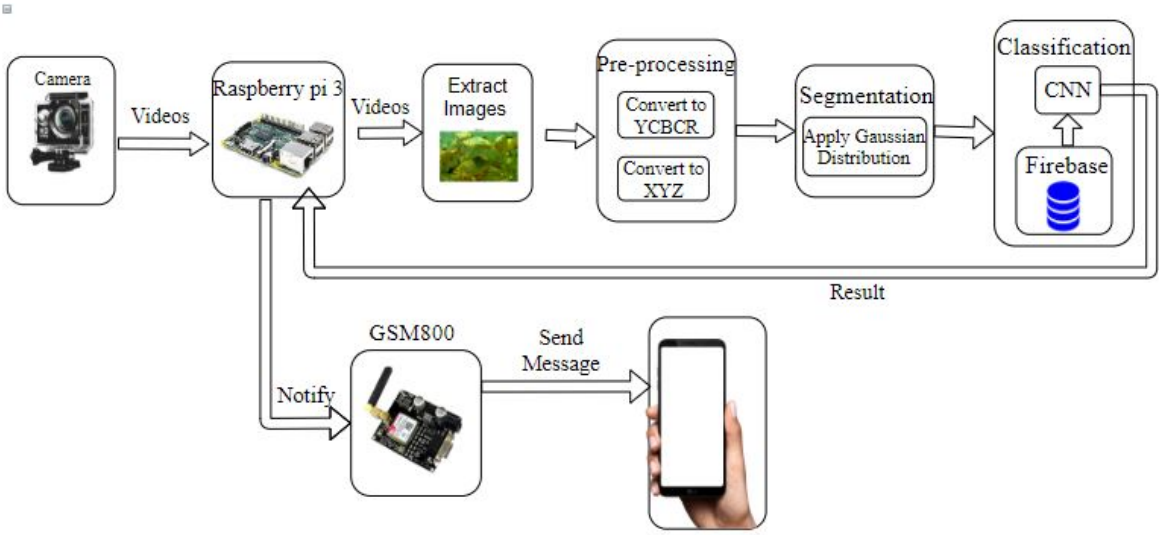

Figure 2: Block diagram for image classification

1.4 Business Context

Fish diseases have a serious impact on country economy. Still, most experts in the fish industry currently have limited time and have to make a quick decision without a good diagnosis of the problem. The process of manually detecting fish diseases and fish abnormal behavior using human vision consumes a lot of time and limits the accuracy of detection. Experts also may face difficulties by human vision due to fast fish movement and Poor quality of unclear water in Earthen ponds that also cause limitations in diagnosis and tracking. So, There is a urgent need for an automated system using computer vision to detect and reduce the impact of fish diseases. This automated system will save time for experts and provides more accurate results. Moreover, Reduce system running costs by eliminating the need for continuous human monitoring and increasing behavior analysis accuracy by excluding human subjectivity factor. Our proposed automated system also reduce the cost of fish production by controlling fish diseases as the infectious disease can cause multibillion-dollar loss annually.

2 General Description

2.1 Product Functions

3.

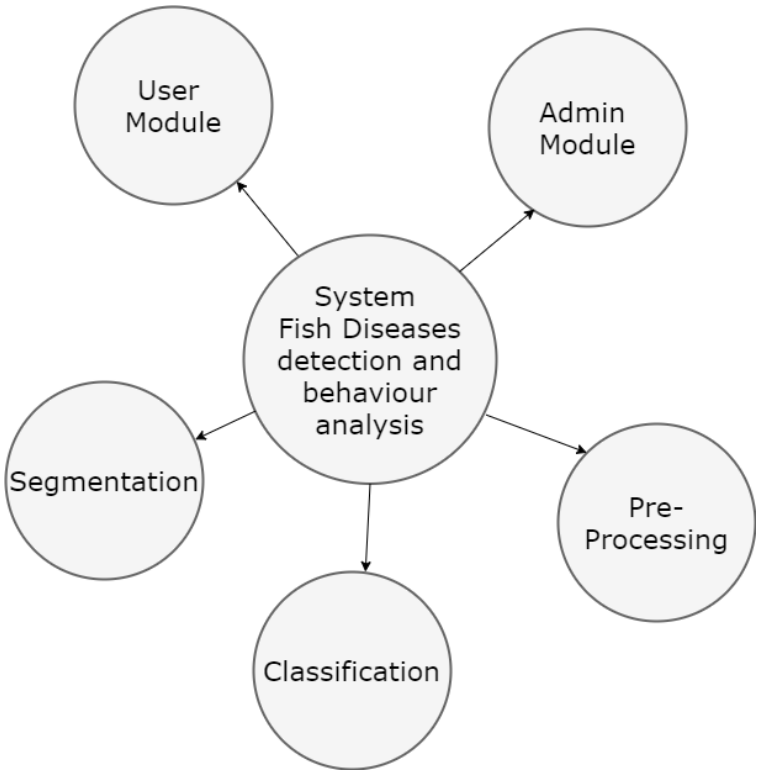

Figure 3: Proposed System Block diagram

This part outlines all the modules separately in details:

2.1.1 The Admin Module

Is the module responsible for:

- Sign in and Sign out.
- Search for a user.
- Create user account.
- Delete user account.
- Listing all users.
- Update user information.

2.1.2 The User Module

Is the module responsible for:

- Sign in/up and Sign out.
- View Profile.
- Edit profile.
- View Report.
- View latest statistics.
- View Notifications.

2.1.3 The Pre-Processing Module

- Convert to YCBCR color space.
- Convert to XYZ color space.
- Resizing.

2.1.4 Segmentation Module

- Apply Gaussian distribution.
- Calculate mean of Cb/Cr.
- Calculate co-variance.

2.1.5 Classification Module

Responsible for the classification of the input image as Fish disease/not Fish disease and diagnose which type of diseases.

- CNN

1. ResNet50
2. ResNet101
3. Alex-Net
4. ResNet18
5. VGG16
6. VGG19

2.2 Similar Systems

Different approaches [1], [2], [3] [4] applied computer vision techniques to detect and identify fish diseases. Some approaches [1] [3] were proposed to classify epizootic ulcerative syndrome (EUS) diseased fish. Color segmentation methodology is often applied on fish images to extract damaged skin [2]. Another approach [4] extracted infected regions and send notifications to fish farmers. Notification include diagnosed disease and the suggested treatment. The overview of this approach is shown in Fig 4.

Another approaches [5] [6] [7] are introduced to analyze fish trajectories in videos. Trajectories are classified to normal and abnormal behaviors. The study of fish behavior is important to analyze the environmental conditions that may cause diseases in the future. Normal fish trajectories are first identified then abnormal ones are detected by applying filtering mechanisms [5] [7].

An Approach [1] applied histogram equalization followed by edge detection for segmentation. Canny's edge detector achieved the best results, compared to other edge detectors. Features from Accelerated Segment Test (FAST) [8] outperformed other features like Histogram of gradient (HOG) [9] features when been applied on EUS infected images. Principal Component Analysis (PCA) [10], [3] was applied after FAST features to reduce feature vector dimensions. Neural Network [11] achieved better recognition results compared to K-Nearest Neighbor (k-NN) [12] when applied as a classifier.

K-Means clustering [13] was applied for segmenting diseased area in hue-saturation-value (HSV) color space of fish diseased images, based on the hue values. Morphological operations [14] were applied to compute the diseased area, as shown in equation 1.

$$A \bigcirc B = (A \ominus B) \oplus B \tag{1}$$

Where $\ominus$ and $\oplus$ represent erosion and dilation, respectively and B is the structuring element.

Another usage of morphological operations was noise removal and edge detection during preprocessing stage [4]. Morphological erosion and dilation operations were applied to delete noise as shown in equations 2 and 3. Diseased area were detected by discriminating small and large connected components.

$$Erosion : I \otimes S_E = X : S_E + X < I \tag{2}$$

$$Dilation : I \oplus S_D = I^c \ominus (-S_D)^C \tag{3}$$

where I is a source image, S_E and S_D are the structuring elements for erosion and dilation operations,respectively. Two types of features were extracted [4], the first is based on the polar coordinates and the second set is based on the geometrical features as defined in equations 4 and 5, respectively.

$$X = r\cos\theta, Y = r\sin\theta \tag{4}$$

Where $r$is the radial distance from the origin and θ is the counterclockwise angle with the x-xis, In terms of X, Y, r and θ the geometric features were calculated by

$$r = \sqrt{x^2 + y^2}, \theta = \tan^- 1(\frac{y}{x}) \tag{5}$$

Convolutional Neural Networks (CNN) [15], were applied for fish disease classification in another approach [16].Images were enhanced by applying Gaussian blurring [17] and morphological operations. Otsu's thresholding [18] and

Pyramid Mean Shifting (PMS) [19], defined in equation 6, were then applied to enhance classification by CNN.

$$m(x) = \frac{\sum_{x_i \in N_n} K(x_i - x) x_i}{\sum_{x_i \in N_n} K(x_i - x)} \tag{6}$$

Approach [5] proposed a filtering mechanism like a cascade classifier [20] that is based on filtering mechanism. It define rules for normal trajectories. Any trajectories not satisfying the rules are considered abnormal behaviors.

Hierarchical approaches [6] [7] were proposed to extract different types of features, like curvature scale space (CSS) [21], moment descriptors [22], velocity, acceleration, centered Distance Function (CDF) [21], Vicinity Features, Loop Features, Features Based on Normalized Size of Bounding Box. Affinity propagation (AP) [23] is applied for clustering method. AP perform better than K-means, mixture models and mean-shift clustering. Outlier detection [24] method is applied. It is presented in two types of outlier trajectories: those located in small clusters and those that exist in dense clusters.

$$\theta_i = \frac{Y_{i+1} - Yi}{X_{i+1} - X_i} \tag{7}$$

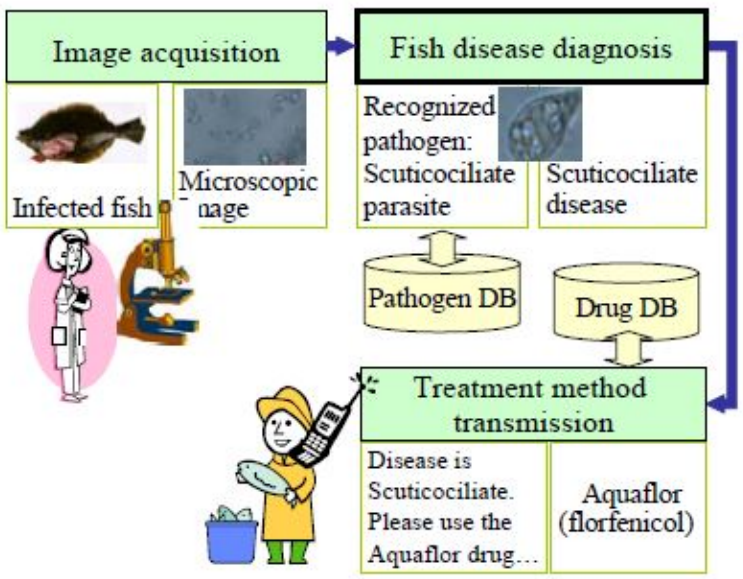

Figure 4: Flow of the developed fish disease diagnosis system based on image processing.

Table 3: Proposed systems comparison

System	Function	Data	Algorithms	Accuracy
[1]	Automatically detects or diagnoses-the EUS diseased fish	Images of the EUS infected fish collected from sources as NGRF, Lucknow and CIFRI	Cannys edge detection algorithm–Fast algorithm–PCA–Neural Net-work	86%
[4]	Extract pathogen area from the microscopic images of infected fish and sending notification about diagnosed disease and treatment to the fish farmers	Microscopic images of diseasedfishes collected from National Bu-reau of Fish Genetic Resources(NBFGR, Lucknow) and ICAR-Central Inland Fisheries ResearchInstitute (CIFRI), Kolkata	3x3 mean filter and edge sharp-ening filter–Morphological erosionand dilation operations–Polar andgeometric feature–PCA 4) PCA	90%
[3]	Detects or diagnoses the EUS diseased fish	Fish effected with (EUS) were collected from the different part of the Barak Valley, Assam	PCA–K-Means Clustering–HSV	90%
[16]	Classification of fish species	Images from fish4knowledge	1) CNN 2) Gaussian Blurring, Morphological Operations, Otsu's Thresholding and Pyramid Mean Shifting	96.29 %
Proposed Approach	Detecting fish diseases	Collecting our own data (extract images from videos)	CNN (Alex-Net with XYZ) CNN (ResNet18 with XYZ) CNN (ResNet50 with XYZ) CNN (ResNet101 with XYZ)	99.0446% 95.8599% 96.4968% 97.4522%

2.3 User Characteristics

There are 2 types of users that interact with the system:

1. Owners of fish farms:

- Must have basic knowledge in using Android mobile devices, how to use the device and apps.

2. Experts of fish domain:

- Must have basic knowledge in using Android mobile devices, how to use the device and apps.

3. Admin:

- Must be able to work with firebase and to manage the firebase through UI.
- Must have knowledge in using Android mobile devices, how to use the device and apps.

2.4 User Problem Statement

Fish disease diagnosis suffers from some limitations that need high level of expertise to be solved. Fish diseases domain is affected by varying expertise of experts. Diagnosis differs based on experts skills. Experts may face some problems due to Fast fish movement, which cause tracking infected fish to be impossible by human vision. Poor quality of unclear water in earthen ponds also cause limitations in diagnosis and tracking. So we proposed a system to detect fish diseases and analyze fish behavior automatically.

2.5 User Objectives

Using image processing and computer vision techniques, vision can be improved and tracking fish becomes easier by slowing down motion in videos. The user will only receive notification in their mobile phones, to know if there is any improper changes in fish farm environment or any detected infections.

2.6 General Constraints

There is no system that has no constrains, our system will have some constrains:

- Mobile application applicable for android mobile devices only.
- Device must be connected to the internet to receive notification.
- The connection under the water that the camera could face.

3 Functional Requirements

3.0.1 Admin/User

FID	FR1
Name	Register
Description	The user registers with his/her information to create an account
Input	Name , Email , Password and Telephone
Output	Confirmation Message and asks user to log in or error message upon validating the fields
Action	Checks validation of all fields and if so the data is entered in a new record in the database accordingly
Pre-condition	None
Post-condition	Database is updated with a new user account
Dependencies	None

FID	FR2
Name	Login
Description	user/Admin can login with his/her username and password into his/her account
Input	Email, Password
Output	The homepage is previewed and login successful message or error message upon validating the fields
Action	Checks validation of all fields and if so compares data entered to that in the database records
Pre-condition	User/Admin is already registered in the database
Post-condition	Redirected to the homepage
Dependencies	FR1

FID	FR3
Name	Sign Out
Description	User/Admin will sign out of his/her account
Input	None
Output	Logged out confirmation
Action	User/Admin will sign out
Pre-condition	Admin/User is signed in to his/her account
Post-condition	Admin/User is signed out
Dependencies	FR2

FID	FR4
Name	Adding user
Description	The admin adds user to the system
Input	Name , Email , Password and Telephone
Output	Confirmation message or error message if something went wrong upon validating the fields
Action	Checks validation of all fields and if so the data is entered in a new record in the database accordingly
Pre-condition	User ID doesn't previously exist
Post-condition	Database is updated with a new user's account
Dependencies	None

FID	FR5
Name	Editing a user's Account
Description	The Admin edits user's information
Input	User ID
Output	Confirmation message or error message if something went wrong upon validating the fields
Action	The information changed is taken and sent to the corresponding attribute in the user's record in the database to be updated
Pre-condition	Desired user is already registered in the database
Post-condition	Desired user's record in the database is updated with the new information in the database
Dependencies	FR4

FID	FR6
Name	Deleting a user's Account
Description	The Admin deletes a user's account from the system
Input	user's ID
Output	Confirmation message or error message if something went wrong upon removing the user from the system
Action	Delete selected user's record from the database
Pre-condition	Desired user is already registered in the database
Post-condition	Desired user's record is removed from the database
Dependencies	FR4

FID	FR7
Name	listing all user's
Description	The Admin lists all the users found in the system
Input	User Type
Output	All users registered in the system and their information are previewed
Action	Retrieves information about the users registered in the system from the database
Pre-condition	At least one user is registered in the database
Post-condition	None
Dependencies	FR4

FID	FR8
Name	Searching for a user
Description	The Admin searches for a desired user
Input	ID
Output	the desired user information are previewed
Action	Retrieves information about the user, whose name has been entered by the admin, from the database
Pre-condition	Desired user is already registered in the database
Post-condition	None
Dependencies	FR4

FID	FR9
Name	View Report
Description	user can view report for fish farm details, including details of sensors readings
Input	day's date
Output	The selected report is displayed
Action	Retrieve the data from the database
Pre-condition	user is logged in to the system
Post-condition	Data is fetched from the database
Dependencies	FR2

FID	FR10
Name	View statistics
Description	user can view report of latest details for fish farm, including details of sensors readings
Input	date range
Output	The selected report is displayed
Action	Retrieve the data from the database
Pre-condition	user is logged in to the system
Post-condition	Data is fetched from the database
Dependencies	FR2

FID	FR11
Name	Show Notification
Description	user can show notification being sent when there is any improper change in fish farm environment
Input	Boolean choice
Output	Show notification
Action	user show notification
Pre-condition	Sensors readings is checked
Post-condition	Notification is received
Dependencies	FR2, FR16, FR17

FID	FR12
Name	Adding fish farm
Description	The admin adds farm to specific user
Input	Farm Name/ID
Output	Confirmation message or error message if something went wrong upon validating the fields
Action	Checks validation of all fields and if so the data is entered in a new record in the database accordingly
Pre-condition	User has an account
Post-condition	Database is updated with a new user's account
Dependencies	FR2,FR4

3.0.2 Hardware

FID	FR13
Name	Take video
Description	This function is used to take video from camera
Input	None
Output	Video
Action	Raspberry pi takes video from camera
Pre-condition	Raspberry pi is connected to camera
Post-condition	video is taken from camera
Dependencies	None

FID	FR14
Name	Get PH sensor reading
Description	Get Reading from PH sensor and pass it in Raspberry pi
Input	Readings from PH sensor
Output	Collection of PH sensor data
Action	sending readings to Raspberry pi
Pre-condition	sensors is connected to raspberry pi
Post-condition	Readings passed to Raspberry pi
Dependencies	None

FID	FR15
Name	Get Temperature sensor reading
Description	Get Reading from Temperature sensor and pass it in Raspberry pi
Input	Readings from Temperature sensor
Output	Collection of Temperature sensor data
Action	sending readings to Raspberry pi
Pre-condition	sensors is connected to raspberry pi
Post-condition	Readings passed to Raspberry pi
Dependencies	None

FID	FR16
Name	Check PH value
Description	This function is for checking PH value is within the normal range for PH or not.
Input	PH reading
Output	Boolean choice
Action	checking PH value
Pre-condition	Readings passed to Raspberry pi
Post-condition	Boolean choice
Dependencies	FR14, FR15

FID	FR17
Name	Check temperature value
Description	This function is for checking temperature value is within the normal range for temperature or not.
Input	temperature reading
Output	Boolean choice
Action	checking temperature value
Pre-condition	Readings passed to Raspberry pi
Post-condition	Boolean choice
Dependencies	FR14, FR15

FID	FR18
Name	Send message from GSM800
Description	Message will be sent from GSM800 to the user mobile to notify him/her that he/she has improper changes in farm environment or detected infections
Input	Boolean choice
Output	Message is sent to user's mobile
Action	Check sensors values and send message to the user accordingly.
Pre-condition	PH and Temperature values is not normal with false choice.
Post-condition	user received the message
Dependencies	FR14, FR15, FR16, FR17

FID	FR19
Name	Send Notification
Description	Notification will be sent to the user through mobile application to notify him/her that he/she has improper changes in farm environment or detected infections
Input	Boolean choice
Output	Notification is sent
Action	Check sensors values and send notification to the user accordingly.
Pre-condition	PH and Temperature values is normal with true choice.
Post-condition	User received notification
Dependencies	FR14, FR15, FR16, FR17

FID	FR20
Name	Upload PH sensor readings to firebase
Description	This function is for collecting PH sensor readings from raspberry pi and uploading it to firebase
Input	Readings of PH
Output	PH sensor data are uploaded to firebase
Action	Sending readings from raspberry pi to firebase
Pre-condition	Sensors reading are available in raspberry pi
Post-condition	Data are uploaded to the firebase
Dependencies	FR14, FR15, FR16, FR17

FID	FR21
Name	Upload temperature sensor to firebase
Description	This function is for collecting temperature sensor readings and uploading it to firebase
Input	Readings of temperature sensors
Output	temperature sensor data are uploaded to firebase
Action	Sending readings from raspberry pi to firebase
Pre-condition	Sensors reading are available in raspberry pi
Post-condition	Data is uploaded to the firebase
Dependencies	FR14, FR15, FR16, FR17

FID	FR22
Name	Listing all sensors readings
Description	This function is for listing all sensors readings found in the system
Input	Boolean choice
Output	All sensors readings registered in the system are previewed
Action	Retrieves sensors readings registered in the system from the database.
Pre-condition	At least one sensor reading is registered in the database
Post-condition	None.
Dependencies	FR20, FR21

FID	FR23
Name	Data augmentation
Description	This function is used to increase the diversity of images that is available in data-set for training models
Input	RGB image
Output	Size of training data-set is expanded
Action	Choose an image to apply data augmentation on it.
Pre-condition	RGB image
Post-condition	Collection of RGB images
Dependencies	None

FID	FR24
Name	Create XML file
Description	This XML file contain data which is extracted from video in the dataset to be compared with frames taken from video.
Input	image
Output	XML file
Action	compare data in XML with given image
Pre-condition	Images from the dataset
Post-condition	XML Created
Dependencies	None

FID	FR25
Name	Draw border
Description	This function is used to add border on detected fish.
Input	image
Output	Detected image by drawing border
Action	Add border when fish is detected.
Pre-condition	snapshots from video
Post-condition	images of detected fish
Dependencies	FR24

FID	FR26
Name	Count Number of detected fish
Description	This function is used to count borders of detected fish.
Input	snapshots from video
Output	Number
Action	count number of detected fish.
Pre-condition	border is added on detected fish
Post-condition	Number of border is added
Dependencies	FR24, FR25

FID	FR27
Name	Video segmentation
Description	This function is used divide video into frames then Convert frames to YCBCR then change values of YCBCR
Input	video
Output	video after applying segmentation
Action	Convert frames to YCBCR, then change values of YCBCR
Pre-condition	video
Post-condition	video after segmentation
Dependencies	FR13, FR31

FID	FR28
Name	Point Tracker
Description	This function is used to track a set of points.
Input	Video frame
Output	Tracked points and reliability of track
Action	This function is used to apply Kanade-Lucas-Tomasi (KLT) feature-tracking algorithm to track a set of points.
Pre-condition	Videos
Post-condition	Set of points
Dependencies	None

FID	FR29
Name	Velocity and acceleration
Description	This function is used to calculate velocity and acceleration
Input	image detect corners of fish
Output	Rate of position and speed
Action	calculate velocity and acceleration
Pre-condition	fish is detected
Post-condition	velocity and acceleration is calculated
Dependencies	FR27, FR28

FID	FR30
Name	Estimate Geometric Transformation
Description	This function is applied to find the transformation matrix
Input	MatchedPoint1 and matchedPoints2
Output	Geometric transformation
Action	This function is applied to find the transformation matrix which maps the greatest number of point pairs between two images.
Pre-condition	points location of the frame
Post-condition	Geometric transformation matrix
Dependencies	FR28

FID	FR31
Name	Detect Minimum Eigen Features
Description	This function detects corners and return cornerPoints. object.
Input	Image
Output	Points
Action	This function detects corners by applying minimum eigenvalue algorithm and return cornerPoints object.
Pre-condition	points location of the frame
Post-condition	CornerPoints
Dependencies	FR28

FID	FR32
Name	Transform Points Forward
Description	This function applies the forward transformation of 2-D geometric transformation
Input	Geometric transformation and x,y,z-coordinates of points to be transformed and Coordinates of points to be transformed
Output	x,y,z-coordinates of points after transformed and Coordinates of points after transformed
Action	It apply the forward transformation of 2-D geometric transformation
Pre-condition	Geometric Transformation Matrix
Post-condition	Reshape of bounding box
Dependencies	FR30

FID	FR33
Name	Histogram Based Tracker
Description	This function is used to identify the tracked object.
Input	Video frame
Output	Bounding box[x y width height] and Orientation angle
Action	It is applied to identify the tracked object.
Pre-condition	Fish is detected
Post-condition	Histogram tracker
Dependencies	FR25

3.0.3 Image Pre-processing

FID	FR34
Name	Convert to YCBCR
Description	Converts RGB image to YCBCR
Input	RGB image
Output	YCBCR image
Action	Check that image is in RGB color space
Pre-condition	Acquired from video frame
Post-condition	Image is converted into YCBCR
Dependencies	FR23

FID	FR35
Name	Convert to XYZ
Description	Converts RGB image to XYZ
Input	RGB image
Output	XYZ image
Action	Check that image is in RGB color space
Pre-condition	Acquired from video frame
Post-condition	Image is converted into XYZ
Dependencies	FR23

FID	FR36
Name	Resize image
Description	Image will be resized to cover the part that will be classified
Input	RGB image
Output	image is resized
Action	Check that image is uploaded
Pre-condition	Acquired from video frame
Post-condition	Image is resized.
Dependencies	FR23

3.0.4 Image Segmentation

FID	FR37
Name	Apply Gaussian distribution of ycbcr
Description	It applies the predefined Gaussian filter on the image
Input	YCBCR image
Output	segmented image
Action	It applies the gaussian filter on the image after applying the low-pass filter
Pre-condition	The image before applying the Gaussian filter
Post-condition	The image after applying the Gaussian filter
Dependencies	FR34

FID	FR38
Name	Calculate Mean of CB/CR
Description	It Calculates the Mean of CB/CR
Input	YCBCR image
Output	Image Mean
Action	Takes the image and calculate the Average of the Pixels.
Pre-condition	Image's mean is not calculated
Post-condition	Image's mean is calculated
Dependencies	FR34

FID	FR39
Name	Calculate Co-variance of ycbcr
Description	It Calculates the co-variance.
Input	YCBCR image
Output	Image with co-variance value
Action	Takes the image and calculate the co-variance
Pre-condition	Image's co-variance is not calculated
Post-condition	Image's co-variance is calculated
Dependencies	FR34

FID	FR40
Name	Calculate Mean of X/Y
Description	It Calculates the Mean of X/Y
Input	XYZ image
Output	Image X/Y Mean
Action	Takes the image and calculate the mean X/Y of the Pixels
Pre-condition	Image's mean is not calculated
Post-condition	Image's mean is calculated
Dependencies	FR35

FID	FR41
Name	Calculate Co-variance of XYZ
Description	It Calculates the co-variance.
Input	XYZ image
Output	Image with co-variance value
Action	Takes the image and calculate the co-variance
Pre-condition	Image's co-variance is not calculated
Post-condition	Image's co-variance is calculated
Dependencies	FR35

FID	FR42
Name	Apply Gaussian distribution of xyz
Description	It applies the predefined Gaussian filter on the image
Input	XYZ image
Output	segmented image
Action	It applies the gaussian filter on the image after applying the low-pass filter
Pre-condition	The image before applying the Gaussian filter
Post-condition	The image after applying the Gaussian filter
Dependencies	FR40,FR41

FID	FR43
Name	Adaptive threshold
Description	It applies the threshold on Gaussian distribution model result
Input	Result from Gaussian distribution
Output	Binary image
Action	It applies adaptive threshold on Gaussian distribution model result
Pre-condition	Gaussian distribution is applied
Post-condition	The image after adaptive threshold
Dependencies	FR42

FID	FR44
Name	Crop
Description	It crops diseased area
Input	Result from adaptive threshold and test image
Output	Crops
Action	It crops diseased pixels
Pre-condition	Adaptive threshold is applied
Post-condition	Image is cropped
Dependencies	FR43,FR43

FID	FR45
Name	Convert to gray scale
Description	Converts RGB image to gray scale
Input	RGB image
Output	Gray scale image
Action	Check that image is in RGB color space
Pre-condition	Acquired from video frame
Post-condition	Image is converted into gray scale
Dependencies	FR23

FID	FR46
Name	GLDM
Description	It gets the probability density function
Input	Gray scale image
Output	Probability density values
Action	It gets the probability density
Pre-condition	Grey scale image
Post-condition	Probability density values
Dependencies	FR45

3.0.5 Classification

FID	FR47
Name	CNN Classifier
Description	this function is used to train data and integrate with it with features to classify new inputs of images
Input	training features
Output	Accuracy results
Action	Training features are mentioned including functions for pre-process of images
Pre-condition	Testing and training available but not calculated with each other
Post-condition	Training and testing compared with each other then the disease is classified
Dependencies	FR44

4 Interface Requirements

4.1 User Interfaces

The system user interface is designed to be simple enough and allow minimal interaction.

4.1.1 GUI

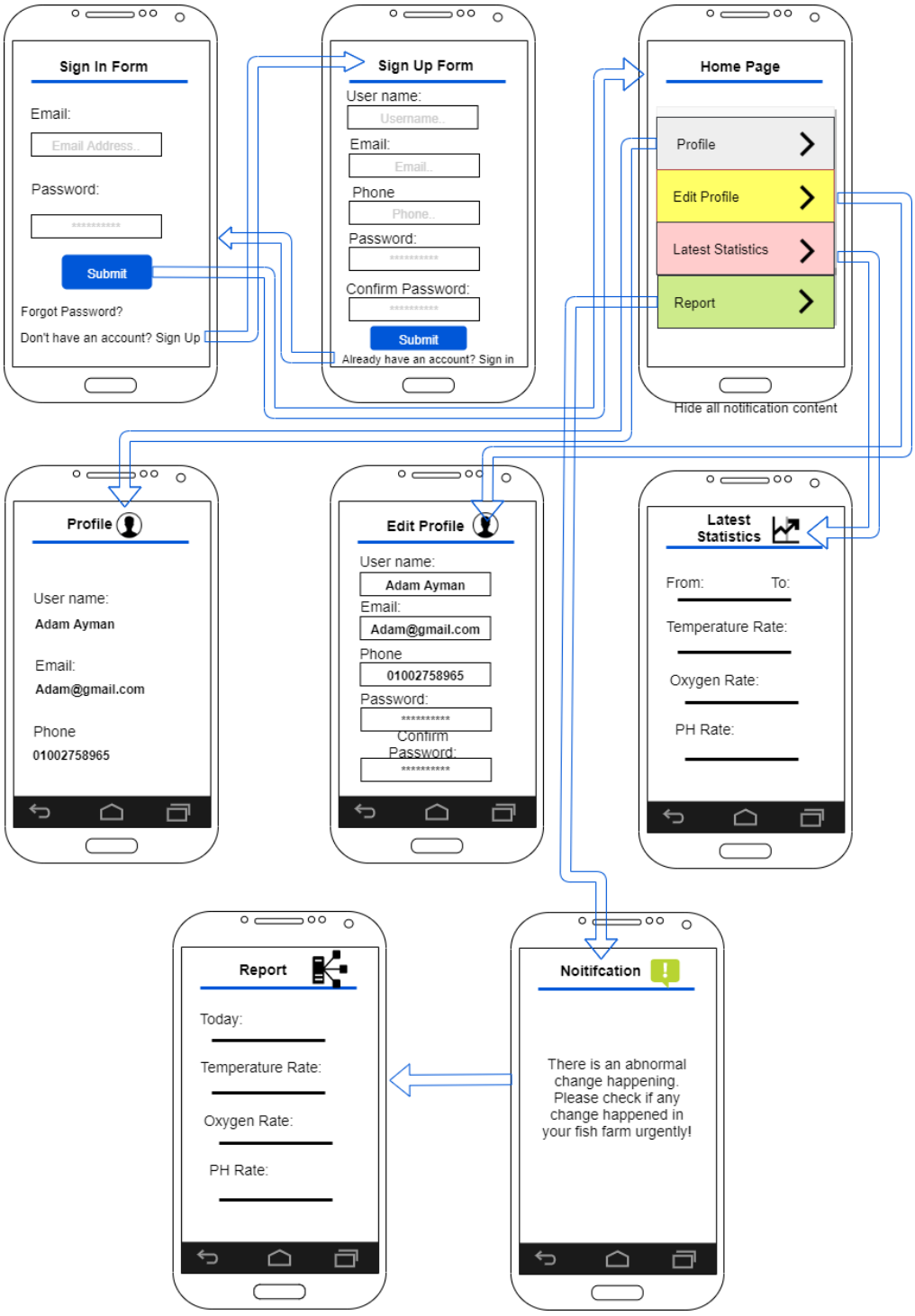

Figure 5: user's Mobile Application Wireframe

4.1.2 CLI

N/A

4.1.3 API

- Image Label
- Train Cascade object detector
- Vision cascade object detector.
- Vision deployable video player.
- Threshold
- Mask
- Classify

4.1.4 Diagnostics or ROM

N/A

4.2 Hardware Interfaces

N/A

4.3 Communications Interfaces

The system only needs internet connection.

5 Performance Requirements

- The system must be able to handle large training datasets to ensure model accuracy.
- The time for sending notification after detecting any abnormal behavior must be short.
- No performance needed in the mobile, the mobile will only receive notification to notify if there is any improper change in fish farm environment.

6 Design Constraints

- This system needs to be user friendly to ease the process if the user lack of professional computer skills.
- Any smart mobile device that include the android operating system and must have the connection with the internet to deal with the real-time data transfer.
- The camera resolution should not be less than HD 1080.

6.1 Hardware Limitations

- This system is in need of powerful hardware to be able to deal with the huge datasets proposed in this system.

7 Other non-functional attributes

7.1 Security

Users passwords must be hashed in the database. Users of our system shall authenticate themselves using their username and password. Also personal information about the users such as mobile numbers and passwords for instance must be protected.

7.2 Reliability

The system being developed has to be reliable in its operation. If the internet is disconnected, it saves the readings data to the database to prevent any losing of data. The user should be able to trust that the system should be reliable enough which does not cause failure or crash.

7.3 Maintainability

The system could be improved by different developers so ease of system maintainability is important, it should be easy to extend thought the implementation of MVC design pattern and using naming convention which ease the use of functions and understanding their purpose. MVC design pattern divides the system into three modules which are Model, View and controller, it simply separates handling of the data from the how the interface appears to the user and the intermediate communicator between both of them.

7.4 Performance and speed

This system will do all the processing part on the machine so no performance needed in the mobile. Also the system is automatically clearing all the readings each 3 months to to free up storage which might have an impact on the mobile

performance. The system must be interactive and the delays involved must be reduced. Detection and classification must have no delays.

8 Preliminary Object-Oriented Domain Analysis

8.1 Inheritance Relationships

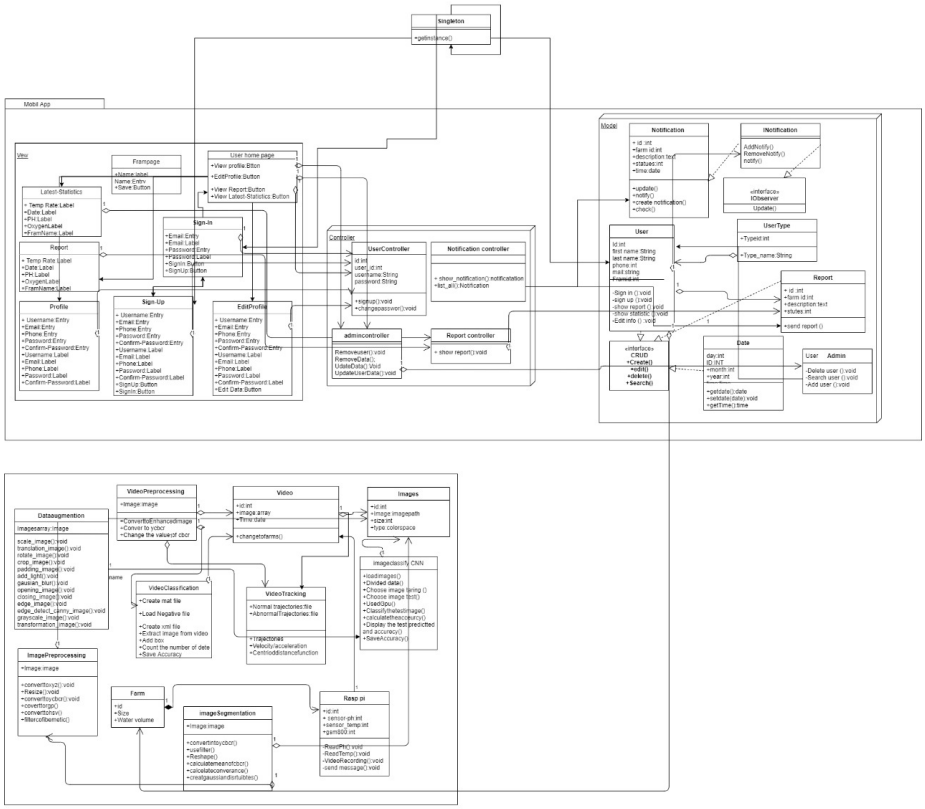

Figure 6: System ClassDigram

9 Operational Scenarios

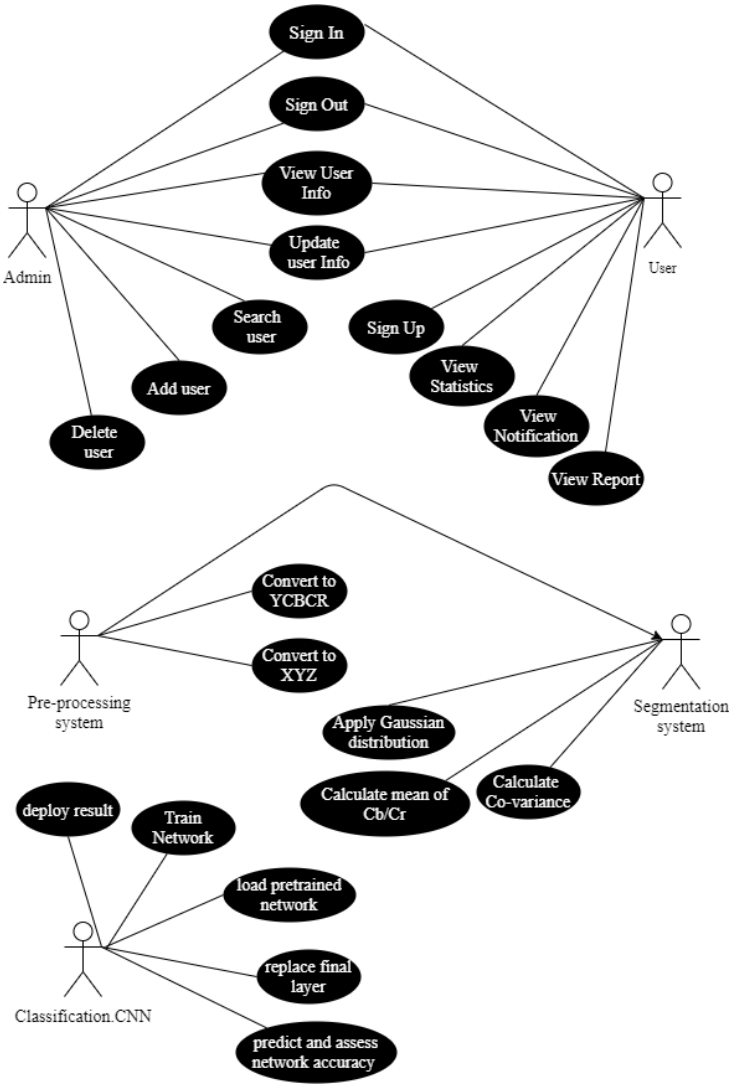

Figure 7: System UseCase

Tabular description of the Search for user use case
Actors: Admin
Description: Admin can search for users that are saved on the system.
Data: User id.
Response: All user's are displayed.
Comments: Admin must be logged in.

Tabular description of the Create user account use case
Actors: Admin.
Description: Admin will be able to create accounts for new user.
Data: user info (Name, telephone , password).
Response: Confirmation that account has been created.
Comments: Admin must be signed in.

Tabular description of the Delete user account use case
Actors: Admin.
Description: Admin will be able to delete user accounts.
Data: user id.
Response: Confirmation that account has been deleted.
Comments: Admin must be signed in.

Tabular description of the Update user info use case
Actors: Admin.
Description: Admin will be able to update user's data.
Data: User ID.
Response: User Profile displayed for editing.
Comments: Admin must be signed in.

Tabular description of the Convert image to YCBCR use case
Actors: Pre-processing System.
Description: Test image is converted from RGB to YCBCR.
Data: RGB Test Image.
Response: Image is converted.
Comments: None.

Tabular description of the Convert image to XYZ use case
Actors: Pre-processing System.
Description: Test image is converted from RGB to XYZ.
Data: XYZ Test Image.

Response: Image is converted.
Comments: None.

Tabular description of the Perform Gaussian Distribution use case
Actors: Segmentation System.
Description: Perform Gaussian Distribution to image.
Data: YCBCR image to segment.
Response: segmented image.
Comments None.

Tabular description of calculating mean of CB/CR use case
Actors: Segmentation System.
Description: calculate the Average of the Pixels.
Data: YCBCR image to segment.
Response: Mean is calculated.
Comments None.

Tabular description of the View Report use case
Actors: User.
Description: User can view report.
Data: None.
Response: Report data are displayed.
Comments: user must be logged in.

10 Preliminary Schedule Adjusted

Task	Start Date	End Date
Proposal evaluation	12/9/2019	26/9/2019
Writing SRS document	30/10/2019	28/11/2019
SRS evaluation	28/11/2019	28/11/2019
Writing SDD document	1/1/2020	12/2/2020
SDD evaluation	12/2/2020	15/2/2020
System implementation	19/2/2020	30/2/2020
Implementation evaluation	1/3/2020	5/3/2020
Validation and testing	10/3/2020	30/3/2020
Final presentation	5/5/2019	5/5/2019

11 Preliminary Budget Adjusted

Item	Quantity	Cost
PH sensor	1	660.00 LE
Raspberry Pi 3	1	1,900.00 LE
Waterproof Temperature Sensor	1	50.00 LE
Raspberry Pi Professional Infrared Camera	1	560.00 LE

12 Appendices

12.1 Definitions, Acronyms, Abbreviations

- UI: User interface is the space where interactions between humans and machines occur.
- YCBCR: is a family of color spaces used as a part of the color image in video. Y is the luma component and CB and CR are the blue-difference and red-difference chroma components.
- GUI:Graphical user interface.
- API:An application programming interface (API) is a set of routines, protocols, and tools for building software applications.
- FR: Functional Requirement.
- Firebase: A mobile and web application platform.
- GSM: Global System for Mobile.

13 Reference

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