ROBOT PATH PLANNING IN CLASSROOM MONITORING

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***Abstract*—** It presents about the robot which is controlled over the internet through the Web Browser, where the monitoring and controlling is done by the robot for detecting and recognizing the face of staffs for comparing it with the data which is available in the integrated database and yields the result for a while who wants to access the stored data of staffs handling classes.

***Keywords*—** *Raspberry Pi Micro Controller, Pi Camera, DC Motor, Motor Driver, SVM Algorithm, HOG Algorithm, Face Recognition*

INTRODUCTION

A monitoring and surveillance system is usually designed and built based on the characteristics of the area to be monitored. For example, areas that are too dangerous for humans to operate in require a dynamic monitoring system to act in place of a safety officer. This includes areas in which flammable liquids or gases present in excessive quantities can easily lead to an explosion or fire. In dangerous places such as these, installation of equipment and special techniques should also be designed to avoid potential explosions and fire. Another example scenario requiring dynamic and mobile monitoring system is an area too small to be accessed by humans. To monitor such areas, a monitoring system must be small enough to fit in the area and have the ability to move through small spaces.

There are many methods available for path planning in the field of robotics, but planning must be done in such a way that it must be collision free and shortest path

EXISTING SYSTEM

In this paper[6], An application for tracking and detecting faces in videos and in cameras which can be used for multipurpose activities. The intention of the paper is deep study of face detection using open CV. A tabular comparison is performed in order to understand the algorithms in an easier manner. It talks about various algorithms like Adaboost, Haar cascades, Cam Shift Algorithm, Finding via motion. But there is a difference among the algorithms regarding over the efficiency to perform and is expensive to buy them and quite not realiable. So, We are improving these problems in our project.
According to this paper[7], Human face detection has been playing an important part in human-machine interaction and computer vision based applications. As a human identity information, human face has the advantages of uniqueness and non-replicability. This human face are based on skin hue histogram matching i,e. images of people are processed by a primitive Haar cascade classifier, nearly without wrong human face rejection (very low rate of false negative) but with some wrong acceptance (false positive). its more efficient because of its easiness and simplicity of implementation. So thus, more research work should continually focus on human face detection for people of different races, instead of faces of single race as in our work. Computation time should also be further saved for real world applications.
From paper [8], A robot is usually an electro-mechanical machine that is guided by computer and electronic programming. We use Bluetooth communication to interface Arduino UNO and android. Arduino can be interfaced to the Bluetooth module though UART protocol. According to commands received from android the robot motion can be controlled. The consistent output of a robotic system along with quality and repeatability are unmatched. But unfortunately the technology is not fully utilized due to a huge amount of data and communication overheads through Bluetooth.

Referring the paper [9], the speed control of Permanent Magnet DC (PMDC) motor is done using Lab VIEW interfaced with Arduino. The main advantage of using Lab VIEW with Arduino is the cost and simple in structure. The other speed control methods like FPGA method, fuzzy control, using 555 timer and PID controllers are having the drawback of complicated design involved, unreliable control, difficult in the online monitoring with high speed motors

DESIGN AND IMPLEMENTATION

A. Raspberry pi

The Raspberry Pi is a small debit card sized single-board computer with an open-source platform that has a thriving community. It is similar to the Adriano The Raspberry pi is a single computer board with credit card size, that can be used for many tasks that your computer does, like development, word processing, spreadsheets and also to play HD video. The main purpose of designing the raspberry pi board is, to encourage learning, experimentation and innovation for students. The raspberry pi board is a portable and low cost. Maximum of the raspberry pi computers is used in mobile phones. In the 21st century, the growth of mobile computing technologies is very high, a huge segment of this being

driven by the mobile industries. The 98% of the mobile phones were using ARM technology.

The raspberry pi comes in two models, they are model A and model B. The main difference between model A and model B is USB port. Model A board will consume less power and that does not include an Ethernet port. But, the model B board includes an Ethernet port and designed in china. The raspberry pi comes with a set of open source technologies, i.e. communication and multimedia web technologies. In the year 2014, the foundation of the raspberry pi board launched the computer module, that packages a model B raspberry pi board into module for use as a part of embedded systems, to encourage their use.

The raspberry pi board comprises a program memory (RAM), processor and graphics chip, CPU, GPU, Ethernet port, GPIO pins,power source connector. And various interfaces for other external devices. It also requires mass storage, for that we use an SD flash memory card. So that raspberry pi board will boot from this SD card similarly as a PC boots up into windows from its hard disk.

Essential hardware specifications of raspberry pi board mainly include SD card containing Linux OS, keyboard, monitor, power supply and video cable. Optional hardware specifications include USB mouse, powered USB hub, case, internet connection.

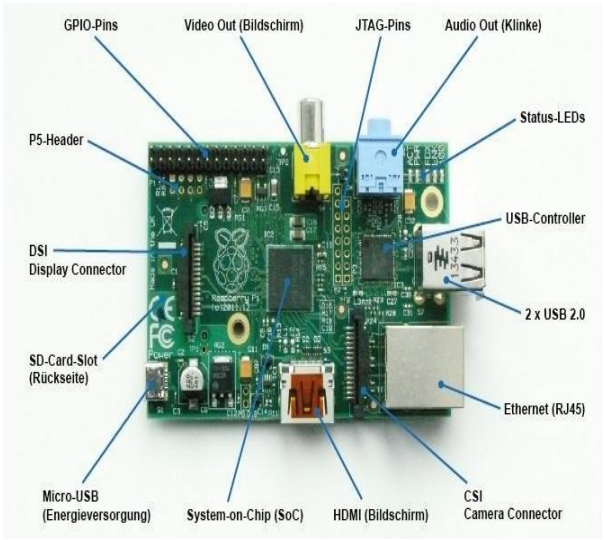

Fig. 1 Raspberry pi board diagram

The raspberry pi model Aboard is designed with 256MB of SDRAM and model B is designed with 51MB.Raspberry pi is a small size PC compare with other PCs. The normal PCs RAM memory is available in gigabytes. But in raspberry pi board, the RAM memory is available more than 256MB or 512MB. pi board and that is responsible for carrying out the instructions of the computer through logical and mathematical operations. The raspberry pi uses ARM11 series processor, which has joined the ranks of the Samsung galaxy phone. The GPU is a specialized chip in the raspberry pi board and that is designed to speed up the operation of image calculations. . This board designed with a Broadcom video core IV and it supports OpenGL. The Ethernet port of the raspberry pi is the main gateway for communicating with additional devices. The raspberry pi Ethernet port is used to plug your home router to access the internet. The general-purpose input & output pins are used in the raspberry pi to associate with the other electronic boards. These pins can accept input & output commands based on programming raspberry pi. The raspberry pi affords digital GPIO pins. These pins are used to connect other electronic components. For example, you can connect it to the temperature sensor to transmit digital data.

The power source cable is a small switch, which is placed on side of the shield. The main purpose of the power source connector is to enable an external power source. The connection options of the raspberry pi board are two types such as HDMI and Composite. Many LCD and HD TV monitors can be attached using an HDMI male cable and with a low-cost adaptor. The versions of HDMI are 1.3 and 1.4 are supported and 1.4 version cable is recommended. The O/Ps of the Raspberry Pi audio and video through HMDI, but does not support HDMI I/p. Older TVs can be connected using composite video. When using a composite video connection, audio is available from the 3.5mm jack socket and can be sent to your TV. To send audio to your TV, you need a cable which adjusts from 3.5mm to double RCA connectors.

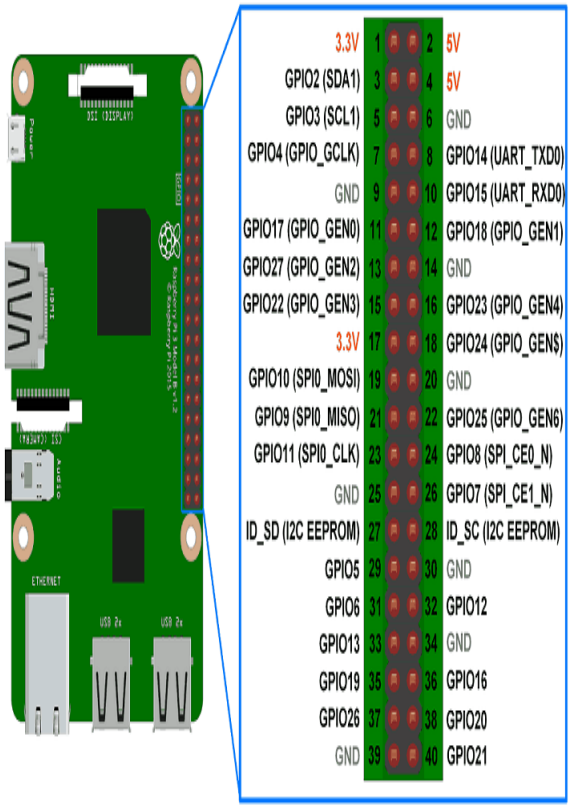

Fig.2 Pin diagram of Raspberry Pi board

B. Pi Camera

The Raspberry Pi Camera Board plugs directly into the CSI (Camera Serial Interface) connector on the Raspberry Pi as shown in Fig.3. It's able to deliver a crystal clear 5MP resolution image, or 1080p HD video recording at 30fps.

The CSI bus is capable of extremely high data rates, and it exclusively carries pixel data to the BCM2835 processor. The board itself is tiny, at around 25mm x 20mm x 9mm, and weighs just over 3g, making it perfect for mobile or other applications where size and weight are important. The sensor itself has a native resolution of 5 megapixel, and has a fixed focus lens onboard. In terms of still images, the camera is capable of 2592 x 1944-pixel static images, and also supports 1080p @ 30fps, 720p @ 60fps and 640x480p 60/90 video

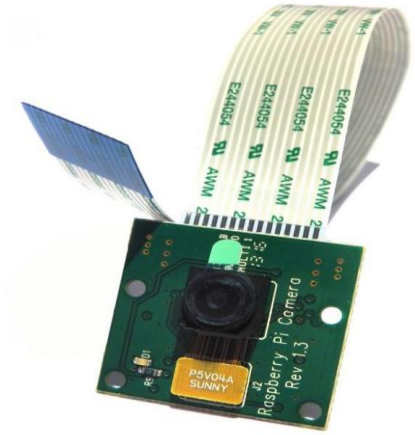

Fig.3 Raspberry Pi Camera

B. Ultrasonic Sensor

The HC-SR04 ultrasonic sensor as shown in Fig.4 uses SONAR to determine the distance of an object just like the bats do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package from 2 cm to 400 cm or 1" to 13 feet.

The operation is not affected by sunlight or black material, although acoustically, soft materials like cloth can be difficult to detect. It comes complete with ultrasonic transmitter and receiver module. It has the technical specifications as

Power Supply	+5V DC
Quiescent Current	<2mA
Working Current	15mA
Effectual Angle	<15°
Ranging Distance	2cm – 400 cm/1″ – 13ft
Resolution	0.3 cm
Measuring Angle	30 degree

Fig.4 Ultrasonic Sensor

D. DC motor

200RPM 12V DC geared motors of 125gm weight for robotics applications. Very easy to use and available in standard size. Nut and threads on 6mm shaft with internal diameters to easily connect and internal threaded shaft for easily connecting it to wheel.

Fig.5 DC motor diagram

E. Motor Driver

The Motor Driver is a module for motors that allows to control the working speed and direction of two motors simultaneously. This Motor Driver is designed and developed based on L293D IC.

L293D is a 16 Pin Motor Driver IC. This is designed to provide bidirectional drive currents at voltages from 5V to 36V.

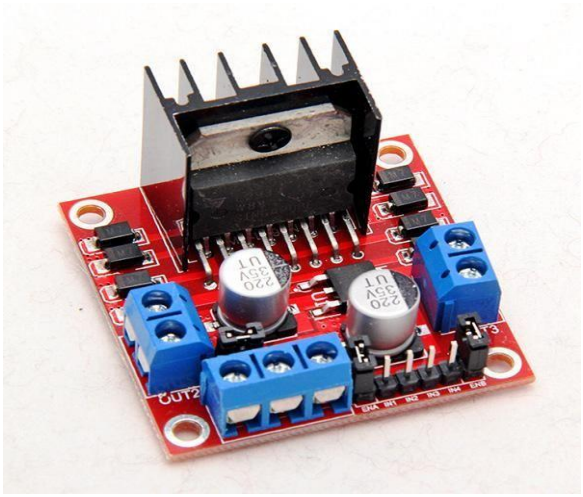

Fig.6 Motor Driver

F. SVM Algorithm

"Support Vector Machine" (SVM) is a supervised machine learning algorithm which can be used for both classification or regression challenges. However, it is mostly used in classification problems. In this algorithm, we plot each data item as a point in n-dimensional space (where n is number of features you have) with the value of each feature being the value of a particular coordinate.
Support Vectors are simply the co-ordinates of individual observation. Support Vector Machine is a frontier which best segregates the two classes (hyper-plane/ line).

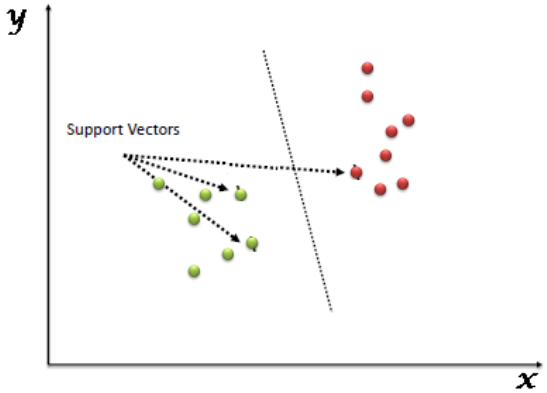

Fig.7 Support Vector Machine

Identify the right hyper-plane (Scenario-1):

Here, we have three hyper-planes (A, B and C). Now, identify the right hyper-plane to classify star /circle

You need to remember a thumb rule to identify the right hyper-plane: "Select the hyper-plane which segregates the two classes better". In this scenario, hyper-plane "B" has excellently performed this job.

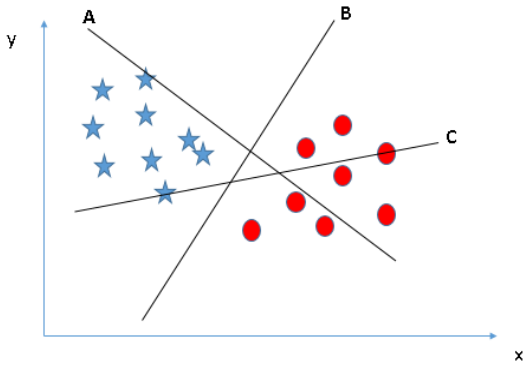

Fig.8 Scenario-1

- **Identify the right hyper-plane (Scenario-2):**

Here, we have three hyper-planes (A, B and C) and all are segregating the classes well. Now, How can we identify the right hyper-plane?

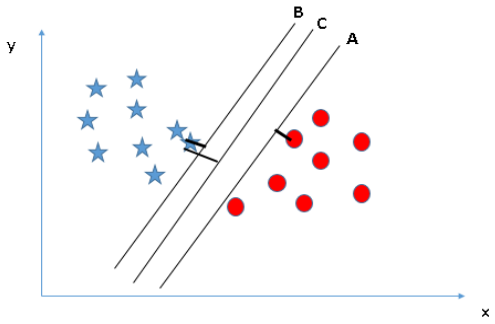

Fig.9 Scenario-2

Here, maximizing the distances between nearest data point (either class) and hyper-plane will help us to decide the right hyper-plane. This distance is called as **Margin**.

Above, you can see that the margin for hyper-plane C is high as compared to both A and B. Hence, we name the right hyper-plane as C. Another lightning reason for selecting the hyper-plane with higher margin is robustness. If we select a hyper-plane having low margin then there is high chance of miss-classification.

- **Identify the right hyper-plane (Scenario-3):**

  Hint: Use the rules as discussed in previous section to identify the right hyper-plane

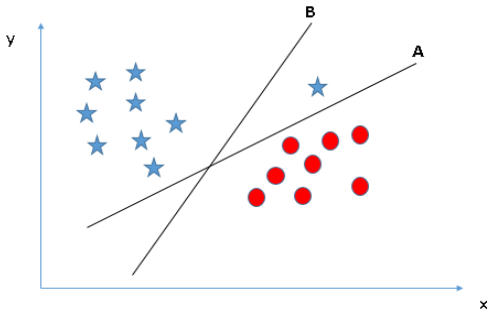

Fig.10 Scenario-3

Some of you may have selected the hyper-plane **B** as it has higher margin compared to **A.** But, here is the catch, SVM selects the hyper-plane which classifies the classes accurately prior to maximizing margin. Here, hyper-plane B has a classification error and A has classified all correctly. Therefore, the right hyper-plane is **A.**

- **Can we classify two classes (Scenario-4)?:**

  Below, We are unable to segregate the two classes using a straight line, as one of star lies in the territory of other(circle) class as an outlier.

  As we have already mentioned, one star at other end is like an outlier for star class. SVM has a feature to ignore outliers and find the hyper-plane that has maximum margin. Hence, we can say, SVM is robust to outliers.

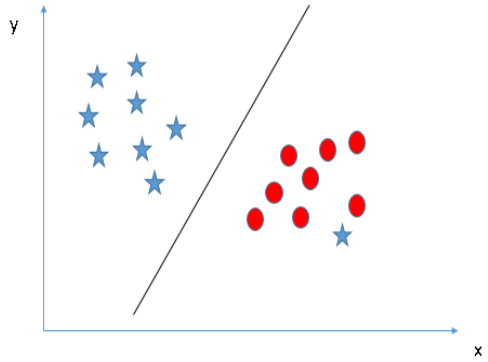

Fig.11 Scenario-4

- **Find the hyper-plane to segregate to classes (Scenario-5):**

  SVM can solve this problem. Easily! It solves this problem by introducing additional feature. Here, we will add a new feature z=x^2+y^2.

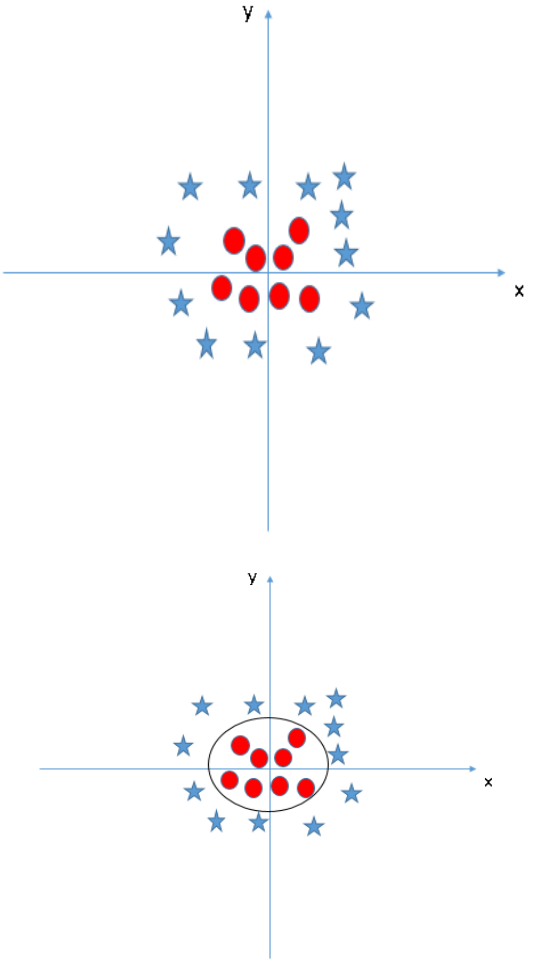

Fig.12 Scenario-5

In above plot, points to consider are:

- All values for z would be positive always because z is the squared sum of both x and y
- In the original plot, red circles appear close to the origin of x and y axes, leading to lower value of z and star relatively away from the origin result to higher value of z.

In SVM, it is easy to have a linear hyper-plane between these two classes. But, another burning question which arises is, should we need to add this feature manually to have a hyper-plane. No, SVM has a technique called the **kernel trick**. These are functions which takes low dimensional input space and transform it to a higher dimensional space i.e. it converts not separable problem to

separable problem, these functions are called kernels. It is mostly useful in non-linear separation problem. Simply put, it does some extremely complex data transformations, then find out the process to separate the data based on the labels or outputs you've defined.

F. HOG Algorithm

A HOG is a feature descriptor generally used for object detection. HOGs are widely known for their use in pedestrian detection. A HOG relies on the property of objects within an image to possess the distribution of intensity gradients or edge directions. Gradients are calculated within an image per block. A block is considered as a pixel grid in which gradients are constituted from the magnitude and direction of change in the intensities of the pixel within the block.

In the current example, all the face sample images of a person are fed to the feature descriptor extraction algorithm; i.e., a HOG. The descriptors are gradient vectors generated per pixel of the image. The gradient for each pixel consists of magnitude and direction, calculated using the following formulae:

$$g = \sqrt{g_x^2 + g_y^2}$$
$$\theta = \arctan \frac{g_y}{g_x}$$

In the current example, Gx and Gy are respectively the horizontal and vertical components of the change in the pixel intensity. A window size of 128 x 144 is used for face images since it matches the general aspect ratio of human faces. The descriptors are calculated over blocks of pixels with 8 x 8 dimensions. These descriptor values for each pixel over 8 x 8 block are quantized into 9 bins, where each bin represents a directional angle of gradient and value in that bin, which is the summation of the magnitudes of all pixels with the same angle. Further, the histogram is then normalized over a 16 x 16 block size, which means four blocks of 8 x 8 are normalized together to minimize light conditions. This mechanism mitigates the accuracy drop due to a change in light. The SVM model is trained using a number of HOG vectors for multiple faces.

G. Face Recognition

The recognition of a face in a video sequence is split into three primary tasks: Face Detection, Face Prediction, and Face Tracking. The tasks performed in the Face Capture program are performed during face recognition as well. To recognize the face obtained, a vector of HOG features of the face is extracted. This vector is then used in the SVM model to determine a matching score for the input vector with each of the labels. The SVM returns the label with the maximum score, which represents the confidence to the closest match within the trained face data.

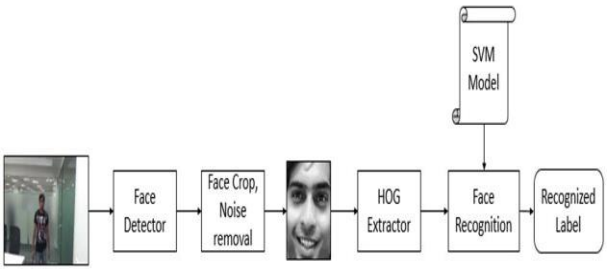

Fig.13 Block diagram of the face recognition process

The task of calculating matching scores is exceptionally heavy to compute. Hence, once detected and identified, the labeled face in an image needs to be tracked to reduce the computation in future frames until the face eventually disappears from the video. Of all the available trackers, the Camshift tracking algorithm is used since it produces the best results with faces.

PROPOSED METHOD

The Obstacle must be detected and notified to the super user where with the help of the ultrasonic sensor, whose light is emitted on the surface of the obstacle to the robot, accurate distance is measured due to which the user could get to know in prior about any obstacles which may be caused in future and can take decision what should be done next. Image is recognized by the camera installed on the robot which is once activated, gets into the control of the super user where he moves the robot through the wheels attached to it by Path planning and moves to the respective classes on observing the image and comparing it with the data available on integrated database yielding result which could be accessed for a week in the form of report.

According to [1], it is explained by the author as The monitoring and controlling of the mobile robot via internet using Raspberry pi board through the use of creating the webpage is done successfully. It needs only the Internet connection which can be obtained by wireless communication network. There is no interrupt can be occurred during the commands to the robot from the user and the response from the robot to user.The robot can be easily controlled through using the personal computer or a smart phone. By use of the internet there will be a small time delay occurs which depends on the type, speed and distance of the network. But we are using from this, the system else than the smart phone for storage purpose, as system consists storage about terabytes(TB) whereas the smartphone till now has the storage of about Gigabytes(GB).

From [2], This paper proposes a small sized robot equipped with a camera, as an efficient device for locating the survivors hidden inside the debris. Such a robot when manually controlled by any human either through a computer or a mobile phone, can easily tell the exact location of any human body by streaming video over to a server. We are adopting the

feature of having Wi-Fi over Bluetooth as, Wi-Fi could give high performance of range in communication

According to [3], Real time Face detection is a computer technology that determines the locations and sizes of human faces in arbitrary (digital) images. It detects facial features and ignores anything else, such as buildings, trees and bodies. Human face perception is currently an active research area in the computer vision community. Human face localization and detection is often the first step in applications such as video surveillance, human computer interface, face recognition and image database management. Locating and tracking human faces is a prerequisite for face recognition and/or facial expressions analysis, although it is often assumed that a normalized face image is available..From this we are taking the concept of fast feature evaluation of the images, and this proves to be an effective means to speed up the classification task of the system.

In the paper [4], it has been discussed about the design is integrated with infrared sensors,bluetooth module,wifi module control with dc gear motors which controls the speed of the vehicle of the robotic vehicle and avoid collision with any obstacle detected in the path of the robot. From this paper we are inheriting the properties of getting the distance from the obstacle to the robot and gets it notified to user who is controlling the robot.

In the paper [5], Support Vector Machine proved to be capable to increase the accuracy of face recognition by 4.4% - 20.8% by using polynomial and Radial Basis Function (RBF) kernel. Voting techniques between Principle Component Analysis (PCA) and max win strategy Support Vector Machine (SVM) result successfully predicted m nearest class and optimized the number of testing for bottom-up binary tree. So, Therefore it will be used in our project further.

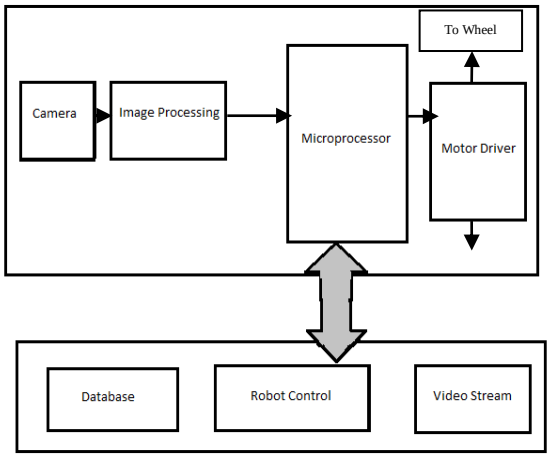

Fig.14 Block Diagram of the Proposed System

CONCLUSION AND FUTURE WORK

This paper presents the development work of remote monitoring prototype system using a Wi-Fi controlled Robot driven by an Raspberry Pi. The different hardware components and their assembly were described and a few studies were conducted to explore ways on how the components can be integrated to communicate with a web interface. The camera acts as the viewer, either to provide surveillance view or to guide the user while remotely navigating the car. The web interface enables live streaming video, while the user is provided with the navigation controller panel to allow control of the Robot movement. With a fully functional prototype, this project may be used for monitoring purposes in a building, in a hazardous area and other such locations. Several improvements can be made to enhance the capability of the project. For example, the camera maybe upgraded to a higher-quality camera to boost the quality of live streaming and reporting of those live streaming is done in the database. But there are some drawbacks like door of the class must be opened before the robot needs to enter and For the correct staff detection some must be present under some time constraint which could be achieved in future

ACKNOWLEDGMENT

I take pleasure in presenting my work done in Raspberry Pi, robotics and IOT. I would like to express my deep sense of gratitude to my guide Mrs. Ramya.S for her valuable suggestions. I am deeply indebted to her for giving me chance to do this innovative project providing constant guidance throughout this work. I acknowledge with thanks, the assistance provided by Head of Department, department staff, Information Science and Engineering faculty staff. Finally I would like to thank my colleagues, friends and at last but not least my lovely family who helped me directly or indirectly for the same.

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