

Design and Development of Aqua Monitoring System using Machine Vision

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Abstract : Aquaculture, generally called aqua farming, is the cultivation of organic creatures for instance, fish, prawn. Because of progress in continuous climatic conditions, checking of prawns is troublesome under the water. The farmers may not know about the state of them. since If the prawns die, the body won't float on water. Inorder to check the availability of prawns in water and also to check its lifetime of prawns a machine vision model is proposed. This paper presents the design and development of aqua monitoring system using raspberry pi. This system isdesignedto observe the status of prawns under the water. To capture the prawn images from the water we use the camera connected with Raspberry pi. Then these images are sent to the farmer through email. It is easy for the farmer to identify the growth, lifespan and size variations of the prawn.

Keywords : Aqua Monitoring System, Machine Vision, raspberry *pi*, IOT board.

1. INTRODUCTION

Aquaculture is right now evaluated to represent around 13 percent (10.2 million tons) of world fish creation. More than 10 crore people from farmers to fish processors and retailers rely on upon the aquaculture business for their employments. While comparing fish to prawns the investment and profit are very high in prawn's development with a cycle of 3.5 months. So careful precautions must be taken with in that time period. In any case, farmer doesn't have the knowledge of the prawns under water. Prawns will be affected to diseases easily with change in climatic conditions, due to insufficient feed size variations will be seen. So to solve this we are using an underwater USB camera connected with raspberry *pi*. Raspberry *pi* is an affordable computer in the size of a credit card. It has the functions almost resembles a personal computer. The other advantage of this system is it's a simple circuit. Raspbian is the Operating system used here, by using this image/video can be transmitted to the user email.

2. COMPONENTS DESCRIPTION

The functions of various components are given below :

1. **USB camera :** USB camera captures the images and videos and sends to the USB port of raspberry *pi*. According to our application, water resistant camera must be taken. 2.0 camera model is used here.
2. **Raspberry *pi* :** The raspberry *pi* is a small advanced mini-computer, which is having the size of the smart phone, that plugs in to a TV having HDMI port, and uses a standard keyboard and mouse.

The various functional components of raspberry *pi* are:

- **SD card slot :** It is used to install the operating system that supports for raspberry *pi*, here we are using raspbian. Different type of OS's that support for raspberry *pi* are arch Linux, open ELEC, pidora, rasp BMC, raspbian, risc OS, open ELEC & XBMC, retro pie, Firefox OS, plan9.

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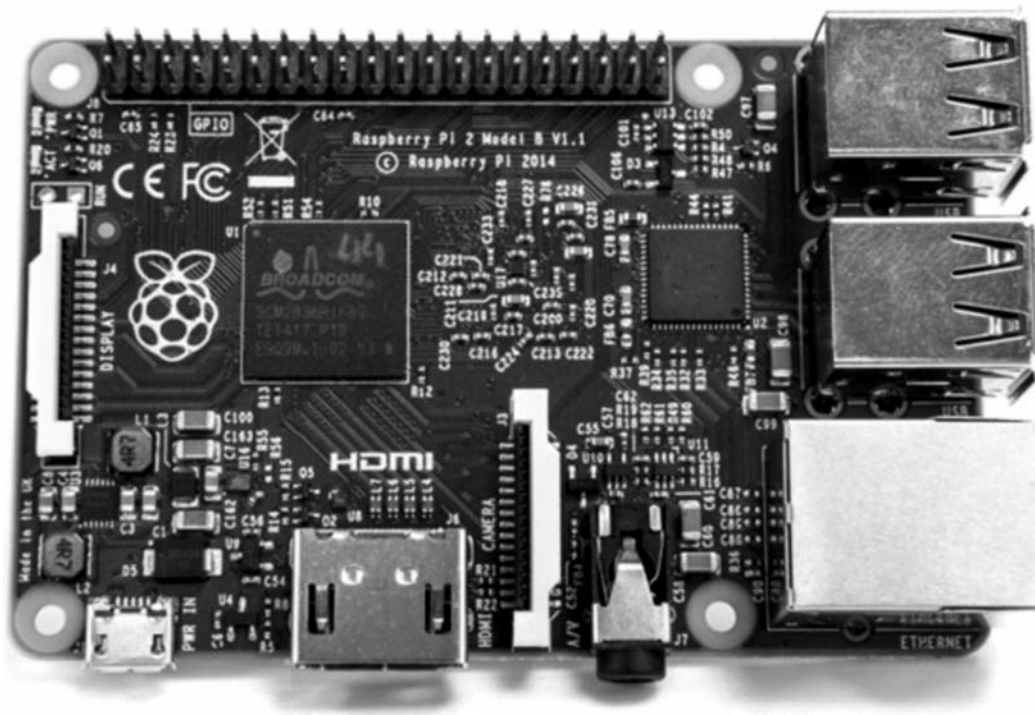


Figure 1: Raspberry pi v2

- **Camera module** : The Raspberry Pi camera module is fit for taking full HD 1080p photo and video which can be controlled programmatically.
 - **GPIO** : Used to interact with real world.
 - **Micro USB power port** : + 5.1v.
 - **HDMI out** : Can plug directly to a monitor or TV.
 - **Broadcom BCM 2837 64-bit** : This is a system on chip with 1.2GHz processor and 1GB ram.
 - **Ethernet** : Used to connect raspberry pi to internet and used for updating software.
3. **GSM/GPRS Module (SIM 900A)** : A GSM/GPRS module connect a GSM/GPRS modem with RS-232, USB as a standard communication interfaces. so that it can be easily interfaced with another PC or a μ processor/ μ controller based system, there is a built-in power supply circuit which can be activated by using a suitable adaptor.
 4. **IOT Board** : This is an environment which provides unique identification for people and objects. Its capable of data transfer over a network without human-to-human or human-to-machine interface. Data can be updated to a specific site or to mobile where user can be able to access
 5. **Motion detector (PIR SENSOR HC-Sr501)** : Detects the motion of a moving objects. A motion detector automatically performs a task and alerts a user of motion in an area.
 6. **Buzzer** : It is an electronic device which makes noise when motion detector is activated or detects any motion.
 7. **MAX 232 shield** : These comes under the family of USB to TTL serial UART converters. It is TTL compatible digital logic circuit.

3. HARDWARE ARCHITECTURE

In the figure 2, USB camera was connected to raspberry pi through USB port, Raspbian OS was installed in SD card of raspberry pi. Here we use a minimum of 4GB SD card with class 10. But we recommend 16GB memory capacity so that, there is a provision for storing videos and images that were captured by USB camera.

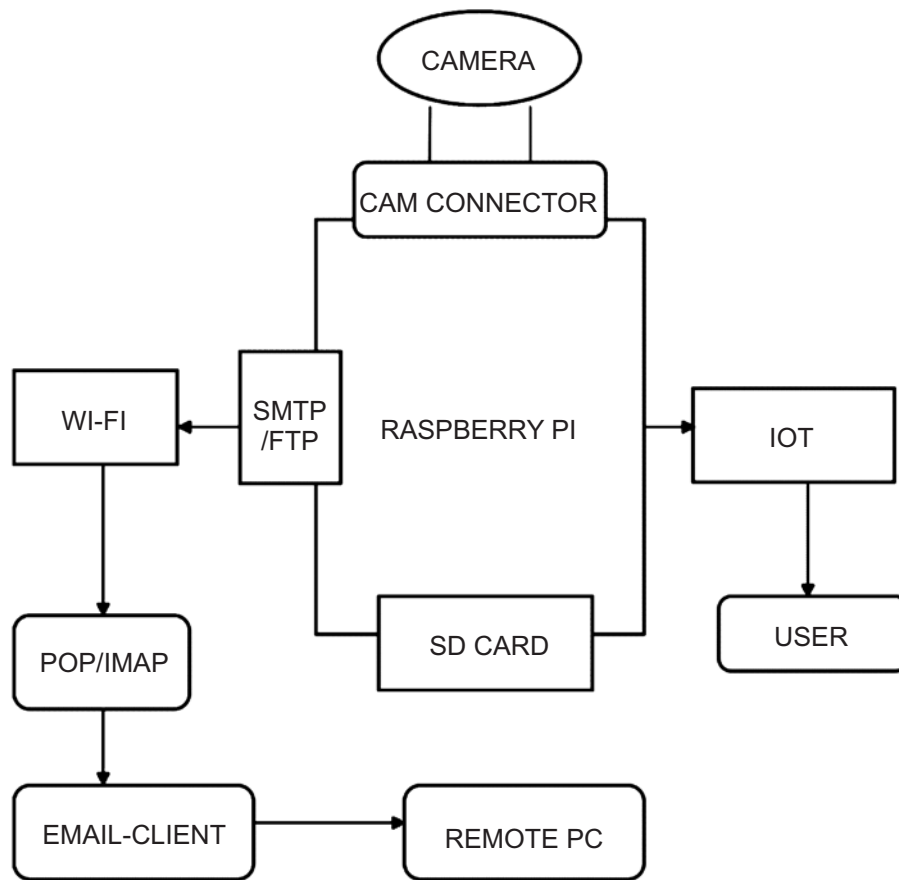


Figure 2: System design

Raspbian is a free operating system which can be used for raspberry *pi* hardware, and it is a set of basic programs and utility with over 35000 packages, together in a nice format for easy installation. Better likeness with the latest enlightening activities and programming, BCM 2836 System on Chip (SoC) keeps running at 900 MHz makes the use of raspberry *pi* here.

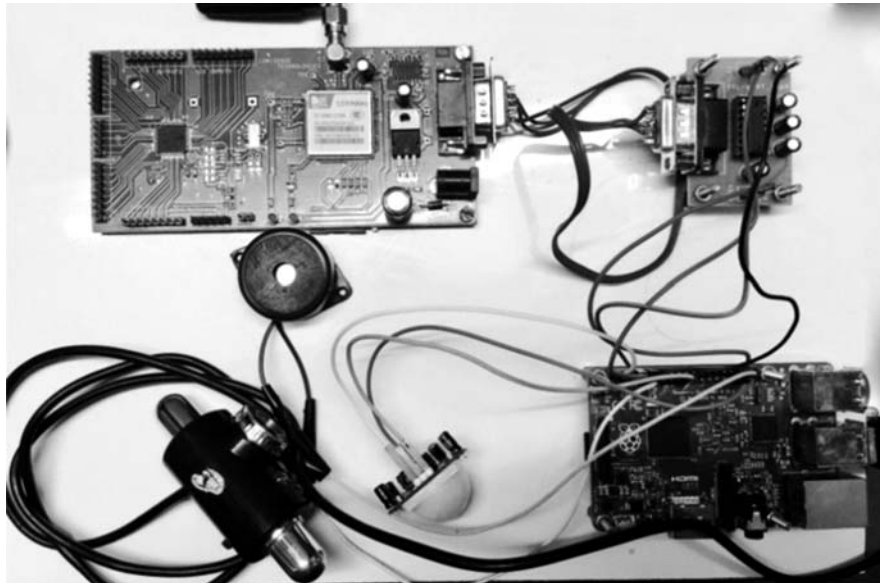


Figure 3: Connection of USB camera and GSM module to raspberry *pi*

Raspberry *pi* is associated with the WI-FI router, USB submerged camera is utilized for catching pictures and recordings. Simple mail Transferprotocol is utilized to send the caught pictures and recordings to the *e-mail*.

Build in library functions for utilizing SMTP

Import smtplib

Built in library functions for utilizing E-mail

From email.MIMEMultipart Import MIMEMultipart

From email.MIMEtext import MIME text

From email.MIMEbase import MIME base

From email import encoders

With the help of these built in functions we can send images and videos to user *e-mail* from raspberry *pi*

The IOT Board consists of a GSM/GPRS modem connected together with power supply circuit and interfaces like RS 232, USB for communication.

For enabling serial communication

```
Port = serial.serial("/dev/ttyAMA0",
baudrate = 9600, timeout = 3.0)
```

By using this above function, we can enable serial communication and can send SMS to user directly. SMTP (simple mail transfer protocol) is an internet standard for electronic mail transfer and FTP (file transfer) is a built on client-server model architecture used to transfer the files in computer between a client and server on a computer network. POP (post office protocol) is used to download emails from the server for permanent local storage and IMAP (internet message access Protocol) is used to leaves them on the server and stores temporarily. Email client is a computer program that enables configuring one or more email address to receive, read, compose and send emails from email address through the desktop interface. Client is nothing but a role.

4. INSTALLATION OF RASPBIAN OS IN RASPBERRY PI

To install raspbian, you need to write the operating system image file on to the SD card. Un-compression of the Zip file must be done after downloading from raspberrypi.org. After un-zipping is done now it's time to write the image on SD card

Mac

1. Open terminal by using command + space.
2. Change your directory to the location of extracted image, if image is on desktop the type **cd/ desktop** and press enter
3. Identification of the disk using **diskutil list** and look for the name of your SD card, generally it will look like Disk2 or Disk3 with memory.
4. Now you have to select the right Disk and type **diskutil unmountdisk /dev/ [disk name]**.
5. Finally, writing the image to the disk using the command **sudo dd bs=1m if=[image].img of=/dev/r[disk name]**. you will need to enter admin password and press enter.

Windows

The process for windows is a bit straight forward. You will be needed to download Win32disk imager

1. After Win32disk imager is installed, open it as administrator by selecting **Run as administrator**.
2. Select the image file that you extracted.
3. Select the device by choosing the drive letter. Make sure twice you selected the right device.
4. Click write.

This process will take several minutes, but after completing eject the device and insert it in to raspberry *pi* and boot it up.

Updating of system packages and Upgradation of installed packages must be done using following command lines:

1. Sudo apt-get update
2. Sudo apt-get dist-upgrade

5. USING MOBILE PHONE AS RASPBERRY PI SCREEN

Raspberry *pi* is small device that is very convenient for travelling. Also we can easily carry charger for it. But carrying screen is a difficult task. It'll be super beneficial if can use our smart phone as raspberry *pi* display. Taking this as advantage we can stream live videos and images right in our smart phone. This arrangement is possible if both the our mobile and *pi* are connected to same network

1. Checking the raspberry *pi* IP address
2. Setting up SSH (secure socket shell) client: It is a protocol for accessing our raspberry *pi*. SSH client must be installed in smart phone using play store. Creation of new host must be done by entering the following parameters like Alias, hostname, username, password.
3. Installation and setup of VNC server must be done on raspberry *pi*. Use the following commands
 - (a) Sudo apt-get install tightvncserver
 - (b) Run Tightvncserver
You will be asked to enter password
4. A script file must be created to start the VNC server.
Use the following script in NANO editor
 - (a) `#!/bin/sh`
 - (b) `vncserver :1 -geometry 1920x1080 -depth 24 -dpi 96`
Use CTRL+O to save the file, extension should be “.sh”. Now for executing the file use the following command
 - (a) `sudo chmod +x <saved file name>.sh` with this file name we can start VNC server for our mobile device by sending a command via SSH `./vnc.sh`
5. Now installation of VNC viewer on Mobile device. Many VNC viewer are available in play store for android platform. Download and install VNC viewer app and set it up by giving raspberry *pi* IP address followed by 1. 1 indicates display no.1. then you will be prompted to enter VNC server password that we have created.

6. PYTHON PROGRAMMING

Python is an open source programming language made to look good and easy to read. It is an interpreted language *i.e.*, no need to compile to run and can run on any kind of computer it can run itself. This means if there is any change in the code result can be quickly seen. Python program contains syntax functions and several import functions with more than 35000 inbuilt packages, nicely molded for user freedom. Here we are writing a python programming for capturing an image using USB camera and sending to user email by using Wi-Fi, which is inbuilt in raspberry *pi*.

7. ALGORITHM

Here we are using motion detection algorithm, which works on frame differences basics which means it will compare change in pixel location in each frame.

Threshold is an important parameter to be taken in to consideration. There will be always environment movement under water and if the threshold is too sensitive, smallest change in the environment will be detected and continuous recording of videos will be taken place. So threshold must be a bit high so that only movement of lives will be detected not the environment. The Motion detector will be having convex

lens at one end which spreads the radiation emitting from the light emitting diode. The emitted radiation will be reflected back by a moving object and the reflected radiation will pass through infrared filter screens to neglect the unwanted radiation. This filtered radiation will be converted to electrical pulses with the help of photo electric transducer. The output will be correlated to the motion of the object under water.

Algorithm process

1. Comparing the current frame with the previous frame.
2. Finding the regions where there is difference in these two frames. For that difference and threshold filters are used
3. Every camera produce noise and detect motion where there is no motion at all which can be removed by erosion filter.
4. Threshold > prerequisite, start video recording. or else don't record.

8. RESULT AND DISCUSSION

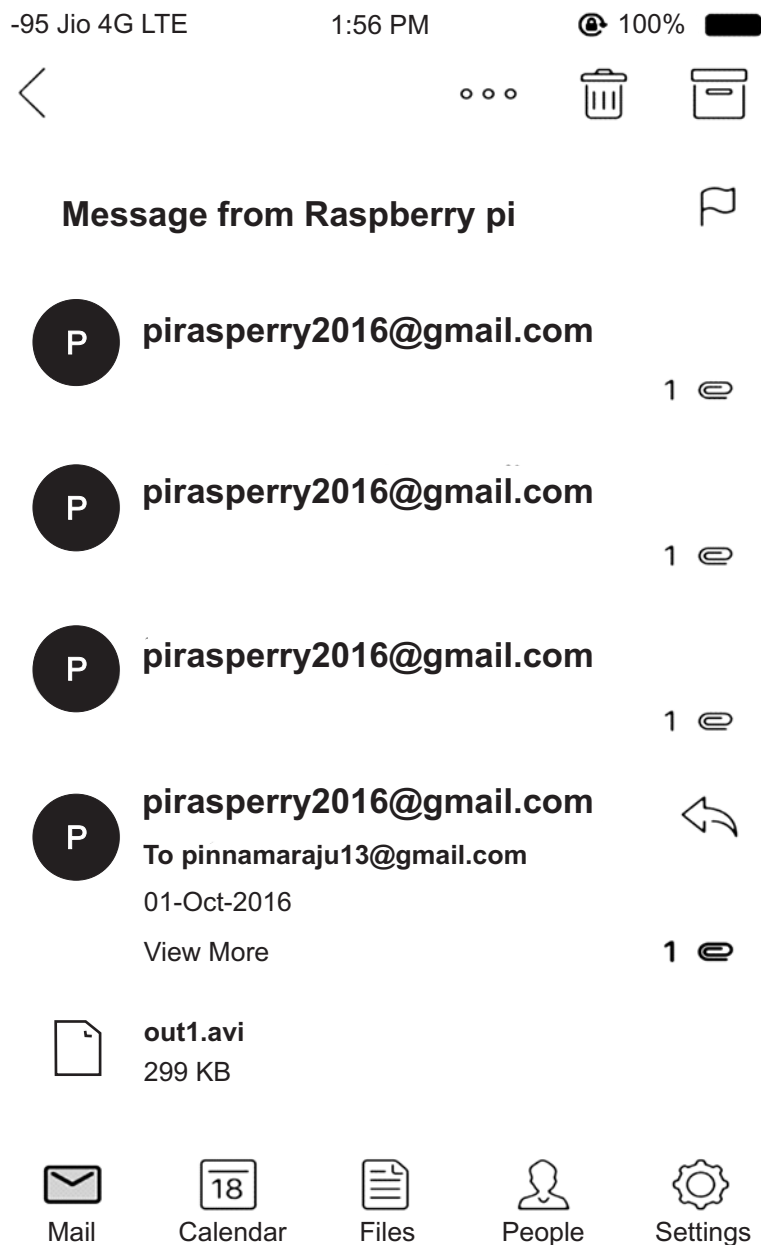


Figure 4: E-mail of the video got to the user from raspberry pi in. avi format

Information about data logs will be sent to user mobile through SMS. It contains the information about the time, images/videos are captured. *fig 4 & fig 5,6* shows the email (video/image) is sent to user with frequent interval of time. Time interval can be changed as per user requirement in python coding. From the video/image obtained, user will get the knowledge of prawns about their growth, size variations, diseases. User will be getting mails directly to his smart phone which he can directly watch and get the exact status under water. Whenever the user needs he can turn his mobile into raspberry pi display, just by opening VNC viewer app and selecting raspberry pi's IP address. User can view the images and videos directly from file manager of raspberry pi, at the same time videos/images will be sent to user email.

From *fig 5* user will get the knowledge about the disease that are effected, *fig 6* gives the information about the size variations.



Figure 5: E-mail of an image got to the user from raspberry pi in. jpg format

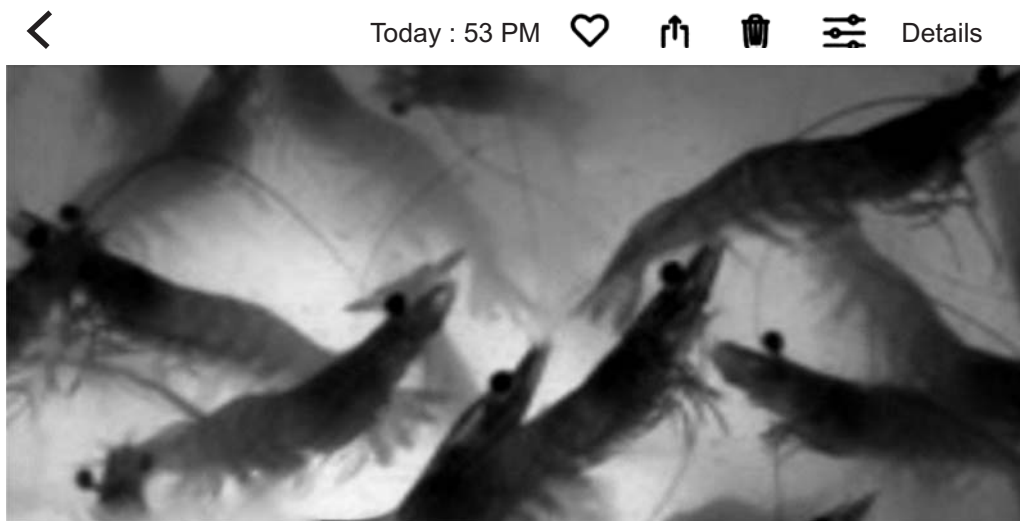


Figure 6: E-mail of an image got to the user mobile from raspberry pi in. jpg format

9. CONCLUSION AND FUTURE WORK

Thus we have designed a system that can record/capture of the video/image and will be sent to the user E-mail. Information about the time and date when an image/video is caught will be sent to user mobile through SMS. This system offers privacy and reliability on both sides. Authentication can be done so that concerned person will be viewing the details. As the crop cycle of prawns is small, necessary precautions

can be taken by the user by viewing the images and videos obtained from the raspberry pi underwater camera, which helps him to yield high profits. Future work is located with mounting the whole setup upon an Arduino based rover that can move in water so that accurate information of the lives in the complete pond will be obtained on the receiver side.

10. REFERENCES

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