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Automated Tele-Health Monitoring System for Animal Health using Image Processing

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Abstract: ***For effective livestock management identification and control of parasites and bacteria is a challenging factor. Parasites, worms and bacteria has a huge hazard to the health of animals, which can harm the gastrointestinal tract, and result in decreased propagative routine, diminished development rates, less yield in terms of meat, fiber and milk, even leads to death of the animals, which in turn causing health problems for human society also. A proper knowledge of animal parasites by identification of them and application of the proper antibiotic or vaccine in appropriate dosage will improve the quality of the livestock and its byproducts leading to the more profits to the farmer. The livestock farms are located at the remote places and the communication between the veterinary doctor to the farmer is poor, took long time and expensive. This can be overcome by utilization of the digital technology and automation of the process which can be handled by a layman at the field to provide electronic information for both e-prescription for intermediate treatment and the information to the expert at the remote location for proper diagnosis and validation of the electronic prescription.***

Digital image processing of the microscopic pictures with high resolution cameras from the samples of the animals will provide a platform for automation of the process. The detection of the parasites and its stages can be done by denoising the images, segmentation of the parasites, templating the images for isolation of parasites and bacteria by comparing them with preloaded data of different types of parasites and their different stages leads to the identification of parasites, bacteria and giving the electronic prescription within a short period then the diagnosed report can be sent to the expert for validation.In the present paper the authors have proposed a smart system for tele-monitoring and mobile health management system.

Keywords: ***parasites, bacteria, image processing, template matching, automation, animal health, electronic prescription, tele health monitoring system.***

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I. INTRODUCTION

There is an enormous increase in demand of nutritional food as the global population is growing from 7 bil to 9 bil by 2050. To meet this one among the two major sources is the livestock products which can be increased by increasing the quantity of animals besides productivity rate. In India the total population of animals are around 0.5 billion and the dairy farmers around 20millions are rely on them. Animal welfare and healthcare are the significant components that influences the efficiency of the livestock, resulting Safer nutrition supplies, Higher farm productivity profitability, reduced utilization of antibiotics, Improved animal prosperity. The livestock has a serious hazard of irresistible sicknesses through parasites and bacteria. They may additionally transmit to individual humans as well.

Parasitic contaminations cause an enormous burden of diseases in both the tropical and sub-tropical as well as in more temperate climates. Reproduction and transmission of parasites are influenced by grazing system, seasonal changes in air, water temperature and by some biotic factors. The Parasites are of two sorts named endoparasite or Internal parasite and ectoparasite or external parasite, these parasites grow and reproduce in explicit conditions, the livestock living in such environments that are prone to high threat of becoming infested. Parasites like Fasciola Species, Paramphistomum, Schistosoma Nasale and Spindale, Moniezia, Taenia, Toxocara, Strongyle, Trichuris and B Coli are the extensively recognized parasites in India.

For long time, microscope is the primary tool widely utilized for the recognition of parasites by examination of blood and feces smears and tissue samplings. But, developing the sample for direct examination is tedious, laborious and proper diagnosis relies on trained technicians. Now a days in addition to Microscope analysis, Serology based evaluations like ELISA: enzyme-linked immunosorbent assay, FAST-ELISA: Falcon assay screening test ELISA, dot-ELISA, RIPA-ELISA: radioimmunoprecipitation-assay, DHA or IHA:direct or indirect hemagglutination assay, DFA or IFA:direct or indirect immunofluorescence assay, IB:Immunoblot, PRISM, RDT:rapid diagnostic test, Molecular Based Assays like PCR:polymerase chain reaction, RT-PCR: real-time polymerase chain reaction, QT-NASBA: quantitative nucleic acid sequenced-based amplification, RT-QT-NASBA: real-time quantitative nucleic acid sequenced-based amplification, LAMP: loop-mediated isothermal amplification, OC-PCR:oligo chromatography Polymerase chain reaction and PROTEOMICS methods like LDMS:laser desorption mass spectrometry, MALDI-

ToF:matrix-assisted laser desorption/ionization time of flight, SELDI-Tof:surface-enhanced laser desorption/ionization time of flight are the available testing methods for parasite diagnosis [3], even though we get the accurate results using the above methods, they are also time consuming, laborious and a skilled technician is required for analysis.

A potential answer for this issue is usage of Digital Image Processing Techniques [1] and automated methods in identifying the Parasites. In current situation Image processing techniques are broadly used to detect and categorize malaria parasites in human beings [2]. These practices can be utilized to detect and categorize the parasites of the livestock without trading off the productivity and time for recognition and also reducing the animal healthiness costs, also a normal individual can be effectively trained in utilizing this strategy, as the vast majority of the diagnosis process consists automated methods.

The trained technicians in the centralized work stations uses the Microscopes attached with high-resolution digital cameras collect the pictures/images and by using the Image-processing techniques like image-enhancement: enhancing the images, image-denoising: removing the noises from the images, image segmentation and template matching technique for identifying the type and stage of the parasites with the preordained data bank.

Apart from image processing techniques application of Artificial Intelligence based strategies and Machine learning are contributing in the diagnosis of the parasites. As per the diagnosis the technician can be issued an e-prescription and furthermore the diagnostic interpretation, a report can be directed to the remote pathology center or a Veterinarian by using tele pathology method for cross verification, validation of the results and suggestions. Simple application software's like TeamViewer, AnyDesk, Chrome Remote Desktop, WebEx Meetings, Ammyy Admin, Mikogo, ThinVNC, UltraVNC can be utilized for transferring the images acquired by the microscope and diagnosis report from centralized work station to a remote Pathology lab. The Network connection of workstation with pathologists shown in fig.1

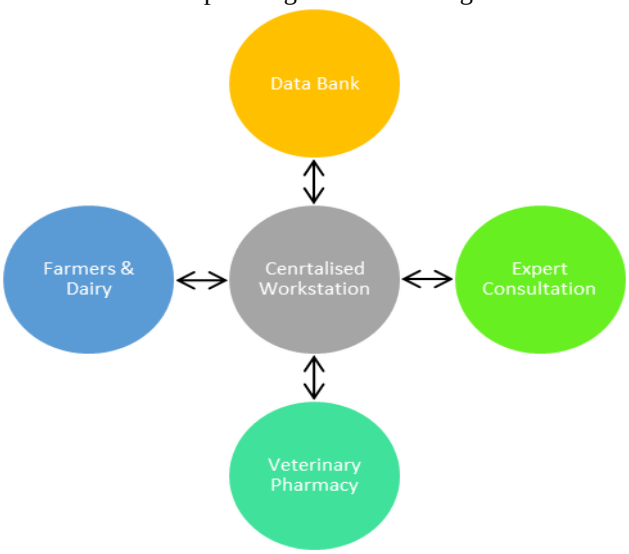

Fig1: Network connection of workstation with pathologists and pharmacy

The process for automation using tele-pathology method is described in the block diagram as appeared in fig.2.Tele-pathology allows online discussion of pathologist and consultant.

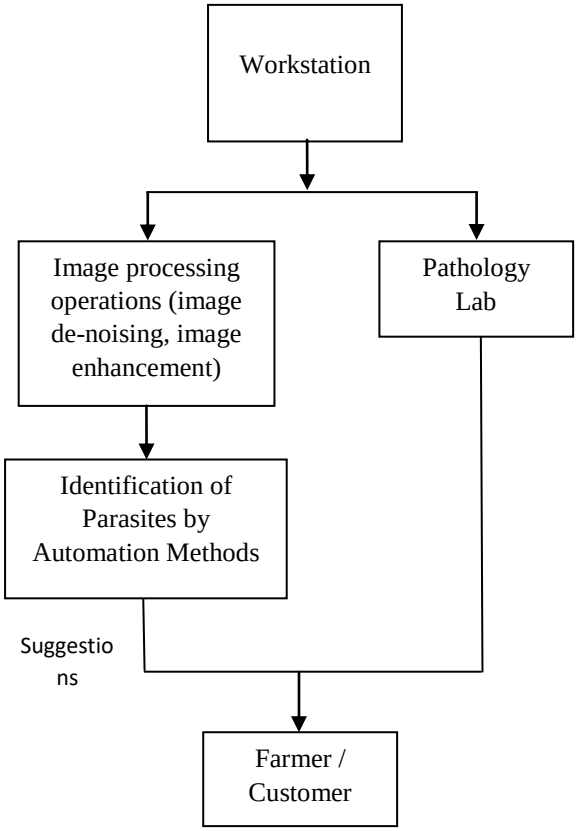

Fig.2: Block diagram of automation using Tele-pathology

A. Methodology

The proposed automated method is developed by the process as appeared in the flow chart fig.3. In the first stage, the samples are collected from the animals. From the collected samples the images will be acquired by using high resolution microscopes. In the second stage these collected images should undergo various images pre-processing tasks such as image-enhancement, image-denoising etc.,

In the final stage the identification of types of parasites exists in the sample and type of diseases are done by using image-segmentation and object/matter identification etc., The diagnostic report will be directed to the expert for validation purpose. At the end the entire process is linked up with mobile-application for user friendly operation of dairy farmers.

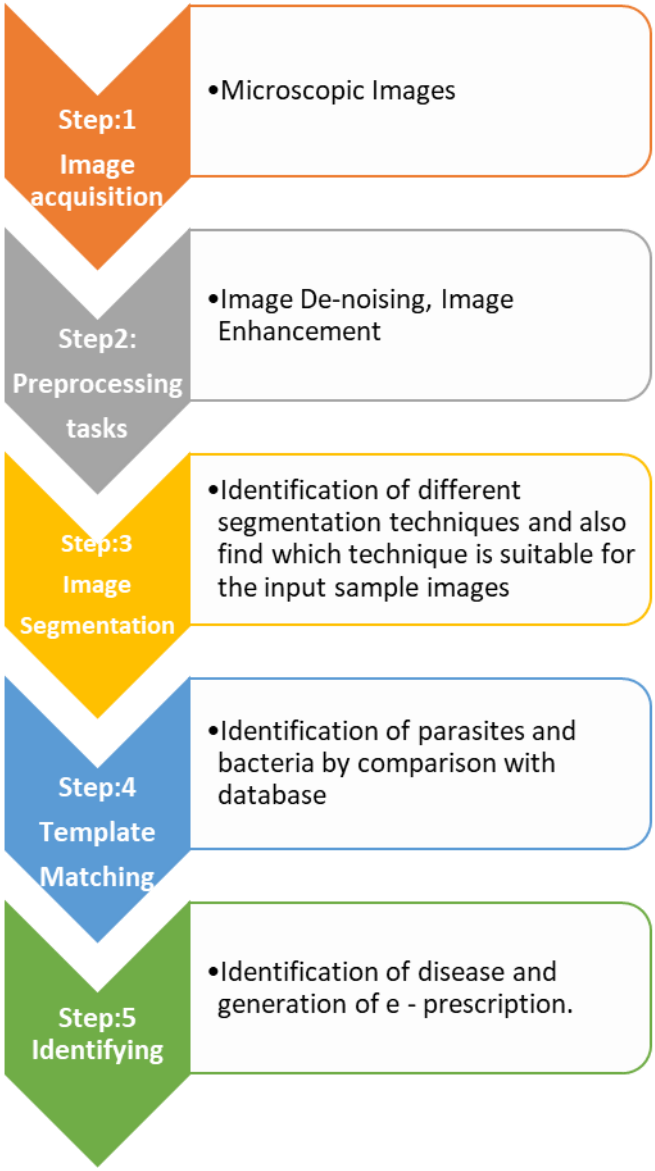

Fig.3: Process flow chart for automation

II. IMAGE DENOISING

In general, the noise is always occurring in digital images during the acquiring of the images, and it represents undesirable information/data in digital images. Because of the noise objectionable/undesirable effects such as artifacts, impracticable edges, unnoticed lines, crooks/corners, indistinct matters and disturbed background scenes produces on images. Initially noise in the images will be removed by using image smoothing then by using different de-noising methods the remaining noise exists in the image/pictures can be removed. The noise exists in the images/pictures can be removed by means of filtering, like linear or non-linear filtering.

Mostly, linear methods/models are used. The advantages of linear noise confiscating models are its speed and the disadvantages/restrictions of the linear models is, they are not ready to safeguard edges/boundaries of the images/pictures, which are recognized as interruption in the image, are smeared out. In contradiction, Non-linear methods/models were more capable of handling edges/boundaries in a much better way than linear models.

In general, during acquiring process of the images/pictures or transmission, noise will be introduced into the image. Various aspects may be influence overview of noise in to image. The essential reasons of noise in the digitized images/pictures are, the sensors that used for acquiring the images/pictures might be influenced by ecological conditions like lacking light levels, sensor temperature, the dust particles exist on the sensor during the process of acquiring the image. Image de-noising is a fundamental task, done preceding to processing of a picture.

Noise in images/pictures is classified as Gaussian, Impulse(spike), Shot (Poisson), Quantization, Film-grain, onisotropic, Speckle (Multiplicative) and Periodic etc., De-noising can be done mainly in Spatial Domain Filtering (SDF), Transform Domain Filtering (TDF) and Wavelet Based Thresholding (WBT) approaches.

A. Spatial Domain Filtering

It is the method suitable for the images when only additive/supplement noise is present. spatial domain filtering is divided into 2 classes: Linear filters and Non- Linear Filters

a) Linear Filters

This method is suitable when only additive/supplement noise is present in the images. Mean filter (averaging filter) and Wiener Filter are examples for linear filters.

b) Non-Linear Filters

This technique is appropriate when multiplicative and work-based noise is available in the images/pictures. Median Filter is the example for linear filters.

B. Transform Domain Filtering

It is classified according to choice of basic functions. Spatial Frequency Filtering & Wavelet Domain Filtering are coming under this category of filtering.

C. Wavelet Based Thresholding

It is a signal estimation technique which removes noise by eliminate quantities that are irrelevant to some threshold. Field images taken from the dung sample using high resolution camera microscope is processed with different de-noising techniques in MATLAB software to remove several categories of noises like Gaussian, Poisson, Gamma etc., is shown in fig.3,4. Initially from the microscope RGB-color image is obtained then for further de-noising process it is transformed to gray-scale image. After image preprocessing, identification of bacteria and diseases process will be done.

Fig.4.a: Original image of sample taken by microscope

Fig.4.b: Gray scale image

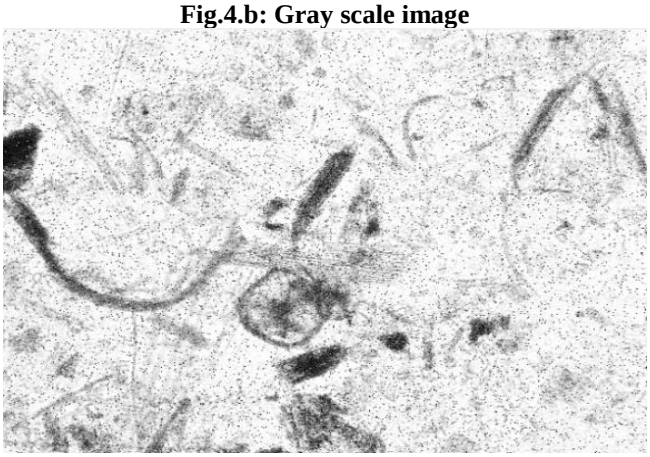

Fig.4.c: Noisy image (Impulse)

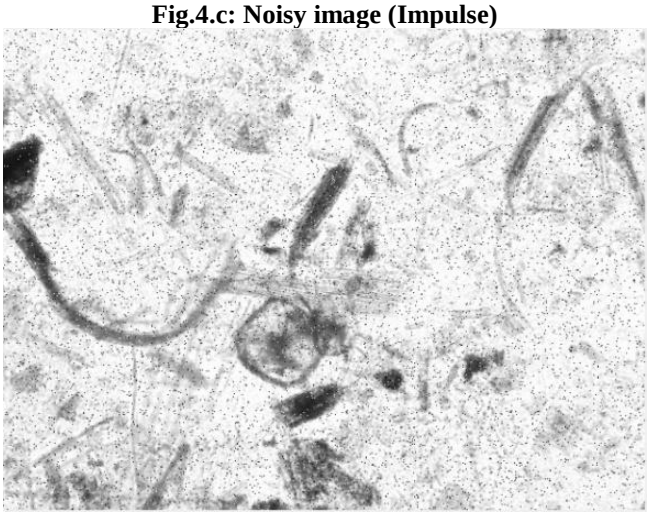

Fig.4.d: Linear filter output

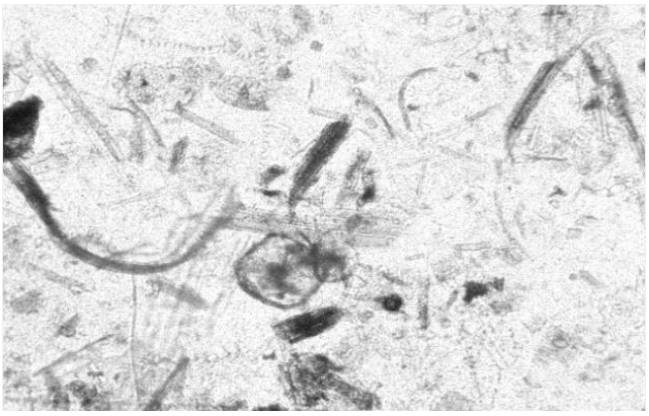

Fig.4.e: FIR filter output

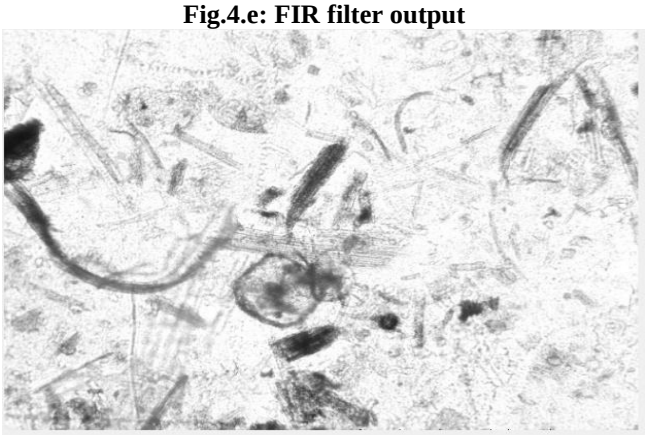

Fig.4.f: Median filtered image

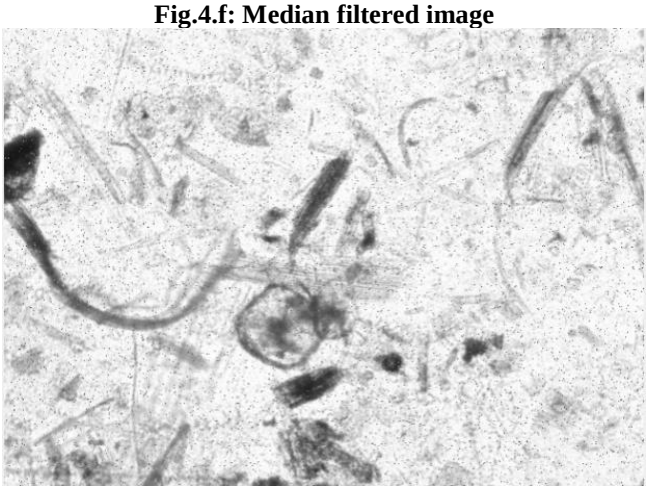

Fig.4.g: Adaptive filtered image

III. IMAGE SEGMENTATION

Image segmentation assumes a huge role in many applications of image processing, segmentation of image/picture is the way of acquiring important physiognomies or parts of the image/picture [5]. These attributes can be unique for the image/picture, for example, picture-element's gray equivalent, color/shading, reflective features and textures, and so on., and it can likewise be structural spectrum, for instance histogram features.

The motivation behind the segmenting of the image/picture is to divide the image/picture into a number of unique segments, which can make the segments uniform and the features of the neighboring sections have clear distinction.

Segmentation of the image/picture is one of the greatest significant issue in applications based on computer vision [6]. It has turn into a problem area in the field of image processing.

Segmentation process isolates the image/picture in the direction of its component parts or objects. The level to which the segmenting the image/picture is accepted relies on the obstacle being settled, and the required objects in a particular application was discovered then segmentation may stop. Segmentation procedures of images commonly depend on the criteria of irregularity and similarity of their values of intensity [7]. The choice of image segmentation method is relying upon the issue being considered.

a) Discontinuity detection based approach

In this class of approach, an image/picture is divided into sections dependent on irregularities. Segmentation based on the edge detection comes in the group wherein edges/boundaries shaped because of irregularities in the intensity are seen and associated to form borders/edges of sections [10].

b) Similarity detection based approach

In this methodology, an image/picture is fragmented into sections reliant on image/picture pixel attributes. The strategies that goes under this methodology are: threshold technique, region-growing techniques and region-splitting and merging. Here strategies will segregate the image/picture into sections has same properties of pixels. The image clustering technique additionally utilizes the indicated style. They segment the image/picture into group of bunches having the same features/properties dependent on built up criteria.

A) Image Segmentation Techniques classification

The methods used for segmenting the images/pictures may be obtained from two elementary methodologies of segmentation i.e. region based or edge-based methodologies. All the previously mentioned methods can be useful on a range of images/pictures to accomplish essential segmentation. The above-mentioned techniques can be grouped as three classifications.

a) Structural Segmentation Techniques

The structural procedures, banks over the data of the topology of essential objects of the image/picture for example the imperative section to be portioned.

b) Stochastic Segmentation Techniques

The stochastic methods chips away at the isolated pixel intensity standards of the image/picture rather than the physical data of area.

c) Hybrid Techniques

These procedures utilize the concepts of both structural and stochastic techniques for example it utilizes both discrete pixel intensity data and structural data.

B) Techniques for segmentation of images:

Thresholding method, Edge-detection based strategies, Region-based strategies, Clustering-based strategies, Watershed-based systems, Partial-differential equation based and Artificial neural-network based methods are some popular strategies of image segmentation [8]. All the above methods change from one another concerning the strategy used by them for segmentation of images. The objective of segmentation of images is to split a given image into numerous portions having comparative physiognomy or peculiarities of the images. The uses of image segmentation are found in Content-based image- recovery, Bio-medicinal applications [9], locating & Recognition of objects and Video surveillance, etc.

IV. FEATURE EXTRACTION

Feature Extraction is a basic procedure of any image Classification and object Recognition System. Feature extraction has lot of significant role in the image processing applications. Before obtaining required highlights from an image, various image pre-processing tasks such as binarization, thresholding, resizing, standardization etc. are applied on the tested image. For automated recognition of the items from remote detecting data/information, they are to be related with specific characteristics which depict them and separate them with one another. The comparability between the images/pictures can be settled through the highlights which are spoken by a vector.

Feature Extraction is worried about the extraction of different qualities of an object and consequently partner that object with an element vector that describe it. Feature Extraction is the procedure to arrange a picture and perceive the items. The different parts of a picture, for example, shading, surface, shape and so on., are used to speak to and list a picture or an article.

In general feature extraction algorithms are depend on color, texture and shape. Feature selection is a vital matter in image analysis. Color is the foremost direct visual feature for indexing and retrieval of images. The mean, variance, skew are important parameters in representing color distribution of images. The texture is one of the required characteristics of image in region based segmentation of images. The Texture topographies show a vital part in computer-based vision and pattern recognition applications. The Shape is also one of the important attributes in feature extraction. They are typically described when the image has been divided into several regions or objects. Shape description was basically partitioned into region based and boundary based. A decent profile illustration feature for an item ought to be unchanged towards properties like transformation, gyration and scaling.

A) Template matching method

Object identification is a method for perceiving a known thing inside an image/picture. It is used to suitably recognize substances in an image/picture and gauge their amount and area.

Template matching [4] is a strategy, utilized in utilizations of picture processing for finding little pieces of an image/picture in a reference image/picture.

In this procedure, client compare a template/layout and given picture, where the template is a sub picture contains the part, really required to recognize.

A similar procedure is used for the whole picture, and the point which prompts a best match, the most extraordinary check, is characterized to be where the necessary shape (the format) lies inside the picture. Templates are commonly used to recognize characters and numbers, and things in the images/pictures.

a) Template Matching approaches

Template matching methods categorized as Featured-based (FB) approach, Area-based (AB) approach, Template-based (TB) approach and motion-tracking & Occlusion Handling [11].

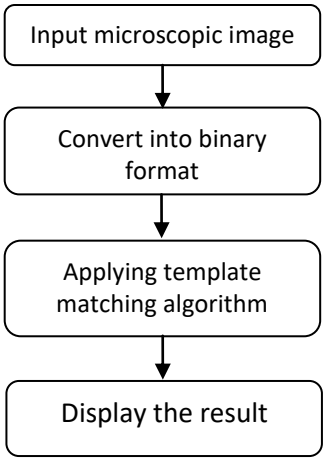

Fig 5: Template matching process flow

Process flow of template matching technique is given in flow chart shown in Fig.5.

V. IMPLEMENTATION

The entire automation process is linked up with the mobile APP for user friendly operation of farmers. By using this mobile APP farmer will upload the image, APP will process the image and find the type of disease and finally prescribe the solution to the farmer. Fig.6.1 represents an original image taken from sample using microscope. Fig.6.2 represents a processed image in that image a parasite is identified after applying digital image processing operations.

Fig.6.1: Original image of sample taken by microscope

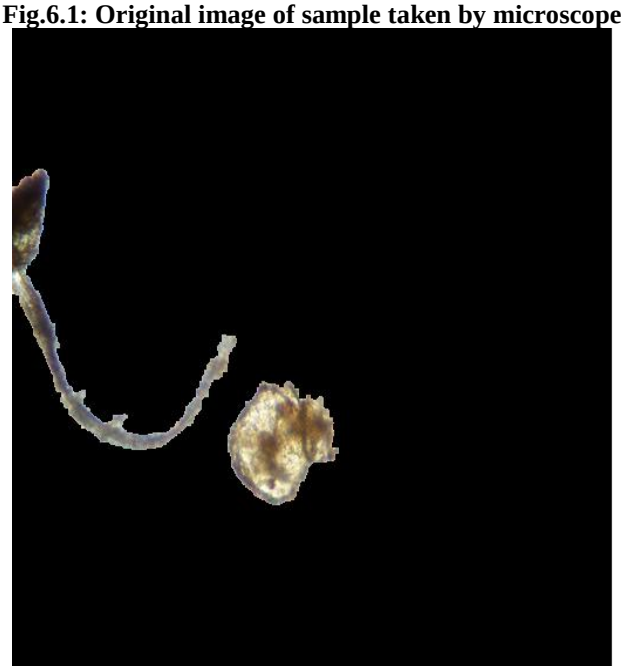

Fig.6.2: Processed image

Table- I: Comparison of different diagnosis methods.

Test Name	Implementation	Type	Cost	Time Taken for Assessment
Serology based evaluations	At any stage of the disease	Manual	Low	Greater than or equal to 24 Hours
Molecular Based Assays	After 1 - 2 weeks from the onset of the illness	Manual / Automated	High	2 Hours
PROTEOMICS methods	At any stage of the disease	Manual / Automated	Low	12 to 24 Hours
Proposed Methodology using Digital Image Processing	At any stage of the disease	Automated	Low	Less than 30 Minutes.

VI. CONCLUSION

The proposed methodology can be useful in the automation of the system to trace what type of parasites and bacteria present in the microscopic images of the sampes by using image processing techniques. By comparing the isolated images of the parasites and bacteria with preloaded data of various parasites and bacteria, for the detection of the type of the parasitic and bacteria diseases from which the system will generates an e- prescription online.

This leads in reducing the diagnosis time of the disease. Later the telepathology is used for validation with veterinary doctors and pharmacist.

Since the proposed methodology is fully automated process it is expected to produce the accurate results in less than an hour.

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