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Images in Logical-and-Linguistic Artificial Intelligence Systems

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ABSTRACT

Visual images are holistic, and when verbalized there is a partial loss of semantic content. However, it should be noted the lack of effectiveness of decision support systems only when using images without an effective context, and systems that do not include holistic images. Inclusion of images in the knowledge base of intelligent systems can significantly improve their effectiveness. At the stage of formation of intermediate diagnostic hypotheses, the system will present to the user (physician) a hypothesis specific to the verbal and visual characteristics. At the same time, it is necessary to take into account the need to use fuzzy logic at the stages of the derivation of solutions. The subsequent process will depend on the physician's confidence in the coincidence of the image of the diagnosed patient with the image(s) in the knowledge base of the intellectual system.

Keywords: logic-and-linguistic-and-image system, holistic images, confidence factors, visual image number, fuzzy logic, orphan hereditary diseases.

1 Introduction

An image is a necessary fragment of the whole picture of the world. We can see this in many of the humanities – in archeology, history and art, for example. In medicine, images occupy a special place in the diagnosis of a number of diseases. The value of holistic images is determined by the fact that the verbal equivalent may be too complex or erroneous. This can be explained by the theory of the specialization of the "image" brain system in parallel or simultaneous image processing [1]. I don't understand why this different font thinks it is Times New Roman. I can't change it on my PC.

For example, it is extremely difficult to convey such visual images as "a skull in the form of a shamrock", "rough or 'gargoloid' facial features", or "beaky nose" in a verbal form that is understandable and can be perceived unambiguously. Metaphorical terms can be perceived differently by physicians who have never seen such images, or only in the literature, but otherwise have met them only in a linguistic form describing the appearance of these patients. In every case, there is at least a partial loss of information. This is due to the fact that it is impossible to fully reflect one-to-many relationships in metaphorical representations that contain latent polysemy (for example, 'poultry head' includes features of the shape of the skull, nose, etc.).

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The defragmentation of the image with subsequent reintegration is also unacceptable, since individual features (for example, the shape of the forehead, ears, etc.) do not create an integral picture of the individual's face [2]. The verbalized image can be generally difficult or incorrectly perceived without context (for example, a rash on the skin without describing its shape, colour, size or other characteristics). At the same time, visual images help to distinguish diseases similar in their manifestations. As modifiers for the perception of images, certainty (probability) may also appear. Naturally, the full picture of the disease develops in the context of linguistic and image characteristics. Context can contain both specific ethnic features of appearance (eye section, lip thickness, etc.), and pathological manifestations on the part of various systems of the human body (colour and thickness of the skin, the nature of breathing, etc.).

Until now, in medical diagnostic systems using computational methods or approaches based on artificial intelligence, images of patients have not been used or demonstrated after making a diagnostic decision based on the analysis of the linguistic signs. Recently, various systems have been implemented in which only images are offered. However, based on our own experience, analysis of the literature and discussions with medical experts, it seems more promising to build logical-lingual-image diagnostic systems.

2 Visual images and their meaning

Consider an entity or concept as a collection of properties of a visual image. We will compare the image of the entity (for example, a beastlike face), whose properties will be called the eyes, lips, teeth, hair, etc. That is, hypertrophied facial features can in general represent the essence of the phenomenon. Analogy can serve as a mask (anger, despair, etc.; for example, threat by the Medusa jellyfish, or anger by Stromboli in a Pinocchio cartoon). Graphics can serve as a way to highlight the main message in the image, giving the "convexity" characteristic features.

At the same time, the "floating" image in memory is associated with the subject's thinking and this contributes to the physician's doubt. This is despite the fact that the image in the system of mental reasoning has the function of an intuitive representation.

Numerous variations of the representation characterize the intermediate states of the image, which can be complete or represented by separate relevant fragments, as a contour representation. It is possible to compare the individual segments (for example, the shape of the forehead, chin, ears, etc.).

From the point of view of logic, an image or object characterized by a certain content is a symbol or token. For example, an image may be a symbol from ancient times, such as a petroglyph. Nevertheless a symbol is not always an image; for example, Japanese characters are images, but Greek, Latin and Cyrillic are not. Petroglyphs can be considered as an intermediate variant of image-symbolic representations, which in the knowledge base of the intellectual system will correspond to linguistic and image symbols.

3 Image series

Images can be static or dynamic. The dynamics of the image can be associated with the different perceptions of people in different epochs and in different countries (for example, the image of a sphinx), or with changes in a human face over a lifetime or during severe illness. These dynamics can be considered as an image series [3]. By analogy with the topology of the possible [4], the genotype in hereditary diseases can be compared with the image-archetype and a series of phenotypic images. This situation, “genotype-phenotypes”, corresponds to the “one-to-many” relationship.

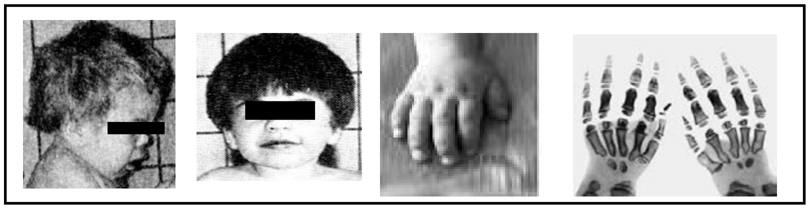
In the medical domain, this is particularly evident in orphaned hereditary metabolic storage diseases. Such visual phenotypic characteristics of pathological signs form in the physician’s mind on the basis of observed real objects, mental images stored in their memory, although in time they can be deformed. This corresponds to the opinion of J.T.E. Richardson [5] that structures located in the occipital part of the left hemisphere of the brain play an important role in the formation of images, and the structures of the right hemisphere are associated with the processes of image transformation.

Identification of images by a person occurs by comparison with a prototype in long-term memory. The theory of sensor prototypes [6] assumes a complete correspondence between the object and its internal representation (benchmark). This identification of persons occurs even after a long period of interruption, although during this period there are often significant changes. Therefore, the dynamic image series proposed for viewing can be extremely useful in the process of forming diagnostic hypotheses.

The images in one visual series, although different from each other, are characterized by a commonness with a typical representative, a kind of figurative archetype. The image series considered as a quasi-continuum that is characterized by fuzzy transitions between similar images related to the same disease can also be characterized as a set, and individual age groups can be considered as subsets. A rough set can also be associated with the image series [7, 8]. In this case, two boundary lines are established to describe inaccurate concepts that can allow us to determine the conditional “distance” between the proximity of the new image and one of the image series. Rough sets are a mathematical tool for solving uncertain tasks, which in principle can be applied to the analysis of elements in the image series. In addition, each image can be accompanied by the confidence factors of experts. Respectively, image series of phenotypic (external) manifestations of a disease, representing a wide class of similar but different individual images for different diseases, can serve as a basis for visual diagnostics (prediagnosis).

Inclusion in an image series can also be carried out on the basis of association. Let us consider this with examples from medicine:

- association by similarity – close persons, objects, situations, including separate fragments;
- association on metaphorical reflection, for example, gargoyle-like facial features in mucopolysaccharidosis;
- memory associations (by mental connections) between images or between images and verbal signs (for example, at a certain age, gross facial features and “clawed hands”, rough facial features and corneal opacity when suspected of the Hurler or Hunter syndrome, the possibility of combining macrocephaly and external hydrocephalus). In this case, associative signs can be presented in the image series (Figure 1).



a b c d

Figure 1. Associated series of images of the Hurler and Hunter syndromes: coarse facial features (a, b), (c), radiographic clawed foot (d)

Elements of an image series should be arranged in a certain order. First, the most typical representative of the series (archetype) should be located, and then, in descending order of similarity, the remaining images, ending with the least characteristic for the given image series (in medicine atypical manifestations of the appearance of a specific disease). The arrangement of images in the composition of the series can be carried out in accordance with expert estimates of the similarity of certain attributes. Confidence-building measures are similar to the scale of confidence factors [0,1].

4 Logic-and-linguistic-and-image models

Decision making using images in medicine is determined by the intuitive-image nature of thinking. This is important to bear in mind, since the analysis of a holistic image (for example, rough facial features) is more informative than the examination and mental unification of its fragments. However, combining verbalized signs in intellectual systems of knowledge with imaginative visual series of clinical manifestations that allow an experienced physician to form a primary diagnostic hypothesis for a number of diseases, especially of a hereditary nature, remains unrealized for the time being. Nor does the use of only a holistic image, without appropriate linguistic content, allow us to make the final diagnostic decision.

Logic-argumentative mental processes include signs and images, which indicates the expediency of constructing context-dependent logic-and-image models. It should be borne in mind that the image-argumentation models should assume an alternating order of inclusion of linguistic concepts and visual representations (images).

Verbalized qualitative and visual image knowledge can be represented in the form of frame or ontological models [2]. Visual imagery series included in the frame or ontological model of knowledge representation can be used at the stages of formation and confirmation of hypotheses by their sequential presentation to identify the expert system to the user. This will make it possible to include in the knowledge base poorly verbalized or non-verbalized concepts that correspond to holistic images. Along with medicine, where there are characteristic phenotypic manifestations in certain diseases, this approach can find application in ethnography, archaeology, sculpture, painting and other subject areas in which images are of fundamental importance.

5 Principles of constructing logic-and-linguistic-and-image systems

The architecture of the hybrid linguistic-and-image intellectual system is similar to the traditional one. At the same time, the consequence of the appearance of an image component will be the presence in the knowledge base of a block of images rigidly connected with a block of verbal knowledge [2].

A specific frame will represent a certain image (archetype, parent frame or a typical representative of an image series), and slots will be represented by separate images (elements of an image series). In this range, holistic and fragmentary images which are specific characteristics (markers) of a specific disease can be included. Context in frames can explain (accompany) visual images, but images in a series can be the context in relation to linguistic arguments as logic premises.

When the user enters a sign, the “daemon” in the frame system will activate the “linguistic” frame and the associated frame with images. At this stage, in accordance with the preliminary hypothesis, the corresponding image series will be displayed to the user of the intellectual system to visually identify any similarity with the diagnosed patient. This will speed up the diagnostic process, since erroneous system decisions will be rejected immediately if the images do not match.

As an example, consider the diagnostic fragment for Hunter syndrome, whose knowledge base project includes linguistic and image frames. In the linguistic slot are two signs (thickened skin, noisy breathing) as conditions for the hypothesis. They represent a context and are accompanied by an image series represented by three photos of the heads of patients (Figure 2). Visual images presented to users will be judged by the external similarity with the appearance of the new patient. It is possible to focus on the essential features of the visual image, its fragments. The scale of visual images for assessment at the stages of diagnostic hypotheses promotion ranges from “it seems unlikely”, through “it is possible” to “one can not exclude the similarity”. When the similarity of the diagnosed patient to one of the members of the imaginary range is revealed, the diagnostic hypothesis will be practically confirmed. In case of doubt, the physician will be able to enter information about other symptoms. If the appearance does not coincide, the search will continue through connection to other image series.

And {thickened skin expressed}

And {noisy breathing expressed}

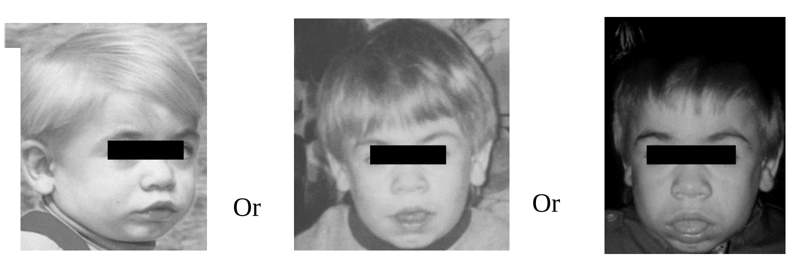


Figure 2. Fragment of linguistic and image frames for Hunter syndrome (3 fotos)

To compare the new object with the elements of the image series, the method of subjective scaling in the quantized-continuous form can be used, with an estimate of the degree of similarity of visual images on a categorical scale. Objective knowledge in the form of pairwise proximity measures between objects of the image series is a “semantic space” of the subject domain [9]. Alternative approaches to logical inference based on similarity relationships can be based either on a strictly probabilistic approach [10], or on the apparatus of fuzzy logic and theory of possibilities [11]. In case-based reasoning systems, use-case libraries can also include visual images or image series, including those reflecting the dynamics of temporal changes.

Yang et al. [12] showed that similar images from the inquiry library can provide a deeper interpretation of the newly observed radiological image in mammography. For this, the choice of a metric that preserves both visual and semantic similarity is important. The authors evaluated the algorithm using interactive search-assisted decision support and medical images obtained with ImageCLEF.

6 Intellectual analysis in the classification of images

The use of image series can allow us to set and solve the problems of searching for characteristic unifying features among images of one type (for example, faces of patients with the identical disease or belonging to one group of diseases) or a person's face in the course of development of the disease, i.e. time-series or sequencing of images that change over time. In principle, it is possible to analyze images using previously obtained expert estimates of each individual image.

Accordingly, denotative spaces of image series can be formed on the basis of similarity of certain characteristics into classes called metadenotates (for example, according to the principle of forming subclasses and classes of diseases). In some cases, metadenotates can pool groups of closely related diseases with similar or "masked" images (for example, the Hurler syndrome and pseudo-Hurler polydystrophy or, in modern classification, mucolipidosis II).

7 Discussion

The mental image represents an amalgam of known facts with knowledge in the given area. It is possible to speak about associative-rational activity on the basis of memories of similar situations. In this respect, image representations can be of great importance.

In the earlier systems for the diagnosis of hereditary diseases, including intellectual systems [13, 14, et al.], the verbalization of images led to a partial loss of information or even to misinterpretation. Displaying the photos on-screen after the formation of the diagnostic hypothesis did not allow for correction of earlier mistaken decisions. Nor does the transition to systems that support only image representations without the necessary context [15, 16, 17, et al.] solve the problem. Accordingly, the paradigm of the image-contextual knowledge base was formed, as presented above.

The complex of programs which allows the presentation of visual images to the user-physician at the stage of hypothesis promotion can be regarded as an expert partner in a human-machine system.

8 Conclusion

Traditional expert-type intellectual systems are focused on extracting and processing verbalized knowledge. Clinical decision support systems can be physician assistants in the diagnostic process, including the Fuzzy Arden syntax [18]. However, individual concepts need to be included in the whole, since even their defragmentation results in the loss of information. The inclusion of formal specifications in the form of visual images of the corresponding subject area into classical logical-and-linguistic models can fundamentally solve the problem of improving the efficiency of diagnostic solutions. However, the creation of diagnostic systems for subject areas in which visual images, especially holistic ones, play a major role, should change the approach to constructing models. The knowledge base should integrate both linguistic and image components. On the basis of intermediate conclusions presented to users and necessarily including images, a decision will be made regarding the further search and formation of the final hypothesis.

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Improving the Quality of Electronic Cleansing of Colorectal CT Images Using a Hybrid Method

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ABSTRACT

Introduction: Colorectal cancer, as one of the most important fatal cancers, is caused by the lack of timely diagnosis of colorectal polyps. Presently, because of the advancements in CT imaging of the colorectal device, the CTC-CAD is a promising method for the duly diagnosis of these appendages. In this regard, Electronic Colon Cleansing (ECC) is one of the effective factors that enhance diagnostic accuracy in the methods used in CTC-CAD. To date, various methods have been utilized for ECC (e.g., the mosaic decomposition (MD) method) that each has advantages and limitations. Therefore, the aim of this study is to combine the methods of linear computing of previous studies and also some image processing methods to improve the quality of electronic cleansing of data on residual materials existed in CT colorectal images. This proposed method is called LM_ECC.

Method: In this study, to implement ECC, the thresholding method, statistical functions, and image processing methods were combined. Then, to evaluate the proposed method, 22 images were randomly selected and ranked by seven radiologists. Regarding the extent of the interpretable, the images taken before and after ECC were collected using MD and LM_ECC methods. The concordance of concordance of all three categories of opinions was calculated based on Kendall's tau-b correlation coefficient test. Next, the average of the ranked opinions obtained for the main images and the results of the LM_ECC method, as well as for the MD and the LM_ECC method, were included in two T-tests.

Findings: The value of t-test between the mean score of radiologists' opinions for the main images and the results of the LM_ECC method ($p < 0.001$) is -9.355, while it is -5.414 between the mean score of radiologists for the MD results and the results obtained from the LM_ECC method ($p < 0.001$).

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Conclusion: Based on the coefficient of concordance, it is found that there is a high agreement between the ranked opinions of the radiologists, based on which the results of the T-tests show the significant effect of the LM_ECC method on electronic cleansing compared to the main images and the results of MD method. Therefore, it can be concluded that the LM_ECC method is able to improve the quality of electronic cleansing of colorectal CT images.

Keywords: Electronic Colon Cleansing, CAD, Polypeptide diagnosis, CT Colonography

1 Introduction

Given the death rate of 57,000 per year due to colon cancer in the United States and recent advances in colorectal imaging by Computerized Tomography (CT) technology, the CT Colonography (CTC) is known a tool for detecting intestinal cancer [1-6]. CTC is a CT imaging from the abdominal cavity, which is done to detect the colorectal polyps [4,6]. CTC images are utilized in computer-aided diagnostic systems. CTC-CADs consist of three main parts: patient preparation before imaging, standard imaging, and soft computing on images for diagnosis [7-9]. All diagnostic techniques of CTC-CADs require those images that do not have confusing data [4,10,11] because the remainder of the residual materials from colon can be misinterpreted as a part of the colon. Therefore, it would result in increasing the false positives and subsequently reducing accuracy. Today, the electronic cleansing of colorectal CT images is considered a promising technique to remove the residual material in CTC images for the purification of the virtual cleansing after imaging [4,10].

The first and most basic solution proposed for identifying the confounding data is the thresholding method. The methods in this regard were introduced based on the use of statistical image features, vector quantization (in order to dimension reduction), image gradient information, and the classification of the Markov random field [12-17]. Further methods have focused on using the edge modeling during image categorization to effectively describe the labeled areas. Afterward, the image gradient was used in the later methods using a Sobel mask filtering [18-21]. Then, more complex and effective algorithms with several carefully designed steps were proposed. These efficient methods utilize the effective features of the images and the combination of several highly accurate categorization methods. For this purpose, Cai et al. (2011) presented the mosaic decomposition (MD) method. According to the report, the sensitivity of 97.1%, the specificity of 85.3%, the accuracy of 94.7%, and AUC = 0.96 can be obtained in the classification of areas containing residual material [10], which are approximately good results for ECC [4].

Many of the methods proposed for ECC employ the nonlinear computing. Using this computation method may lead to heavy processing and subsequently increasing the run time. Unlike these methods, thresholding is a very simple method with linear computing; however, it contains many challenges. Firstly, thresholding does not eliminate the Partial Volume Effect (PVE), because the voxels of air and residual material are categorized incorrectly when using this method. Therefore, it has an inconsistent effect on segmentation. Secondly, as the thresholding method is sensitive to any range of intensities, a slight change in the threshold value results in a change in the segmentation result, especially the shape of the intestinal surface. Thirdly, thresholding increases the rippling effects of the intestinal tract. Thus, a sharp boundary between the colon and the internal colon space is created, which means the removal of the mucous membrane and the mucous membrane is the key to the discovery of the polyps, and its removal is very unsatisfactory [4].

The mentioned methods that utilized the nonlinear computing such as the MD method have obtained relatively good results, but other methods can also be presented to improve the quality of electronic cleansing image using linear computing methods such as thresholding and solving its challenges. The aim of this study is to provide a combination of linear methods and some image processing methods in order to improve the quality of electronic cleansing of CTC images.

2 Method

2.1 Procedure

The electronic cleansing method of proposed CTC images, called the linear method (LM)_ECC, can be divided into two main groups of labeling and cleansing (Fig. 1).

LM-ECC			
step	**Method used**	**purpose**	**Grouping**
1	Thresholding on the whole image	Determining the initial ROIs	**labeling**
2	Four-neighbor method	Removing bony ROIs	
3	Thresholding on the selected ROIs	Removing non-frontier residual material and identifying the margins of areas containing residual material	**Cleansing**
4	Eight-neighbor method	classifying the margins and removing the residual material	
5	Gaussian filter	smoothing the sharp edges of the mucus	

Fig. 1. Procedures for implementation and their purposes

Step 1 (thresholding on the whole image)

For the first part of the labeling, the thresholding method is used based on relation (1).

$$T(x.y) = \begin{cases} 1. & I(x.y) > 1500 \\ 0. & I(x.y) \le 1500 \end{cases} \quad \text{(relation 1)}$$

Step 2 (The four-neighbor method)

First, the thresholding method was implemented and then the selected neighboring sites were investigated for differentiation of the residual material from the bones having the same HU values. To show the differentiation of the contrast or residual material from the rectangular bone, for each continuous region, the values in T (x, y) are plotted on I (x, y), where each of them is a region of interest (ROI). After obtaining all ROIs for each of them, they all are investigated such that if one of the four ROIs illustrated in Fig. 2 shows the air data, it means that the ROI is related to the residual material; otherwise, it is the bone and therefore should be removed from the selected ROIs.

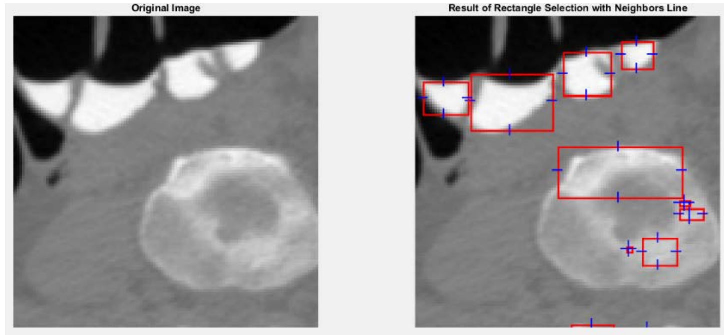

Fig. 2: ROIs and Neighborhood Indicators

In order to reduce the effect of boundary values in exploring the quadratic neighborhood, first, the outlier data (Fig. 3) are eliminated. Then, the average of other ROI values is calculated. Eventually, the average of the values inside the area of interest, after removing the outliers, was considered as the internal criterion while a value with a suitable distance for the external data was considered as the external criterion.

$$\mu = \sum_x \sum_y I(x.y) * (T(x.y) > 500) \Big/ \sum_x \sum_y (I(x.y) = 1) \qquad \text{(relation 2)}$$

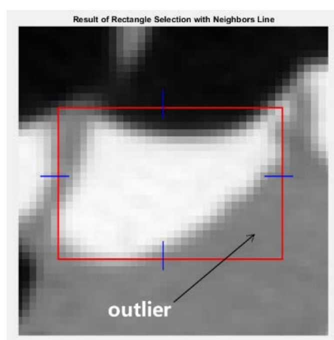

Figure 3: The outlier data in the area of interest

Step 3 (Thresholding on the selected ROIs)

After the labeling step, the values for residual materials in these areas should be properly converted to the values of the air data. To perform this correctly, the ROIs first look at the cubicles to cover the residual materials data that may not have been placed in the ROI. Next, they multiply these cubicles by a few pixels and then the data for each ROI are classified by applying thresholds based on the relation (3). Afterward, the matrix I is updated. All pixels within the ROI are investigated; a value less than 1400 is related to either air or soft tissue and thus does not require any adjustment. But, if the value is greater than 1500, the data is related to residual material, which should be converted to an air value that is close to zero. Other values between 1,400 and 1,500 represent the margins between the residual material and air, or extra material and soft tissue, which should be carefully sorted and categorized. For this reason, the matrix E is defined to hold these sides. This matrix, which has the same size as the matrix I, is initialized with a zero number and takes a value of 1 for the values from 1400 to 1500 per ROI.

$$I(x.y) = \begin{cases} I(x.y) & I(x.y) < 1400 \\ 0 & I(x.y) > 1500 \\ I(x.y) & I(x.y) \geq 1400 \text{ and } I(x.y) \leq 1500 \end{cases} \quad \text{(relation 3)}$$

Step 4 (The eight-neighbor method)

After calculating relation 3, the matrix E contains the boundaries of residual material with soft tissue or air, which should be carefully classified. To do so, the eight-neighbor method is utilized. For all values of one in the matrix E, the neighbors are examined in eight directions. If air data is encountered in the opposite directions, all data between them are converted into air, which results in eliminating the margins between air and residual material with high precision.

Step 5 (Gaussian filter)

In reviewing the eight neighborhoods, if the values in the opposite directions were not related to the air data, it means that the adjacent edge is between the residual material and the soft tissue, which is smoothened by applying the gossip filter to the sharp edges of the mucus. The results can be seen in Fig. 4.

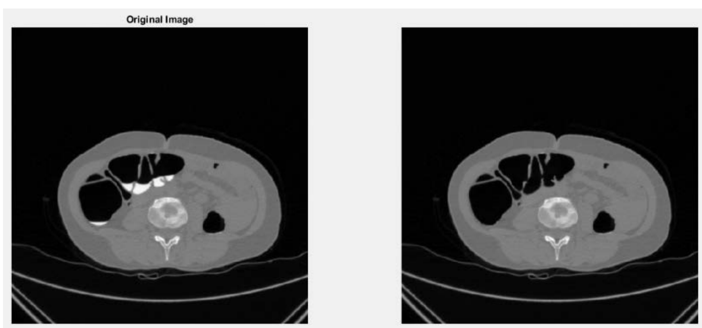

Fig. 4: Initial CTC image and the same image after doing the LM_ECC electronic cleansing method

2.2 The evaluation method

First, based on relation (4) with P-value = 0.05, 22 images were selected randomly among the 35 sets of CTC images (average annual performance) of patients who referred to an educational/therapeutic center and performed the CTC [22].

$$n = \frac{z^2_{(1-\frac{\alpha}{2})} P(1-P)}{d^2} \quad \text{(relation 4)}$$

These images were taken separately by seven radiologists and then they were asked to rate the quality of these obtained images based on the following values.

1. Cannot be interpreted, due to the presence of residual material
2. Can be interpreted, but heavily influenced by residual material
3. Can be interpreted, on average influenced by residual material
4. Can be interpreted, very little under the influence of residual material
5. Can be interpreted, unaffected by residual material

Then, both LM_ECC and MD methods were implemented in MATLAB R2017a and executed on the same images, the images from these two methods, along with the main images. By keeping the name of the applied method secret, they were provided separately to seven radiologists and then they were asked to re-rank the cleansed images according to previous criteria. The results of the image ranking before and after cleansing performed by MD and LM_ECC method were imported in the SPSS software version 23. Afterward, Kendall's tau-b test was utilized to measure the agreement of radiologists.

The T-test was done to compare the effect of the LM_ECC method on the quality of the main images cleansed compared to the quality of the main images. The pre-test was done before the cleansing and post-test were done after cleansing. The dependent variable is defined as the mean of the opinions of the radiologists. The variable values were 1 to 5, with a larger number representing the higher quality of the images. The null hypothesis means that there is no significant difference between the mean of the scores obtained from the opinions of radiologists in the pre-test and post-test. In contrast, the alternative hypothesis means that there is a significant difference between the tests.

3 Results

Usually, CTC images contain data from residual materials that have been in the patient's colon during the imaging. To perform the electronic cleansing of CTC images, the proposed method first should be able to label those places where the residual materials are accumulated. Then, it should remove these sites so that the data related to the residual material are completely removed. Second, the data on the edges of the colorectal mucosa adjacent to these materials will not be affected by the changes because the correct values of these data are very effective in raising the accuracy of the diagnosis of colorectal challenges. As shown in Fig. 5, HU values in the CTC start at zero for air and will end with a value of about 2000 for fluid and bone.

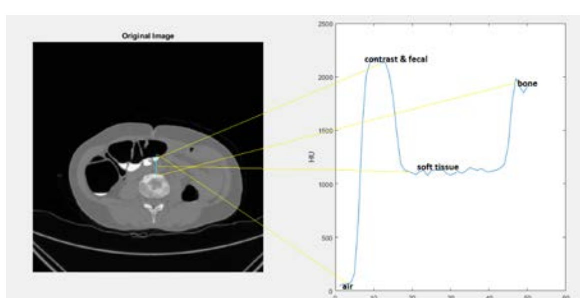

Fig. 5. HU range for air, residual material, soft tissue and bone

As shown in Fig. 5, in the use of the LM_ECC method for labeling the residual materials, the same HU values for the residual materials and bone is the biggest difficulty in separating these two types of data and applying the thresholding. Ignoring this point in the next CTC-CAD systems including the segmentation and diagnosis of polyps is the source of many errors. Thus, handling this challenge has a critical effect on the accuracy of subsequent operations. The distinction between bones and the residual materials is the non-adjacent or adjacent to air. It has to be noted that the residual materials are always in the adjacent of the air data.

In reviewing this neighborhood, there is also another problem in which the regions in the discussion do not have a completely clear boundary. Therefore, one should be considered as a value within the ROI range and then should be compared with a certain amount at the depth of the proximity, based on which the choice of these two values can be a source of some challenges for the efficiency of the proposed method.

To examine the agreement of radiologists in ranking the images, Kendall's coefficient of concordance was used based on the opinions of seven radiologists. The results of this coefficient of concordance for the main images, MD-cleansed images, and images cleansed by the LM_ECC method are presented in Tables 1, 2, and 3, respectively. For all values reported in Tables 1 and 2, the p-value is less than 0.001, while for the values of Table 3, the p-values are greater than 0.001, as represented in parentheses.

Table 1: Results of Kendall's coefficient of concordance of Radiologists' opinions for Main

.

	Radiologist 1	Radiologist 2	Radiologist 3	Radiologist 4	Radiologist 5	Radiologist 6	Radiologist 7
Radiologist 1	-	0.806	0.788	0.827	0.782	0.74	0.864
Radiologist 2	-	-	0.907	0.708	0.818	0.698	0.797
Radiologist 3	-	-	-	0.696	0.757	0.715	0.766
Radiologist 4	-	-	-	-	0.793	0.61	0.784
Radiologist 5	-	-	-	-	-	0.593	0.784
Radiologist 6	-	-	-	-	-	-	0.649
Radiologist 7	-	-	-	-	-	-	-

Table 2: Results of Kendall's coefficient of concordance of Radiologists' opinions for cleansed Images from MD

	Radiologist 1	Radiologist 2	Radiologist 3	Radiologist 4	Radiologist 5	Radiologist 6	Radiologist 7
Radiologist 1	-	0.88	0.728	0.784	0.779	0.784	0.766
Radiologist 2	-	-	0.874	0.791	0.829	0.853	0.839
Radiologist 3	-	-	-	0.6	0.783	0.694	0.656
Radiologist 4	-	-	-	-	0.584	0.632	0.696
Radiologist 5	-	-	-	-	-	0.741	0.651
Radiologist 6	-	-	-	-	-	-	0.649
Radiologist 7	-	-	-	-	-	-	-

Table 3: Results from Kendall's coefficient of concordance of radiologists' opinions for cleansed images by LM_ECC

	Radiologist 1	Radiologist 2	Radiologist 3	Radiologist 4	Radiologist 5	Radiologist 6	Radiologist 7
Radiologist 1	-	0.708	0.578(0.011)	0.454(0.102)	0.71	0.639(0.007)	0.552(0.064)
Radiologist 2	-	-	0.84	0.815(0.001)	0.777	0.914	0.723(0.010)
Radiologist 3	-	-	-	0.692(0.003)	0.591(0.003)	0.746	0.620(0.013)
Radiologist 4	-	-	-	-	0.644(0.003)	0.748(0.002)	0.881(0.008)
Radiologist 5	-	-	-	-	-	0.678	0.579(0.016)
Radiologist 6	-	-	-	-	-	-	0.667(0.012)
Radiologist 7	-	-	-	-	-	-	-

The results of the Paired Samples T-test are reported in Table 4 to evaluate the effect of the LM_ECC method on the quality of the main images cleansed as compared to the quality of the main images based on the average of the radiologists' opinions.

$$t(21) = -9 \cdot 355\ .\ p < 0.001 \qquad \text{(relation 5)}$$

Table 4: Paired samples T-test for the main images and the LM_ECC method

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Original Image & LM_ECC Method	-2.140727	1.073373	.228844	-2.616634	-1.664820	-9.355	21	.000

The results of the paired samples T-test (Table 5) were used to compare the effect of the LM_ECC method on the quality of the main images and compare the effect of the MD method on the quality of the same images, based on the average of the radiologists' opinions.

$$t(21) = -5.414\ .\ p < 0.001 \qquad \text{(relation 6)}$$

Table 5: Paired samples T-test results for MD and LM_ECC method

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 2	MD Method & LM_ECC Method	-.584273	.506199	.107922	-.808709	-.359837	-5.414	21	.000

4 Discussion and Conclusion

An important feature of the LM_ECC method is to take advantages of the various previous methods and to combine them with image processing techniques. For instance, the simplicity of linear computing based on statistical features, enhanced accuracy of the proposed method in the diagnosis and labeling of areas with residual material using image gradient information and linear methods, the edge detection methods for removing the labeled areas, and image processing filters are used to smoothen the boundary between residual material and soft tissue.

In reviewing the agreement between the radiologists' opinions using Kendall's tau-b coefficient of concordance, the obtained results for their opinions about 22 images before and after the cleansing by the MD method and the method LM_ECC are presented in Tables 1, 2, and 3 respectively. It can be seen that the minimum coefficient of concordance is 0.593, 0.584, and 0.454, respectively, while the maximum coefficient of concordance is 0.907, 0.88 and 0.881, respectively. Clearly, in all contrasting views of radiologists in Tables 1 and 2, p-value <0.001 and the Kendall value is greater than 0.5, indicating the agreement of the seven radiologists in rating the images. However, in Table 3, only two items obtained a p-value> 0.05, which is close to 10% with regard to the 21 Kendall values. It indicates the agreement of most radiologists in ranking the cleansed images using LM_ECC.

According to the T-test results presented in Table 4, to investigate the effect of the LM_ECC on the quality of the main images cleaned up compared to the quality of the original images, there is a significant difference between the pre-test and the post-test. The results of this test, as shown in relation (5), with a degree of freedom of 21, reveal that the scores of electronic cleansing are significantly higher than before the cleansing. Therefore, according to test results, the null hypothesis is rejected. This means that the LM_ECC method has a significant effect on the quality of images cleansing than the main images.

Based on the results of the T-test to compare the effect of the LM_ECC method on the quality of the main images compared to the MD method on the quality of the same images (Table 5), it is clear that there is a significant difference between the pre-test and the post-test. The results in this test (relation 6), with the degree of freedom of 21, show that the scores of electronic cleansing data are significantly higher than the MD method using the LM_ECC method. Therefore, according to test results, the null hypothesis is rejected. This means that LM_ECC has a significant effect on the quality of images cleansing as compared to the MD method.

Finally, based on the computational results of the tests, it can be concluded that the LM_ECC method, which benefits the advantages of linear methods and methods of image processing neighborhood analysis to improve the quality of electronic cleansing images, is able to improve the quality of these images in practice compared to main images and the MD method.

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Conflict of Interest

There are no conflicts of interest.

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Two Piscan Aeromonas Vaccine Strategies

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ABSTRACT

A piscan Aeromonas ulcerative infection episode was revisiting Babylon province, IRAQ at 2018 following to that of 2015.. Two Aeromonas hydrophila vaccines are being developed and delivered in two strategies for common carp fish . First the heterologous prime-boost and second the homologous prime boost in combination with Alhagi Root Adjuvant[HRA] 3.5 gm/kg ration. These strategies were as, heat killed[AHKV] prime-live[AHLV] and HPA-AHLV prime-AHLV boost with immunogenicity group, infection group and sham controls in an aquaculture system provided with an optimal culture conditions. Both of Heterologous and homologous prime boost proved to be immunogenic as determined from A. hydrophila specific serum agglutinins which was of up to titre of 1280 and 2560 with survival rate of 100% and duration of immunity to three to six weeks post to the initial vaccination for the survived fish. The developmental evaluation criteria of both of vaccines were matching to that of other workers .In this aquaculture system. preconditioning with HPA for 21 days before vaccination was found comparable to vaccination with dead prime vaccine in the sense of; immunogenicity and survival rate and safety .Wider application of these two vaccination strategies in the natural conditions of commercial fish farming ponds is being an inherent need for confirmation of the present findings

***Key Word*s** : Aeromonas ,Agglutinins ,Homologous ,Heterologous ,Strategy, Vaccines.

1 Introduction

The piscan Aeromonas infections are being evident problem in natural fish farming conditions in more than one geographic areas of the world [1,2,3,4,5,6,7].The common carp ulcerative infection episode has been documented in this area[1].The humoral immune-modulating effects of gelatin ,carboxy methyl cellulose and chitin in the aquaculture of common carp fish have been determined[6,8].Melano-macrophage centers have been tried as an infection marker among aquaculture of common carp fish[9].Currently ,the pican ulcerative Aeromonas infection in carp fish was mapped again at 2018 in an episode form. The present work was aimed at presenting the development of two Aeromonas vaccine strategies in common carp fish aquaculture system.

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2 Materials And Methods

2.1 Natural Infection:

2.1.1 The Episode:

Around 150 common carp fish were collected during the period of Sept. till Oct 2018. with an average weight of 100gs per each fish. Fish collect were made from a number of commercial fish farming bonds. Some of the sampled fish from different ponds appeared to be sluggish, weak with signs of skin ulceration, haemorrhage and descaling .On evisceration the internal organs were congested [10].

2.1.2 Processing :

Direct swabs were made from the affected skin lesions and processed for direct wet and stained films for microscopy and for culture as well as biochemical characterization(both classical and API20E)[11].

2.2 Vaccine Development:

From the clinically proven piscan ulcerative Aeromonas infectious disease, an Aeromonas-like colony morpho-type onto TCBS agar a representative colonies was picked quadrate streaked onto casein Aeromonas selective medium for purity and cultural characters .Then quadrate streaked onto brain heart infusion agar plate for more assurance of colony morphology and purity. Five similar colonies were transferred to brain heart infusion broth and incubated for 2 hr at 37C to prepare the seed culture for biochemical tests[12].The results of both classical and API20E system were indicating the identification of Aeromonas hydrophila[13].From the pure identified A.hydrophila isolate onto BHIA plate dense inocula were transferred into 5mls.BHIB broth medium in screw cape tubes in five replicates and layered with sterile liquid paraffin ,then kept at -18C in the chest freezer of the domestic refregirator as a stocks of the vaccine strains[14].

On time of the laboratory development of A.hydrophila vaccines, one stock culture tube was revived onto BHIB for overnight at 37C,then onto TCBS at 37C for overnight. From growth onto TCBS, colonies were transferred by quadrate streaking onto BHIA plates. The vaccine seed culture was five colonies of similar morpho-types were elected and inoculated into each of two 50 ml flask BIHB medium and incubated for 24hrs at 37C.Growth for both flasks were checked for; viability , purity and viable counts[15].The whole culture viable counts were to determine the actual viable counts helpful in ratifying the number of vaccine units per ml of the prepared prototype vaccines.

For live culture vaccine broth culture was distributed into sterile centrifuge tubes in five ml amounts centrifuged at 5000 rpm for 10 min ,and pellets were twice washed with sterile saline at 5000 rpm for 10 min .Pellets were reconstituted to have 1x10 to 7 vaccine units /ml in the final dispensed vaccine in 5 ml. screw capped tubes. This final lot vaccine tubes were checked for viability purity and safety[15].This prototype experimental live vaccine were used for short time experimentation and on due time.

For the dead vaccine version, the second flask BIHB viable counted culture was heated at 70 C for one hour in water bath, then distributed in 5 ml amounts in centrifuge tubes and centrifuged at 5000rpm for 10 min. Pellets were twice washed with sterile saline at same centrifugation conditions. Then pellets were reconstituted to in rate of 1x10 to seven vaccine units per ml. and dispensed in sterile screw capped tube in 5 ml amounts which represent the final vaccine lot that was checked for purity and safety and kept at 4C for short term experimental use.

2.3 Adjuvant:

Alhagi root adjuvant was prepared incorporated into the fish ration pills with rate of 3,5 gms per kg of the ration[16,17].

2.4 Theme:

The theme of the present work was to simulate a natural state of a commercial fish farming bonds one received dead vaccine and the other received immunostimulant. Both of the bonds have encountered natural concurrent repeated infection with A hydrophila. Based on this theme five groups each on ten fish in an aquaculture system ,were assigned as: Heterologous prime-boost strategy group ,Homologous prime-boost in combination with HPA 3.5% group, infection group ,immunogenicity group and sham group. Immunogenicity was measure as agglutinin levels, efficacy jugged as serum humoral antibody levels and considered as a surrogate of immune protection [18] among test fish groups. Fish in each group at the assigned day of priming or boosting was inoculated in the third scale line under the dorsal fin intramuscularly at the day 22 and 37 of the experiment, Table 1.

Table 1 :Fish assignment groups

Group	Nature	Protocol	Time table	No.of fish
I	Immunogenicity	Heat killed prime boost	Day I,22,37	10
II	Infection	Saline-live-live	Day 22, 37	10
III	Heterologous prime-boost	Dead-live-live	Day 1,22,37	10
IV	Adjuvant-live-live Homologous prime-boost	HPA-Live-live	Day 22,37	10
V	Sham	Nil	Nil	10

2.5 Safety:

Live vaccine within the limits of 1x10 to 3 up to 1x 10 to 5 vaccine unit per ml was with any gross or histologic changes. The limit of vaccine units of live vaccine 1x 10 to seven was the LD50 dose. Both vaccine strategies were being safe .

2.6 Aquaculture System :

Four common carp fish groups each of ten with an average body weight of 100 gms.These fish groups were kept during the experimentation period in an aquaculture system that were monitored in a week-wise manner for PH, salt, weight and given minimal fed with continual shift of O2 ventilation and dynamic continuity[19] .

2.7 Serology:

Fish blood samples were collected at the day 21,36 and 52, clotted and sera saved in composite sampling approach from test and control group of fish. Tube agglutination assays of test and control fish with vaccine antigens were made .Rise up of antibody titers up to three folds than the primary response of the dead antigen titer indicates immune adjuvant effect [20] .

2.8 Biometery :

All of the biometric analysis for the test and control fish groups were assessed as in [21] .

3 Results

3.1 Comparing Fish Groups:

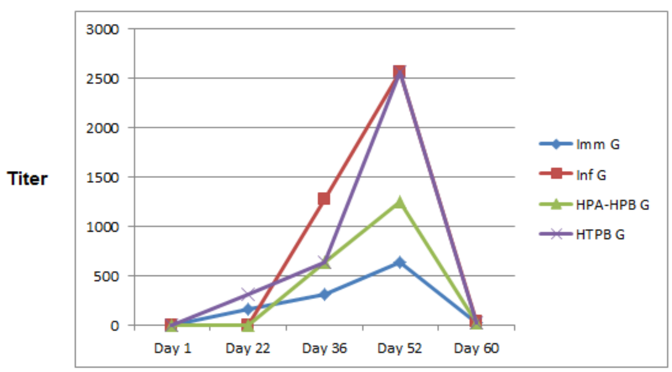
Sham group was designed to exclude non-specific abnormalities that may appearing on the test fish. Immunogenicity group was showing reasonable level of immune response level to heat killed vaccine. Infection group provides high immune response levels up to the titer of 2560 and 60% survival rate.

3.2 Heterologous Prime Boost Strategy(HPBS):

The primary immune responses of fish vaccinated with HPBS strategy was with titer of 320.While the secondary immune response was with titer of 640 ,1280 and the titer was 20 at the day 60 the date of termination of experiment. Such titer profile is an evidence of immunogenicity. The dead vaccine alone was pure and safe. The HPBS has shown survival rate of100%.The relative calculated duration of immunity was six weeks since initial vaccine dose up to day 60.,Table 1. The survived fish in this group was sacrificed at the day 60 was with neither gross nor histologic abnormal changes.

3.3 HRA-Live-live Prime Boost(HRLPBS):

The primary immune response of HRLPS fish was titer of 320 while the secondary immune response was with titer of 1280 ,and the titer was 40 at the day 60 the day of termination of the experiment. Such titer profile was a proof for immunogenicity of HRLPBS.AHLV-HPA induced survival rate of 100% till the day 60 of the experiment. Evisceration of the test fish has shown neither gross nor histologic evidences for abnormalities. The relative duration of immunity of HRLPBS was three weeks since the initial vaccine dose., Table 2,Figure 1.



Duration of Immunity Via Serum Agglutinin titer

Figure 1 The fish immune response time curve

3.4 Vaccine Developmental Parameters:

The purity ,safety ,immunogenicity and efficacy(Serum Agglutinins as a surrogate of efficacy) for both of the tested vaccine strategies, Tables 1 and 2 in their over- all criteria are parallel with that made by the other fish Aeromonas vaccine workers. ,Table 3.On comparing the HPBS to HRLPB, it was evident that both with the higher immunogenicity the higher survival rate and or efficacy.

Table 2:Serum A.hydrophila agglutinin ,duration of immunity and survival rate of the heterologous prime-boost vaccine strategy.

Vaccine Strategy	Time table	Parameters
Dead prime-live boost		
Prime	Day 1	
Reading	Day 36	Titer :320
Boost	Day 37	Titer :640
Reading	Day 52	Titer :2560
End point	Day 60	Titer : 20
Saline control		_
Relative duration of immunity		6 weeks
Survival rate		100 %

Table 3 : Serum A hydrphila agglutinin.duration of immunity and Survival rate of Homologous prime boost vaccine strategy

Vaccine Strategy	Time table	Parameters
HPA-prime live-boost live		
Preconditioning with 3.5% HPA		
Live prime	21 Days	
Reading	Day 22	
Live boost	Day 36	Titer :320
Reading	Day 37	
End point	Day 52	Titer:1280
Relative Duration of immunity	Day 60	Titer : 20
Survival rate		
		3 weeks
		100 %

Table 4 : Criteria for the Laboratory Development of fish A hydrophila vaccines

Criteria [15]	HPBS	HPA-HPBS	Formalin Killed[3]	Formalin Killed[4]
Understanding Disease	Understandable	Understandable	Understandable	Understandable
Understanding causal	Understandable	Understandable	Understandable	Understandable
Preparation of candidate vaccine	Prepared	Prepared	Prepared	Prepared
Laboratory development Purity Safety Immunogenicity Survival rate	 Pure Safe Immunogenic 100%	 Pure Safe Immunogenic 100%	 Pure Safe Immunogenic 53-61 % up to100%	 Pure Safe Immunogenic 76.67%

4 Discussion

Natural fish bacterial infections in commercial fish farming at Babylon province/IRAQ. and in any of which it stands as an ecologic and economic insults[22,23].Aeromonas ulcerative disease in common carp fish has been documented at 2015[1].New episode of the disease was noted in commercial fish farming bonds at 2018.A hydrophila was documented as the causal .the situation was motivating to develop prototype A hydrophila vaccine candidate versions.Heat killed and live vaccine versions were being developed.The vaccine delivery to the test fish groups was through two vaccination strategies.Heat killed prime-live vaccine boost and Live prime-live boost incorporated with 3.5% Alhagi root Powder adjuvant[16,17] .The reported immune efficacy for both of the vaccine strategies 100 % which has been parallel to what have been found by others workers on A.hydrophila vaccines in fish aquaculture [3.4].The higher the immunogenicity, the higher survival rate(Efficacy).This may be attributed to antibody protective role[16,17] .

The two vaccine strategies have shown decline of agglutinin titers at the day 60 of the experiment thought the test fish in aquaria being normal till termination of experiment. This may be due to the phenomenon of sterile immunity , Table 6, were the antibody prevents pathogens from expressing their pathological effect [24,25],decline effector and/ or memory B cell functions or due the interplay of cellular immune factors in immune efficacy of these vaccine strategies. Though the latter possibility is far from being the case. Since Aeromonas is an extracellular pathogen[26]. Both of the vaccine candidate may contained TH2 epitopes or direct B cell epitopes[27].

Fish commercial vaccine safety in an aquaculture system should be safe for; fish wealth ,consumer health and environmental hazard management[28,].Fish vaccination strategies can be of short or long term protection [29] .The presented model in this study may be for short rather than for long term protection. Sham fish group was designed to watch the nonspecific factor that may lead to either morbidity or mortality in this aquaculture system.

Alhagi root adjuvant 3.5% in fish ration bear non-specific immunopotentiation effect[16,17].Twice live vaccine doses in continuum with the test adjuvant rise up the immunogenicity and the efficacy of A. hydrophila vaccine in commercial carp fish[30]. The immunogenicity and protectivity is of an absolute correlate[18] in the both of the prime-boost strategies as apparent in this experimental fish aquaculture system, Table 5.

Table5 : Correlation between serum agglutinins and protection[18].

Term	Definition
Absolute correlate	A quantity of immune response to a vaccine that always provide near 100% protection
Relative Correlate	A quantity of immune response that usually but not always provide protection

Table 6 :Criteria for identification of sterile immunity induced by vaccination[24,25]

Criteria	[24]	This Study
Prevent infection	+	+
Prevent development of clinical signs and symptoms	+	+
Prevent Pathological Effects	+	+
Prevent microbe shedding	+	ND*

*ND = Not defined

The study theme proposed repeated infection events in natural conditions of fish farming bond are being expectable and the study design present a proof by aquaculture system were live vaccine initiate higher antibody levels and maximal survival rates. Advise may be issued as “let fish farmers fed the farmed fish with ration containing 3.5gm/kg ration of Alhagi root powder, and they naturally encountered A hydrphila repeated infection events leading to fish immunity. Though such issue need to be confirmed by wider application under the natural commercial fish pond environment.

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