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In Vitro Fertilization (IVF) Incubator Monitoring System

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Abstract
The aim of this paper is to propose a solution for monitoring of conditions inside incubator for proper development of embryo. In Vitro Fertilization (IVF) technique has involvement of incubators. Sample is kept for 3 to 5 days inside the incubator. To maintain proper environment inside it, there is requirement of a system. System should monitor the temperature levels to 34-degree Celsius and relative humidity of 25% is to be maintained. Harmful gases are to be detected. Idea gives solution to such parameter monitoring with buzzer on disturbance in levels. Internet of Things (IoT) has its importance here to collect data from sensors and through a gateway pass it over the cloud. Dashboard can be prepared in order to give timely live monitoring of the parameters. Image processing using Open CV, Python is used to process the images of samples. Dataset of images of embryo development from laboratory is available.

Keywords: *Incubator, Open CV, Internet of Things.*

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I. INTRODUCTION

The Internet of Things (IoT) has become industry-free language to describe how technology is currently being embedded in various markets, including healthcare, and evolving the way in which business is conducted. The IoT is described as a network of physical devices that uses connectivity to allow the exchange of data. IoT-enabled medical devices give critical data that assist health practitioners do their jobs. One good example of the IoT being used in healthcare is Monitoring of In vitro fertilization (IVF) incubators. Incubator Monitoring systems can be used in IVF laboratories for monitoring the health conditions of embryo growth which needs intensive care. The necessity of these monitoring systems is to improve the quality of life by continuously monitoring the surrounding conditions inside the embryo. High performance generic image acquisition and processing techniques for embryos inside incubators would also result in a convenient way to monitor the development inside the incubator.

Image processing is an emerging biomedical tool contributing to the betterment of the healthcare sector. Image processing tools provide a comprehensive set of standard algorithms, functions, and applications for image processing, analysis, visualization, and algorithm development. Advancements of image processing and computer vision in healthcare are required to be explored. Hence, tried to dig deeper into healthcare using image processing and computer vision along with very important sensor-based activity. Various important areas are covered here, broadly microscopic image acquisition for healthcare, image processing techniques on the dataset of embryo, monitoring surrounding conditions of embryo inside an IVF incubator and triggering alarms on violated levels of parameters which include temperature level, gas content and moisture content. Regular analysis and processing of images is concentrated so as to capture normal and abnormal daily activity understandings/recognition.

II. LITERATURE SURVEY

There is a requirement of a system which monitors the surrounding conditions as well as enables visual monitoring of embryo growth inside the incubator. Long ago, embryo assessment was done by removing embryos from a conventional incubator daily for quality assessment by an embryologist, under a light microscope. A time lapse system (TLS) is developed which can take images of embryos at frequent time intervals, which allows assessment without removing the embryos from the incubator. A TLS can also apply a software program that assists the embryologist in selecting the best quality embryo for replacement, potentially improving the chance of a liveborn baby. The research paper by L. Fassina et al. evaluated the dynamics and kinematics of beating cardiac syncytia and learned about the inotropic effects of electromagnetic simulation and so forth. In their contribution "Model of Murine Ventricular Cardiac Tissue for *In Vitro* Kinematic-Dynamic Studies of Electromagnetic and β-Adrenergic Stimulation," they designed an *in vitro* model of murine ventricular cardiac tissue so that they can study various related parameters like the contraction movement. Panitnat Yimyam et al (2012), proposed an approach to generate computer vision systems for specific tasks from generic components for grading of agriculture produced by machine learning using genetic programming. This approach worked on issues like surface inspection& maturity assessment of Mango, discrimination of apple variety, classification of barley and wheat, and grading of purple gluey rice. It's claimed that the neural network classifies with more accuracy than SVM and genetic programming when the input features like shape, color and texture are used.

III. PROPOSED SYSTEM

Internet of Things (IoT) and Image Processing are the two building technologies for this system. IoT describes the network of physical objects. In the similar manner, this system has a network of sensors, buzzers, LCD, ADC along with the Raspberry Pi. A sensor is a device, module, machine, or subsystem which is used to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. Here we are using temperature sensor (LM35) to detect the temperature inside the incubator, moisture sensor to detect moisture content in air around the IVF sample, and gas sensor (MQ2) to detect presence of harmful gases such as methane, or LPG. Analog to Digital converter is used for conversion of values from temperature sensor and moisture sensor. We are using Raspberry Pi as a microcontroller for our design as it is low cost, single board, a small-sized computer that supports an embedded operating system such as Raspbian. The data from sensors is received by Raspberry Pi and sent it to LCD for the purpose of display. Same values are sent to dashboard at regular intervals. Dashboard uses the values from sensors to represent in graphical form. Graphical representation makes is easier to understand and analyse the data. This is hardware part of monitoring where IoT plays a crucial role.

Now, for image processing the microscopic camera is to be implanted inside the incubator to take images of samples after definite intervals. These images are to be sent to Raspberry Pi for processing them. Various image processing techniques when applied on the embryo images, makes them more useful and enhanced for embryologists to study. These processed images are then displayed on dashboard on hourly basis. This enables the hourly monitoring of embryo development inside the incubator. Buzzer beeps when there is disturbance in required temperature and moisture levels. This circuit also signals by beep, the detection of harmful gas in the surrounding of the IVF sample. Light Emitting Diodes (LEDs) are also used to give signals for various purposes.

IV. PICTORIAL DIAGRAM

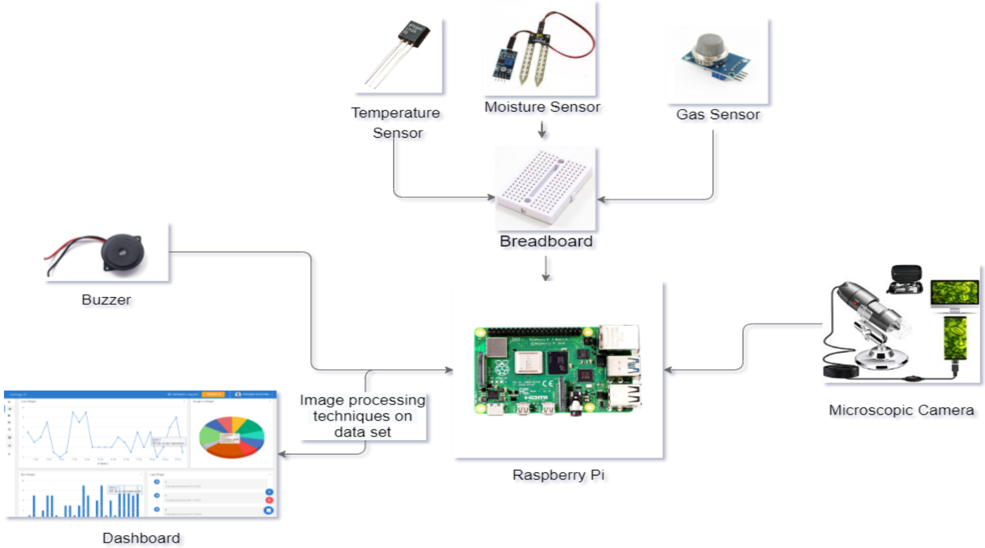

Figure1: Pictorial diagram of proposed system

V. WORKING

5.1 Circuit Simulation

The implementation of the circuit including all its components such as sensors, controller, buzzers, and converter is done using simulation software. Proteus Professional software is used for this purpose. Project is designed, simulated and debugged in Proteus software which can be programmed to real Raspberry Pi in future. The image below shows the implemented circuitry of the proposed project in the proteus software. The source code of the simulation makes it a working system. In the circuit given below,

a. Detection of harmful gases like methane or LPG inside the incubator makes the green led glow and the Buzzer 1 starts to beep.
b. Exceeding temperature levels above the threshold limit, makes the red led glow and the Buzzer 2 beeps.
c. If moisture level increases the threshold value, blue led glows. Here, Buzzer 3 starts to beep.
d. All the values are displayed on the LCD screen, while the simulation is in progress.

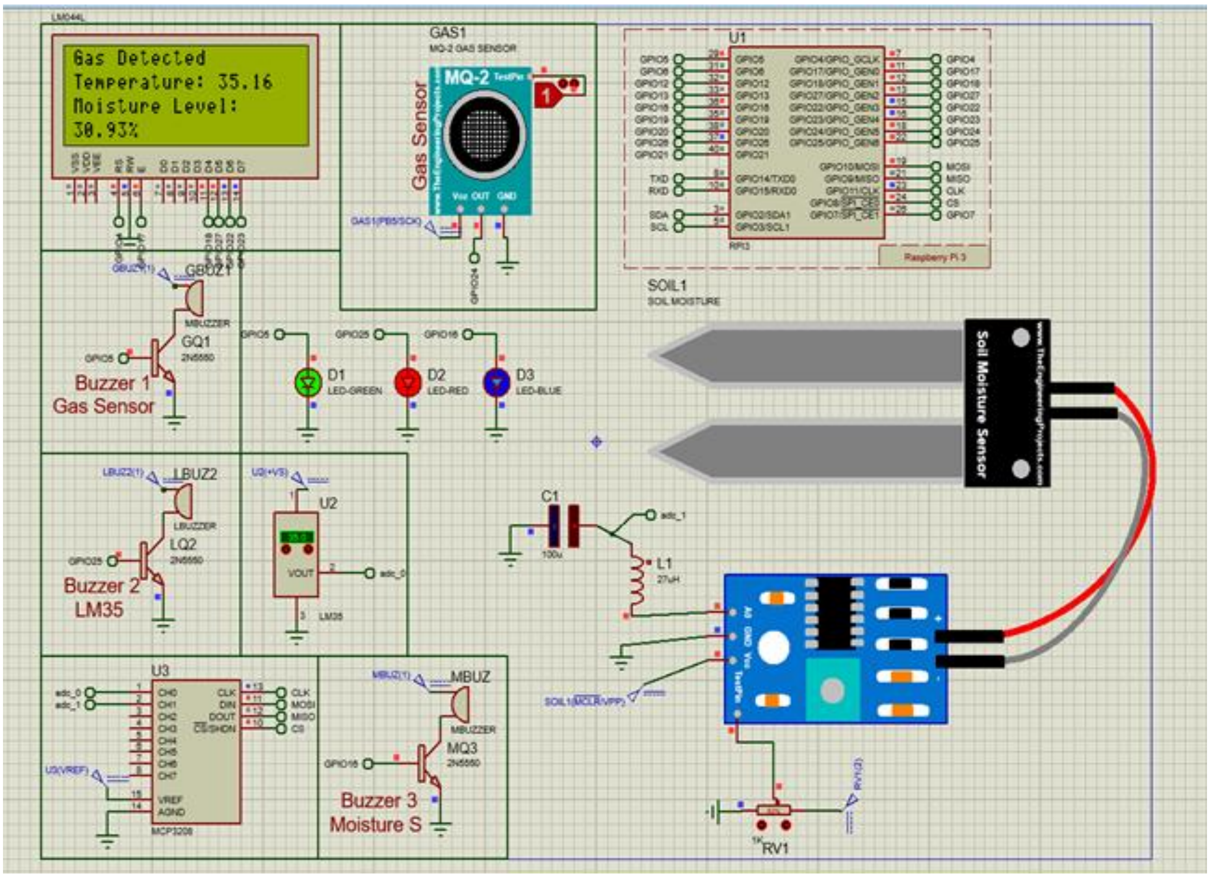

Figure2: Circuit diagram of simulation in proteus software

5.2 Image Processing Techniques

5.2.1 Edge Detection

Points at which the brightness of the image changes sharply are identified as an organized set of straight- or curved-line segments termed edges. Edges are significant highlights for investigating pictures. Edge detection is considered as the first step in recovering information from images. An edge in a picture is a significant local change in the image intensity, generally connected with a discontinuity in either the image intensity or the first derivative of the image intensity.

5.2.2 Image Denoising

The goal is to estimate the original image by suppressing noise from a noise-contaminated version of the image. Denoising of an image means the process of reconstruction of a signal from noisy images. Denoising is done to remove useless noise from image to analyze and study it in better form.

5.2.3 Global Thresholding

Image thresholding is used to give a representation of an image in a simplest form which requires less space. This representation is called segmented image and the method is image segmentation. Image thresholding works on the principle called as pixel classification. It divides an image into segments depending upon the attributes of pixels. This method applies on each pixel and by comparing it to a particular threshold value decides that the picture belongs to an object or background. Global threshold is completely dependent on the histogram of the image. Global thresholding means a single value of pixel intensity threshold is used for all pixels in the images for turning it to a binary image.

5.2.4 Adaptive Thresholding

If an image has different lighting conditions in various areas, adaptive thresholding helps. The algorithm finds out the threshold for a pixel based on a small region around it. So, we get different thresholds for different regions of the single image that provides better results for images with varying illumination.

5.3 Visualization

Data visualization gives us a clear idea of what the information means by providing it visual context through maps, graphs or charts. This makes the data more natural for the human mind to comprehend and therefore makes it easier to identify trends, patterns, and outliers within large data sets. To make this system more user friendly, the concept of a dashboard comes into picture. Here the data from sensors can be plotted in the form of graphs and charts on the dashboard to keep track of the conditions. In the similar manner, the pictures using a microscopic camera can be plotted along with the processed images on the dashboard. This will help embryologists to monitor the conditions on a screen. Data sent over the cloud to the dashboard can be made visible anytime at any place. Dashboard can be customized as shown in the figure below.

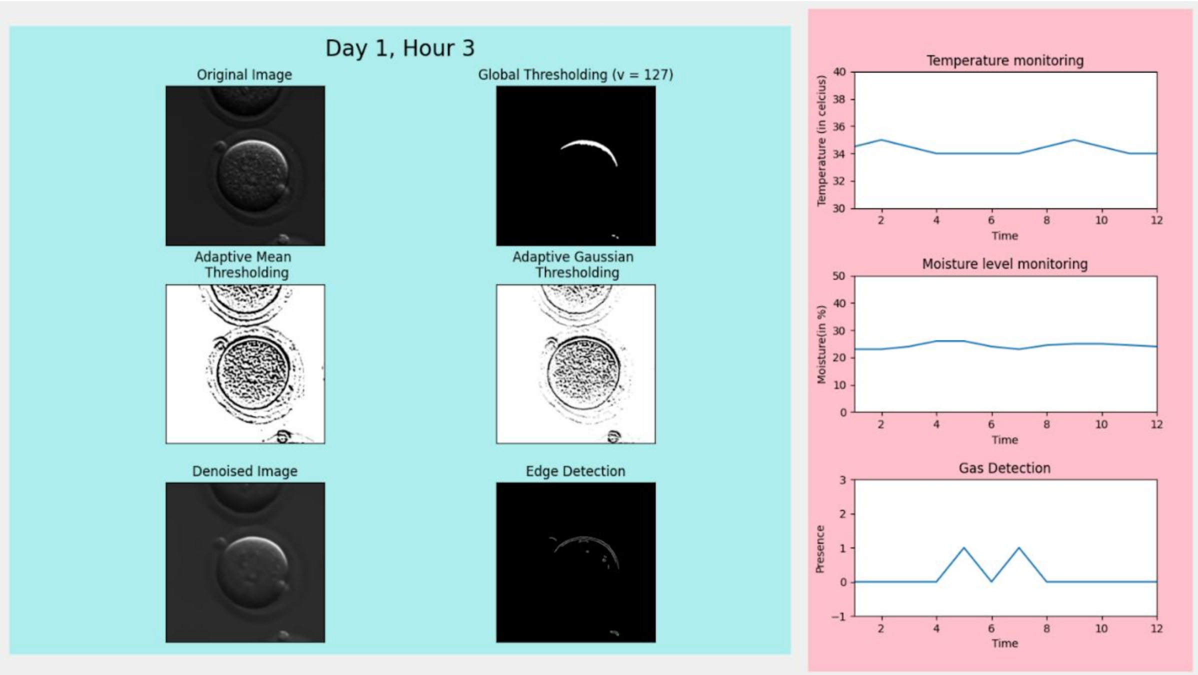

Figure3: Live dashboard

VI. CONCLUSION

To conclude, this system is a model for IVF monitoring that will provide Undisturbed stable incubation, Constant Monitoring, Graphical representation which will make the work easier to understand. Many conventional systems are available to maintain the temperature of IVF laboratories and incubators. The problem with these systems is that unless one visits the lab it is not possible to know the temperature values of the IVF laboratory as well as the operation theatre and incubator. Frequent visits to these places cause the increase in the temperature values, which may further affect the culture medium kept in the incubator. If the temperature of the operation theatre is higher than the incubator, the culture medium will not survive for more than 1 hour. But in this system, there is no need of removing embryos from a conventional incubator for daily quality assessment. With the help of IOT, they can monitor the temperature, moisture level, gas level and growth of embryos from any part of the country. This system will provide a grate help for embryologist and it can definitely improve success rates of IVF.

REFERENCES

[1]. N.M. Chaudhari & B.V. Pawar (2015) Microscope Image Processing: An Overview International Journal of Computer Applications (0975 – 8887) Volume 124 – No.12.

[2]. Alireza Norouzi, Mohd Shafry Mohd Rahim, Ayman Altameem, Tanzila Saba, Abdolvahab Ehsani Rad, Amjad Rehman, et al (2014) Medical Image Segmentation Methods, Algorithms, and Applications IETE Technical Review 31(3):199-213.

[3]. Dogan, H., Ekinci(2014) M.: Automatic panorama with auto-focusing based on image fusion for microscopic imaging systems. SIViP, Special Issue on Microscopic Image Processing. 8(S1).
[4]. Sasikumar Gurumurthy & B.K.Tripathy(2011) Study of Microscopic Image processing , National Conference "Microwave Antenna and Signal Processing" [NCMASP-2011], At India, Volume: 1
[5]. Cristian Smochina, Paul Herghelegiu and Vasile Manta (2011) Image processing techniques used in microscopic image segmentation.
[6]. Xinyu Huang, Chen Li, Minmin Shen, Kimiaki Shirahama, Johanna Nyffeler, Marcel Leist , et al(2016) Stem cell microscopic image segmentation using supervised normalized cuts, IEEE International Conference on Image Processing (ICIP)