Internet of Things based Solar Powered Truck

Nirmala. M[1], Malarvizhi.K[2],

Assistant Professor [1], Professor & Head[2].

[1,2]Electrical and ElectronicsEngineering departmentKumaraguru College of Technology, Coimbatore.

nirmala.m.eee@kct.ac.in[1]

Abstract

An increase in number of commodities and population, complexity of the delivery process also has increased considerably hence it has become a necessity to imbibe automation in the process of delivery. Smart Delivery Truck has been designed which is controlled using a mobile phone through the Internet of Things. The Truck is designed in a more secure way such that only authorized persons can access the products inside the truck. This is achieved through capturing the face of the customer who wishes to access the product and compare with the database to recognize the face. The customer can be taken out the product, once face is recognized a mechanical box would be opened automatically. Once the face is recognized and after delivery, a mail is sent to the seller as a confirmation. The controller is Raspberry Pi 3 Model B. The motion of the truck can be controlled by using a mobile phone or by a computer by sharing a common Internet Protocol (IP) address between the controller and mobile/computer. Open CV with Haar Cascade library is used for recognizing the features of the face. Solar power has been used to power the truck. The importance of the presented system is verified in prototype model.

I. INTRODUCTION

Nowadays a great changeover in mind-set of people from buying goods in retail shops to online purchase sites. Rapid development in e- commerce has set up a trend on door delivery of goods purchased online. As the number of orders increase, it becomes tedious to transport products from the factory to the end customer. There is also a chance of wrong delivery of goods which could cause loss of money and time. Moreover security of products that are transported is at stake when transported manually. Thus, automation when applied in the field of home delivery will be a better solution. With the advent of the Internet of Things (IoT), connecting devices with each other has become simple and can easily be controlled from a remote location[1]. Therefore, IoT can be used in transportation of products from stores to the exact location of the customer in a more comfortable and secure way. The project aims at designing and fabricating a home delivery truck that can be controlled from a remote location. In order to enhance security and correctness in delivering right goods to the right customer, image processing technology is used for face detection and authentication. Advancements in micro controller technology helps in control of the truck in a simple way and image processing in an efficient way which aids in face authentication of customers. As the name suggests the 'Internet of things' is the process of connecting various substantial devices in various network, that actuates these objects to accumulate and interchange data with one another. Few real time applications include home automation where various home appliances such as dryers, automatic vacuum cleaners, air fresher's, ovens, refrigerators with remote monitoring Wi-Fi control. The proposed system uses Wi-Fi which comes under 'Short Range Wireless Control'

9358

method, where a common access point is used for communication between the devices. Very Small Aperture Terminal (VSAT) can be used for long range communications. The truck is operated with the help of solar energy and the charged batteries are used to power the truck.

An extra beneficial data can be mined with help of development in abilities of data communication and assortment network such as satellite based GPS, cloud computing, Machine-to-Machine (M2M) and cell phone triangulation and devices. The extracted data offers statistics about transportable time, origin destination, vehicle volumes and traffic movements. Using cell phone triangulation, traffic flow information can be collected through the broadcast of mobile signal data to the mobile phone network. Google Maps Traffic View is the greatest example, it exploits a crowd sourcing from smart devices. Google recently obtained 'Waze', which is an android based application useful for getting information on traffic and easy navigation. In order to find the greatest routes and save time and gas, Waze develops a crowd sourcing to acquaint other users of traffic conditions. Cloud computing provides the capability to segment computer assets rather than having local servers handle applications [2]. Solar cars utilize the solar energy from the sun, which is converted it into electrical. The solar output is DC voltage which is used to fuels the battery and then the driving energy actuates the motor in solar car. Some solar cars straightly connected to an electric motor from solar panel without a battery. However, two batteries have been employed, thus utilizing solar energy as back-up protection. When batteries are charged, and are used to run the truck. Photovoltaic (PV) cells are used in solar cars to transform sunlight into electrical energy. Silicon semiconductor is used for fabricate of solar panel, that engross the energy. The energy from solar liberates the electron from semiconductors, produces a flow of electrons. The electron flow causes electrical energy, which charges the battery. The output power from the battery drives the motor used

in solar cars.

Two main recent trends in delivery technology includes that of the Amazon's 'Amazon Prime Air' quadcopters and that of 'Track the Truck' GPS tracking system. Though many of these are quite familiar with that of the first, the latter is also impressive[3]. The main objective of the Amazon Prime Air concept can the usage of drones to provide individual packages to customers' doorsteps by unmanned fly. Since it is premature to comment on the process before it starts the delivery process, restrictions that the Amazon demands before the inception of the process is tiresome. So as to be licensed for this distribution, the demand must be below 2.26 kg and this weight is adequate quantity in the cargo box and distribution location should not exceed 16Km radius from a contributing Amazon order fulfilment center. The Amazon sold 86% of packages and robust the weight criterion of the program as per report. With the above constrains in the future, distance of delivery may increase, but there is no way the size of the object can be met. So at one stage it will be a necessity to go for road transportation. 'Track the Truck' vehicle tracking system gives varied options to track the truck as giving informations like getting the vehicle fuel usage report, tracking the current location of the truck, etc. It is clear that in the near future that these two techniques complement each other.

Light Detection and Ranging system (LiDAR) for Adaptive Cruise Control (ACC) based an autonomous car, 'Google Car' which is being developed by the company Waymo [4]. Multinational companies such as Siemens, Hella and Cepton usage of a distance monitor device LiDAR device fixed on the obverse of the vehicle bumper, to monitor the distance between the vehicle and any vehicle in the presence of it. An adaptive cruise control applies the brakes to reduce the speed of the vehicle, when the event of the vehicle in front slows down or is besides close. The control method permit the driver to increase vehicle speed to a stipulated

speed, when the road at the forefront is apparent. So considering the three dimensions, the future is easily presumed that e-Commerce will be the first industry to incorporate this technology.

The seller who delivers the product is unaware if the person who receives the product is authentic or not. Though many of the leading online retail companies like Amazon have tried to develop quadcopter (Prime Air), it would not be feasible if in future there is a increase in air traffic. Similarly, the possibility of the increase in quantity of products makes its efficiency doubtful. Shipping costs are more when air transport is employed. Hence, automation of the delivery system on the road is more efficient and will become a clear necessity, especially for high density countries like India automation on road will be more efficient.

II. IOT BASED TRUCK

A. Face Recognition

Open source Computer Vision (open source CV) is used for recognizing the face of the customer[5]. IoT is used to control the truck. After the face authentication of the customer, the product will be delivered to the customer.

If the face is not authenticated, a mail will be sent immediately to the seller along with the photo of the person on the spot. Solar energy is used to power the truck. The face of the person who orders the product, is stored in the controller database. While delivery, the face of the customer is taken again. The grey scale image is converted from the colour image. As the fundamental process, the human face is sort out from the entire image using the Haar Cascade technique[6]. The block diagram of the Internet of Things based truck is shown in Fig.1, illustrates that various connections involved with that of the Raspberry Pi controller.
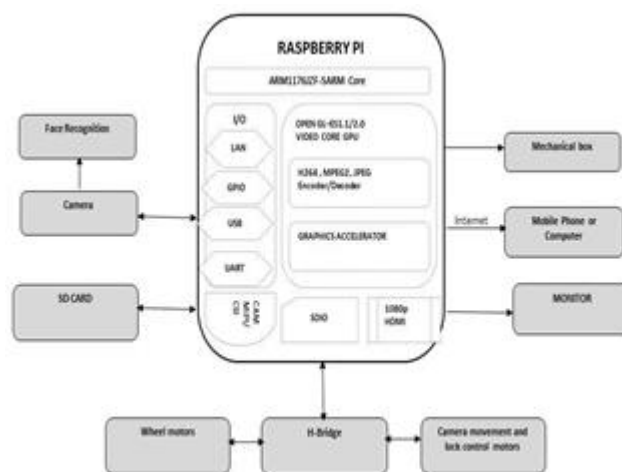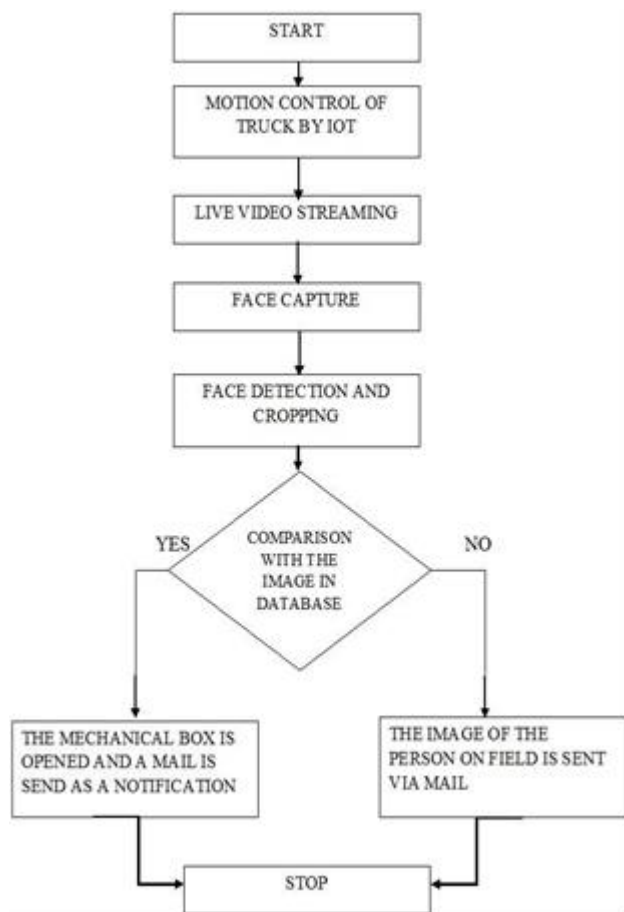

Fig .1 The Block diagram of the Internet of Things based truck.

The groups of positive and negative images are trained in a cascade function of a machine learning based approach and also used to perceive objects in the next image. After perceiving the face from the images, the image cropped and is compared with that of the already stored grey scale images in the database. In the database, there is around 10 images of each person. If the image taken during delivery matches with that of the first person's, the process is straight away terminated and no further check is made with the image of the second person. If authorized, the mechanical box opens automatically for around 5 seconds to deliver the product and then closes automatically. The delay can be varied depending on user comfort. The number of persons can be increased, however there will be corresponding time delay.

A Webcam attached to the truck helps the driving of the truck by live-streaming on-road condition and helps to capture the customer's face. Live streaming is done with the help of the Android application 'VNC viewer'. Direct webpage control is also possible. The motor controls camera module through gear mechanism and the IoT controls movement of the robot. The reliability of the truck depends on the efficiency of the fuel being used. Thus solar power has been used to power the truck. During the working of the truck among the two batteries, the

solar power charges one battery while other battery is used to power the truck. The voltage regulator circuit reduce the voltage level to lower value, which is used to power the Raspberry Pi controller. The output from solar panel is used for the battery charging and it ignites the entire supply of the truck.

The Truck is designed in a more secure way such that only authorized persons can access the products inside the truck. It is achieved from capturing the face of the customer who desires to access the product and compare with the database to recognize the face. Once face is recognized a mechanical box will be opened automatically through which the customer can be taken out the product . Once the face is recognized and after delivery, a mail is sent to the seller as a confirmation. Web-Camera is used to capture the face of the customer and live streaming on-road condition, assists the truck operation.

The Raspberry Pi -3 Model B controller used in the proposed system. The motion of the truck can be controlled by using a mobile phone or by a computer by sharing a common Internet Protocol (IP) address between the controller and mobile/computer. Commands are given from the computer from remote place to control and drive the truck to the required destination of the customer.

Open CV with Haar Cascade library is used for recognizing the features of the face. Solar power has been used to power the truck. During the working of the truck, solar power charges one battery. The Raspberry Pi is also powered by 12 V battery by using a voltage regulator circuit to lower the voltage value. Fig.2 shows that the step by step flow chart of working process for the entire process.

Fig.3 shows the solar powered truck overall block diagram. The solar panel extracts energy from sun and fed to voltage regulator circuit through battery. The DC voltage is fed to H-bridge driver circuit to control operation of motors.
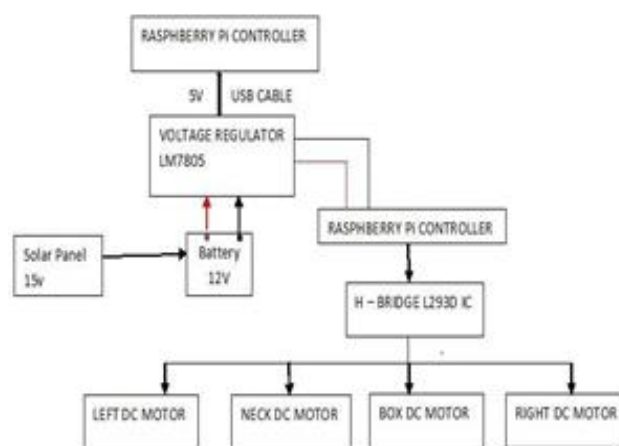
Fig.3. Block Diagram of solar Powered truck

B.Open CV and Haar Cascade Tecnique

The Python programming is the high level programming which is used for general purpose programming. The Python programming also used to create our own types using classes which is similar to that of object oriented programming. The python has a script language for web application in

Fig.2. Flowchart of the working process of truck

this system. With the web server gateway interface, a standard Application Program Interface (API) has been evolved to run the web application. Also the face recognition part is coded and separate programs are run for the truck's final execution process. Open source computer vision normally termed as Open CV consist of set of program functions as library. It intends at real time computer vision. For face detection, the Haar Cascade provided by Open CV is used. Open CV is written in C and C++. Haar feature based cascade classifiers are used for object detection. A lot of positive and negative images can be approached by using Haar cascade used to detect objects in other images[6].

The Haar Cascade approach is used for face detection. In Open CV, there is already built in Haar Cascade functions which are readily available. For example, in order to detect the presence of an eye in the image, it is enough to use haarcascade_eye.xml, xml file in the Open CV library. Similarly, the faces can be recognized with the xml file 'haarcascade_frontalface_alt.xml'. Once the face is detected from the entire image it is cropped. The cropped image is checked with the image in the database. Basically a machine learning based approach has been developed the algorithm. It is next used to detect objects in the next image. To train the classifier, initially the algorithm needs both positive image groups with faces and negative images groups without faces. The addition of pixels from white rectangle are deducted from addition of pixels from black rectangle and results that each feature with single value is obtained[7].

Fig.4 illustrates that the information of various kinds of features present in the Haar cascade platform to build a face detection algorithm. But among all these features, most of them are irrelevant.
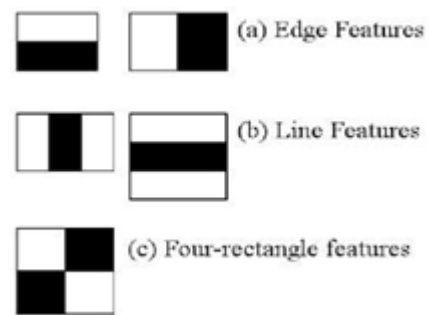
**Fig.4. Comparison of various feature in images**.

Fig.5. Feature Extraction

The Fig.5 shows the various feature extraction ways. The crown line illustrates that two excellent features such as the first feature preferred appears to focus on the assets that the eye's region are often dimmer than the nose and cheek region. The second feature preferred depends on the assets that the gloomy eyes than the association of the nose. But the related windows concerning on unrelated cheeks or any additional unrelated place. In an image, non-face region is mostly engaged. If a window is not a face region, it is a greater way to check the images. The image is discarded in a single shot, if a window is in the face region. Then the image is not processed again.
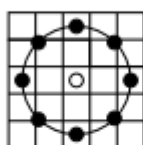
C.Local Binary Pattern

First, the whole region of face area is separated into tiny areas from which histograms of Local Binary Pattern (LBP) are extorted and sequenced into a particular, dimensionally augmented attribute histogram systematically characterizing image of the face. The operator who labels the pixels of an image and the center value of 3x3-neighbourhood of

each pixel is threshold, then binary number output. Then texture descriptor type of histogram of the labels can be used. Fig.6 (a) illustrates that the basic LBP operator. To use neighborhoods of different sizes, the operator can wide afterward. The pixel values allow any radius of circular neighborhoods and number of pixels in the neighborhood and bilinear interpolation. The information P, R for neighborhood is used. P means sampling points on a circle and R means radius of the circle.Fig.6.(b) shows an example of the circular (8,2) neighborhood and Fig.6(c) shows an example of a facial image separated into 7x7 windows[8].
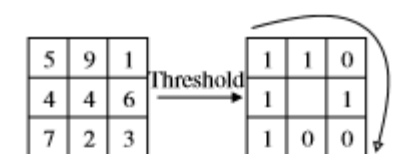

(a). Basic LBP Operation

(b).Circular (8,2) neighbourhood
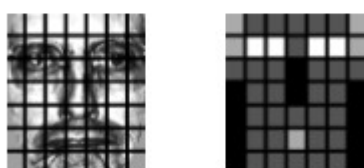
(c) Face images

Fig.6. Facial Image divided into 7x7 window in the local binary pattern.

D.Local Binary Pattern Algorithm

To eliminate the non-face area of the image, the images are recorded using detection of eye coordinates and harvested with an elliptical mask. The non-masked area of the face image from the grey histogram is balanced subsequent to this exclusion. The formation of Labels includes the label that is assigned to the image. The image is

interpreted and is transformed into gray scale. Further, the grey scale image format is cconverted into numpy array. The label of the image is acquired. The face of the image is appended with the faces in the database and labels.
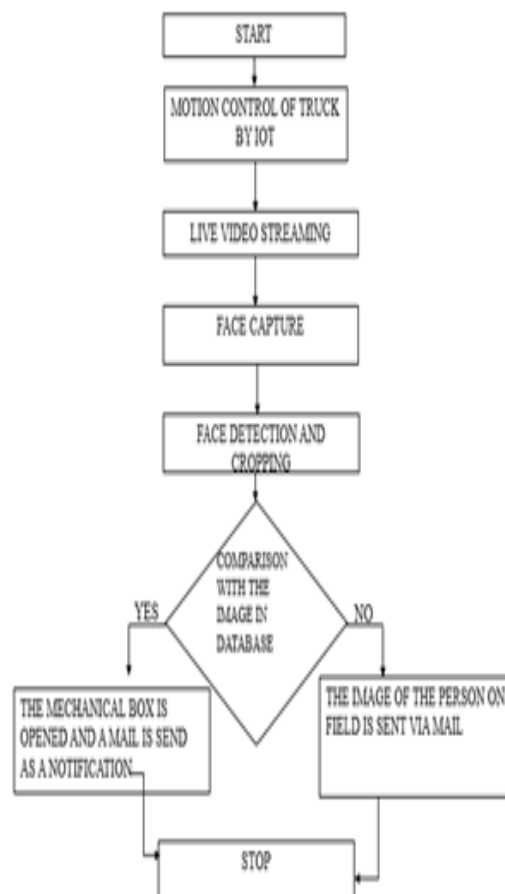

Fig.7.Flow chart for Local Binary Pattern

Table 1.parameters of solar panel

Description	Range
solar panel	Polycrystalline
Peak power	15 WATT
Peak voltage	12V
Open circuit voltage	10.8V
Peak current	0.57A
Short circuit current	0.66A
Dimension	345*215*17mm

Table.1 shows that the various parameters of the solar panel used in this project. The solar panel power rating is 15W power which normally used as a solar charger that is being used to charge the battery. The time requirements that will be needed to charge the battery with solar panel requires the following assumptions. The ampere per hour of the charger is calculated : $I = P/V = 15watts/12 volts = 1.25$ amperes. The charging time is calculated as, Ampere Hour per current is 4 hours for direct sunlight. Therefore the time taken for charging 12 volt, 5 Ah batteries using a 15 watt solar panel is 4 hours. H Bridge motor driver is an electrical circuit that generates a voltage and supplies across in both the directions of the load [9]. These circuits are often used in robots to allow DC motors to run frontage and backside for the effective operation.
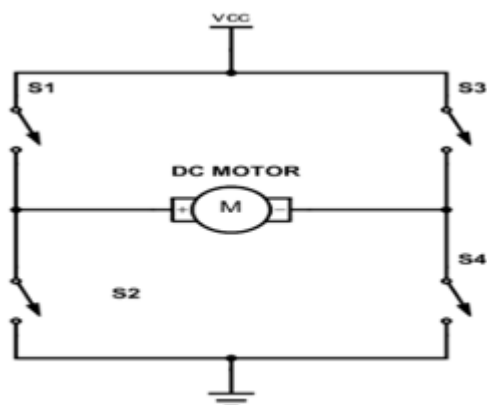
Fig.8. H-Bridge motor driver circuit

A H- bridge circuit is constructed using four solid state switches. When the switches S1 and S4 are closed while S2 and S3 are kept open, a positive voltage is applied across the motor and it operates in forward direction. When S1 and S4 switches are opened and S2 and S3 switches are closed, the negative voltage is applied and the motor operates in backward direction. The switches in same leg S1,S2 and the switches S3,S4 should not be switched on at the same time. If these switched on, it leads to short circuit on the input voltage source terminals and it is referred as shoot-through.
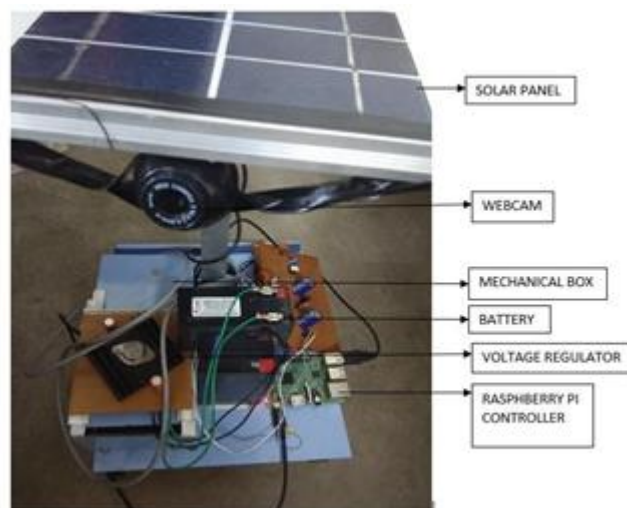
Fig.9. Hardware implementation of IoT based Solar powered truck.

Webcam (Model Id LT 10) is video camera that is used for real time processing and streaming of images. The video stream can be saved to the remote locations which can be viewed later. A 10 MegaPixel camera is used to capture the customers face and compare with the database image for face recognition. The webcam is mounted on a metal pipe which can turn to give 360 degree vision.The mechanical box consists of a movable lid that opens and closes. The opening and closing of the mechanical box is controlled by a DC motor[10].The mechanical box is mounted over the robot. When the face of the customer is being recognised the input signals are sent to the DC motor which runs on the clockwise direction which moves the lid to open and after few seconds, the lid closes automatically[11]. Fig.9 shows that the hardware implementation of IoT based solar powered truck.

III. CONCLUSION

Thus the truck has been designed successfully employing pythan programmed IoT based system to control the truck and Open CV based Face recognition is employed for the improved delivery process by making process more secure and safe. The face images of three persons were used for face recognition. The prototype model of IoT based solar

powered truck is examined and verified the time taken for face recognition is around 40 seconds only. Solar energy is also used to power the truck successfully. The solar based smart truck solves many problems related to the environment as a paramount product delivery system and is the best pollution free method.

REFERENCES

[1]. L. Atzori, and Morabito, G, "The Internet of Things: A Survey. Computer Networks", vol.54, pp.2787-2805, 2010. https://doi.org/10.1016/j.comnet.2010.05.01

[2]. C. Balasubramaniyan and D. Manivannan, "IoT Enabled Air Quality Monitoring System (AQMS)using Raspberry Pi", Indian Journal of Science and Technology,Vol 9(39), DOI: 10.17485/ijst/2016/v9i39/90414, October 2016ISSN (Print) : 0974-6846ISSN (Online) : 0974-5645

[3]. Sunghun Jung, Muzamil Ahmed ,"Analysis of Amazon Prime Air UAV Delivery Service", Journal of Knowledge Information Technology and Systems, ISSN 1975-7700, Vol. 12, No. 2, pp.1-15,2017.

[4]. AzamRafique, "Self-driving and driver relaxing vehicle",proceedings of IEEE conference,DOI 978-1-5090-4059-9/16, 2016.

[5]. Unsang Park, "Face Recognition: face in video, age invariance, and facial marks" Michigan State University, 2009

[6]. T. Ahonen, A. Hadid and M. Pietikainen, "Face description with Local Binary Patterns", Application to Face Recognition. Machine Vision Group, University of Oulu, Finland, 2006

[7]. T. Ahonen, A. Hadid, M. Pietikainen and T. M aenpaa. "Face recognition based on the appearance of local regions", In Proceedings of the 17th International Conference on Pattern Recognition, 2004

[8]. By Md. Abdur Rahim, Md. NajmulHossain, "Face Recognition using Local Binary Patterns (LBP)", Global Journal of Computer Science

and Technology Graphics &Vision,Vol. 13 (4) ,pp.1-9,Year 2013

[9]. M.Nirmala, K.Baskaran, Sasikala,"Optimal energy scheduling for smart home with centralized renewable energy source" International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)Volume 4, Issue 4, April 2015

[10]. .Nirmala. M, Malarvizhi.K, Thenmozhi. G "Solar PV based Electric Vehicle",International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-2S2, December, 2018, pp.276-290.

[11]. M.Nirmala, S,RameshSelvakumar 2017, "Nine switch converter based Hybrid Electric Vehicle", Pakistan Journal of Biotechnology,ISSN:1812-1837,Vol. 14, special issue No. II, August 2017, pp. 59-63.