Research Paper 1

- This paper introduces a system based on image processing to obtain efficient and accurate reading of the electricity digital meter. In this system the back camera of the mobile phones is used to acquire the image of the electricity meter.
- The system then applies a sequence of image processing functions to automatically extract and recognize the digits of the meter reading image. This image goes through three main stages:preprocessing which ends up with cropping the numeric reading area, segmentation of individual digits using horizontal and vertical scanning of the cropped numeric area, and recognition of the reading by comparing each segmented digit with the digits templates.
- The proposed system is implemented using Android Studio software with openCV library and has been tested on 21 images of electric meters captured by Smartphone camera, and results shows a recognition with the accuracy rate of 96,49% (per number digit) and 85.71% accuracy rate for the electricity meter readings. The proposed system will be used in the future to develop a mobile application that could be used by the electricity company employees to facilitate the reading process.

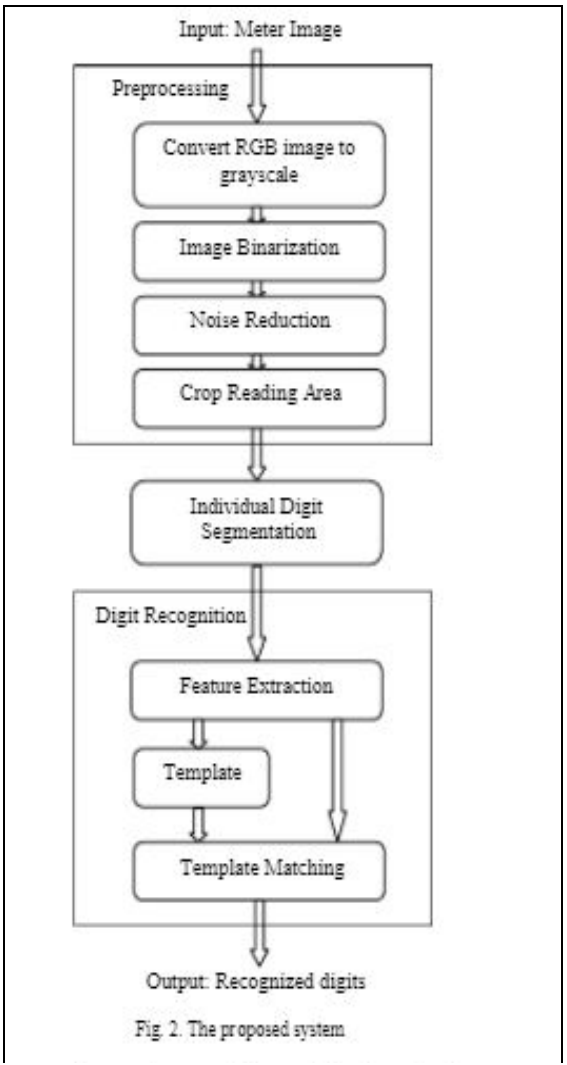


Fig. 2. The proposed system

Steps Involved:

- Preprocessing
  - Convert RGB image to grayscale
  - Image Binarization
- Noise Reduction
- Crop the Reading Area
- Vertical Scanning
- Horizontal Scanning
- Digits Recognition
  - Feature Extraction
  - Template Matching

Research Paper 2

- As in some places now also where the technique of digital meter is not implemented, in those places electric meter reading technique is most useful. As the existing method of manual electric meter reading is not applicable with the increasing consumption of electricity and has a lot of disadvantages like time consumption, more human resources and is prone to lot of errors.
- The difference is in how to collect and process information that both traditional meter reading and electric meter reading follow. Automated Meter reading follows the process of reading the values of electrical meter by using a camera that takes a photo of the meter, recognizes the digits, and then stores the output in a text file.
- The meter image is captured by mobile phone back camera with some constraints: the camera has to be parallel to the meter, the meter reading area has to appear in the image without shadows, part of the meter black box must appears from left and right, and the right most digit must be entirely shown and clear.
- The reading area that is extracted from the image is further segmented for digit recognition. Digit recognition is the process where we match the segmented data with our predefined template.

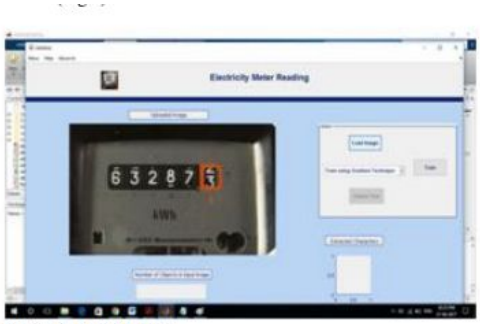


Figure.1. Input Image

Figure.2. Binary Image

Figure.3.Cropped Reading Area

Figure.4. Segmented Digits

Figure.5. Output in a text File

Research Paper 3

The first process is converting input image from color image into grayscale image. After convert to grayscale, the image is transformed into frequency domain to perform Homomorphic Filtering. Figure 3 shows the detail process of homomorphic filtering. The homomorphic filtering is a series of process of filtering an image in frequency domain. Therefore the image is transformed into frequency domain using 2 dimensional Fourier Transform. But, before the image is transformed into frequency domain, the logarithm process is applied to the image. In frequency domain, the frequency spectrum is filtered using Butterworth filter.

$$butterworth(x,y) = 1 - \left((gH - gL) \times \frac{1}{1+\left(\frac{D_0}{dist}\right)^{2\times n}} + gL \right),$$

$$dist = \sqrt{\left(x - \frac{w}{2}\right)^2 + \left(y - \frac{h}{2}\right)^2},$$

where x and y are the spatial coordinate, gH and gLare the variable to adjust the high and low slope of the filter, w and h are the width and height of the filter, D0 is the distance of first cut off from the center, and n is the number of order . Then, the filtered spectrum is transformed back to spatial domain. An exponential process is done to the output image as the inverse of logarithm process in the beginning. The homomorphic filtering is useful to uniform the intensity value [14]. The non-uniform intensity value in an image occurs because the image is taken on non-uniform exposure and it is common in a realworld image. The process after homomorphic filtering is Morphology Tophat. This is a morphological process that performssubtraction between original greyscale image with the result of morphological opening of the image. Top hat process is followed by Otsu Binarization [15]. The binarization process produces a black and white image which contains a candidate of foreground and background area. In this case, the candidate of foreground area is expected to be the digit sequence area. A morphological closing is applied to fill any background area inside a foreground area. This process produces some candidates of digit sequences.

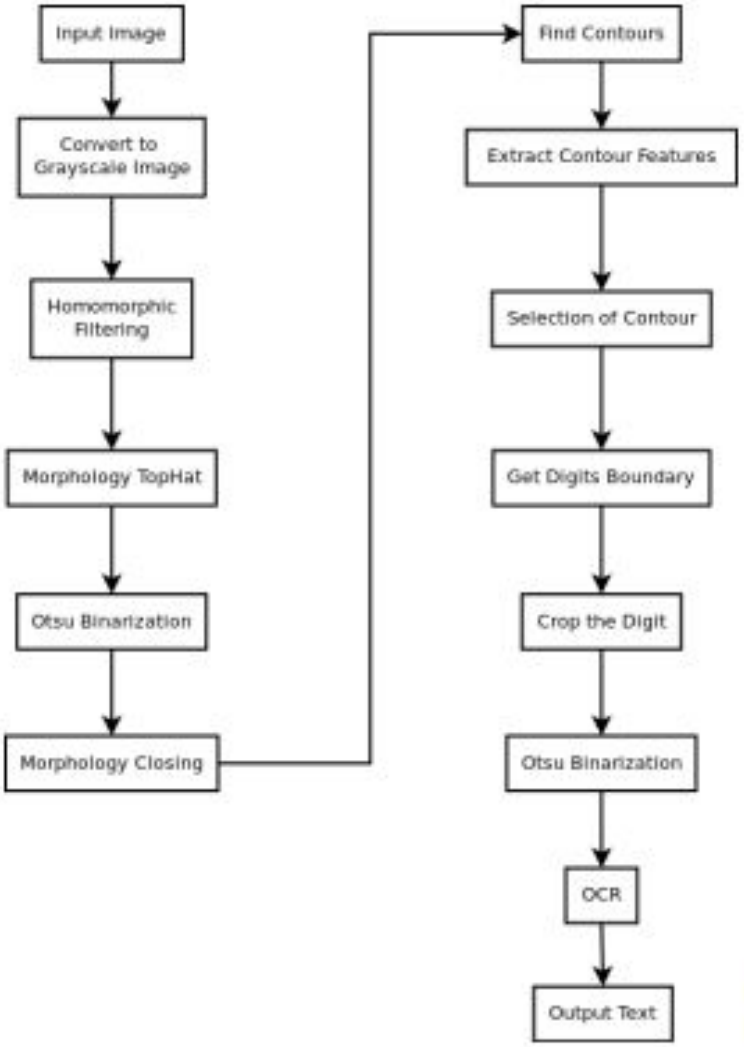
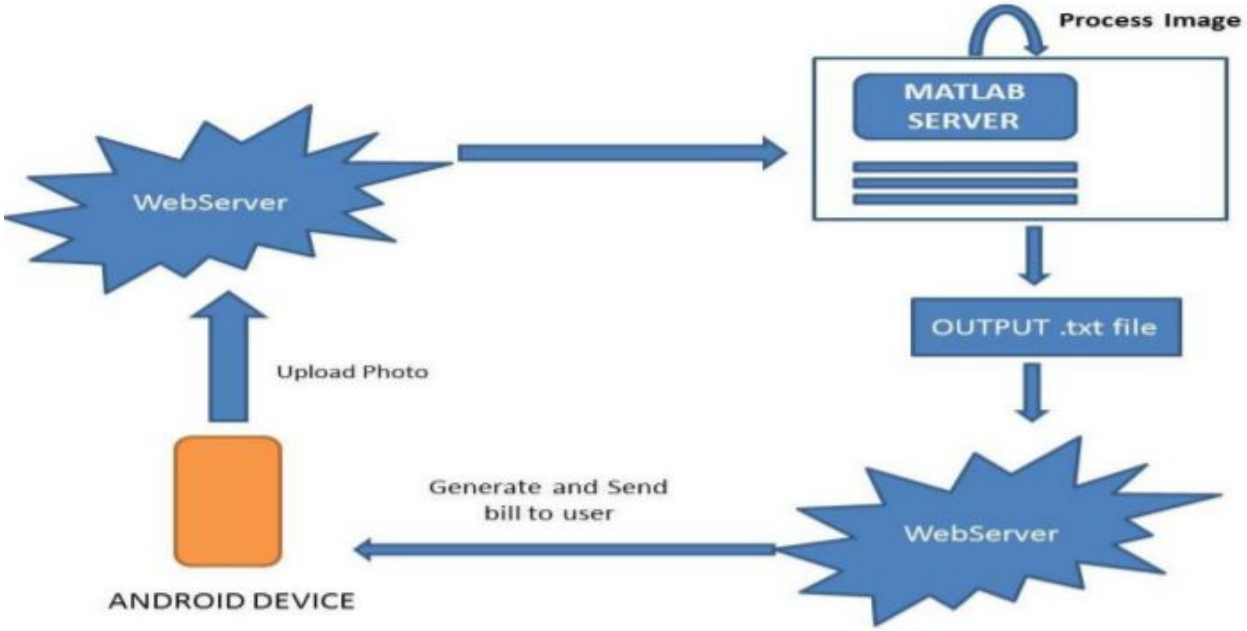


Figure 2. The Proposed Method for Reading Digits.

Figure 3. Homomorphic Filtering.

Research Paper 4

- This paper introduces a system based on image processing to obtain efficient and accurate reading of the electricity digital meter.
- In this system the back camera of the mobile phones is used to acquire the image of the electricity meter.
- The system then applies a sequence of image processing functions to automatically extract and recognize the digits of the meter reading image.
- This image goes through three main stages:
    a) Preprocessing which ends up with cropping the numeric reading area
    b) Segmentation of individual digits using horizontal and vertical scanning of the cropped numeric area,
    c) Recognition of the reading by comparing each segmented digit with the digits templates.
- The output is sent to the Server along with other details such as Consumer name, consumer number, date/time etc
- The proposed system is implemented using Android Studio software with open CV library, MATLAB 2013



Research Paper 5

- The proposed system uses a camera to take automatic meter reading.
- For capturing images the camera is placed in front of the energy meter of the house.
- Contour Algorithm is used to get digits separated out & to calculate the bill for the month.
- The Block Diagram for the system on the server side is given below:

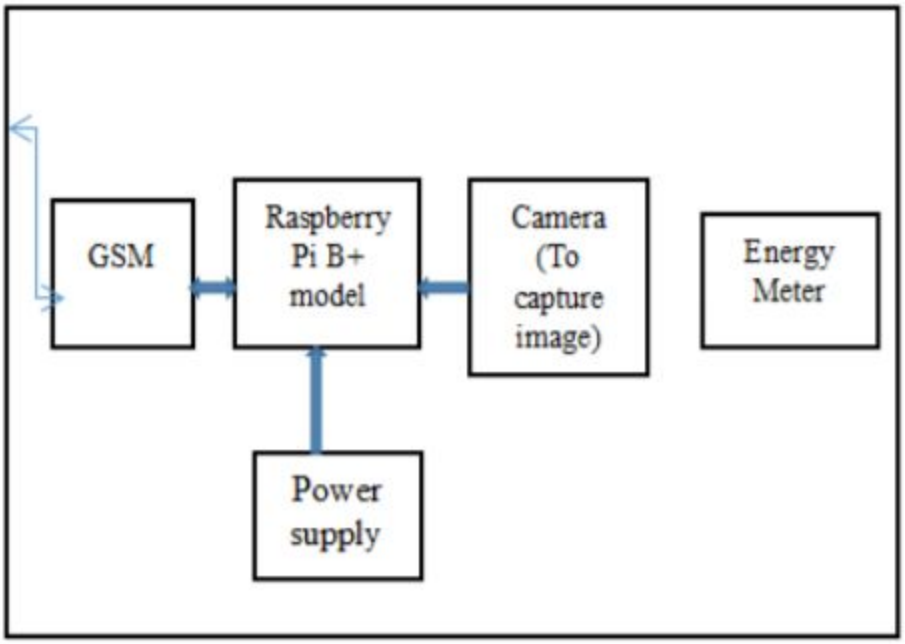
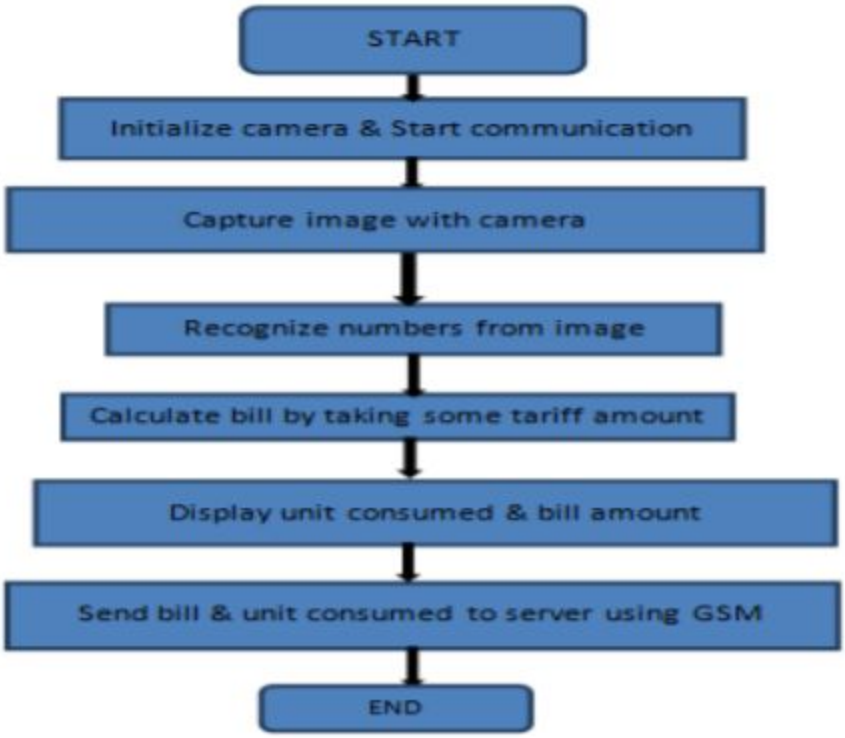


Fig 1: At server side

- In this paper, Raspberry Pi is used because it is a sort of minicomputer. Raspberry Pi is also used to surf the internet, send an email and many more using a word processor. The bill is also send to the server wirelessly using GSM and display on LCD for user's reference.The Flowchart for the system is given below


START
Initialize camera & Start communication
Capture image with camera
Recognize numbers from image
Calculate bill by taking some tariff amount
Display unit consumed & bill amount
Send bill & unit consumed to server using GSM
END

Survey Paper on Different Technologies for Electricity Meter Reading

- This paper discusses the differences of existing system Electronics Meter Reading process and enhanced digital EMR process.
- The paper also discusses the combination of different technologies proposed by different people which can be used to reduce time and human efforts.

1. **Authors**- Nayan Gupta, Deepali Shukla
   Proposed System-
   The meter readings are sent to nearby located central station using RF link and from there to web server using GSM (Global System for Mobile). It also provides the facility of electricity tamper detection.

2. **Authors**- Sneha Salunkhe , Dr.(Mrs.) S. S. Lokhande
   Proposed System-
   Author used contour algorithm for preprocessing the images & recognized the characters. Here processing flow will capture the image by using camera, captured image is pre-processed and characters are recognized by processor using contour algorithm, billing is done by taking difference between two readings of consecutive months and send it to the respective server for documentation using wireless technology.

3. **Authors**- Kiran Mahale ,Shraddha Bansal
   Proposed System-
   The authors propose the use of GSM network to transmit messages of bill to the server and generate a soft copy which will be sent via short messaging services, Email.The GSM based smart automatic energy meter sends information of service usage, power excellence

and outage alert to service company, tampering finding to the service servers

4. **Authors**- Jameer Kotwal, Snehal
   Proposed System-
   Authors proposed the technology that comprises android application as well as web application to get reading, updating information into server and informing consumers about electricity consumption units and bill amount. To make the meter reading task; automatic android application is used to get the readings from the meter by only capturing the image of the meter and then performing the OCR (Optical Character Recognition).

5. **Authors**- S.Arun, Dr. Sidappa Naidu
   Proposed System-
   Authors proposed the design and implementation of a secure low cost AMR(Automatic Meter Reading System) that measures and transmits the total electrical energy consumption to main server using GPRS (General Packet Radio Service) technology provided by GSM networks. The proposed AMR system consists of three main parts: Accurate digital meter, a transmission facility and the billing server. To make an inexpensive AMR system a low cost off the step materials are used.

6. **Authors**- S.Arun , R.Krishnamoorthy
   Proposed System-
   The authors proposed an automatic power meter reading system using GSM and ZigBee communication. The system will utilize the GSM network to send its power usage reading using short message service back to the energy provider wirelessly

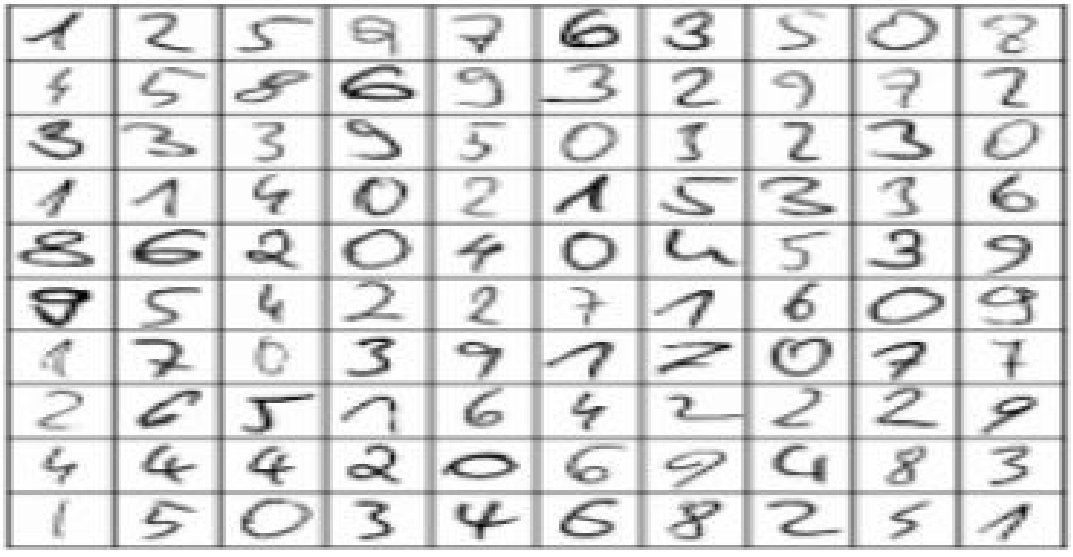
Research Paper 6

- This paper introduces a system **Handwritten character recognition** which is practically important issues in pattern recognition applications by off-line handwritten digit recognition based on different machine learning technique.

- The problem lies within the ability to develop an efficient algorithm that can recognize hand written digits and which is submitted by users by the way of a scanner, tablet, and other digital devices.

- There is a need to ensure effective and reliable approaches for recognition of handwritten digits. Several machines learning algorithm namely, Multilayer Perceptron, Support Vector Machine, Naïve Bayes, Bayes Net, Random Forest, J48 and Random Tree has been used for the recognition of digits using WEKA.

- Different types of hand-written characters are as shown below:-



Name of Algorithms	Correctly Classified Instances % (value)	Incorrectly Classified Instances % (Value)	Time Taken (seconds)	Kappa Statistic
Multilayer Perceptron	90.37	9.63	3.15	0.893
Support Vector Machine	87.97	12.03	0.56	0.8664
Random Forest	85.75	14.25	0.44	0.8416
Bayes Net	84.35	15.65	0.86	0.8262
Naïve Bayes	81.85	18.15	3.45	0.7983
J48	79.51	20.49	0.53	0.7722
Random Tree	85.6	24.94	0.55	0.7228

- Above table is a comparison of various Machine Learning algorithms.

Research Paper 7

- The system proposes a prototype for Automatic Meter Reading (AMR) system that uses a Traditional meter, ZigBee modules, and a serial camera unit.
- The system design is pictured below:-

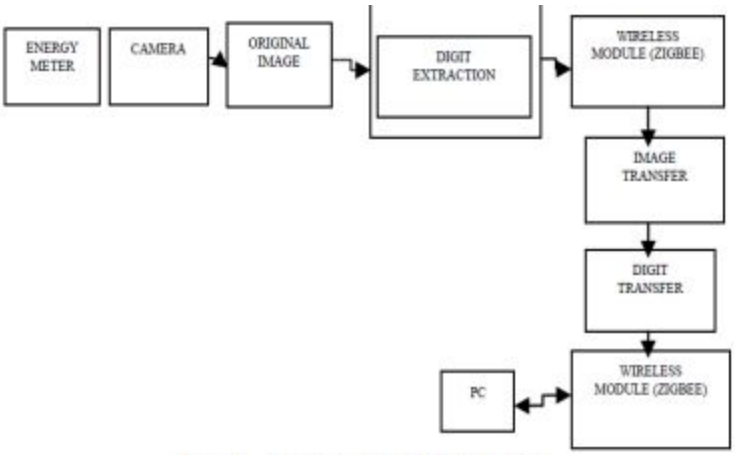


Fig.1. System block diagram

- **Binarization Step** :-The binary of gray scale images is to use proper threshold to transform the 256 grey scale images into the binary images, that is, to set the white pixel bigger than the threshold, in the grey scale images, and set black the pixels smaller than the threshold, to form the binary images with only black and white.

- **CROPPING NUMERICAL AREA**
- **CHARACTER SEGMENTATION**
- **DIGITAL RECOGNITION: -**
    - Energy Meter Image:-

Fig.4. Image of the energy meter.

Extracted digits of the energy meter reading:-

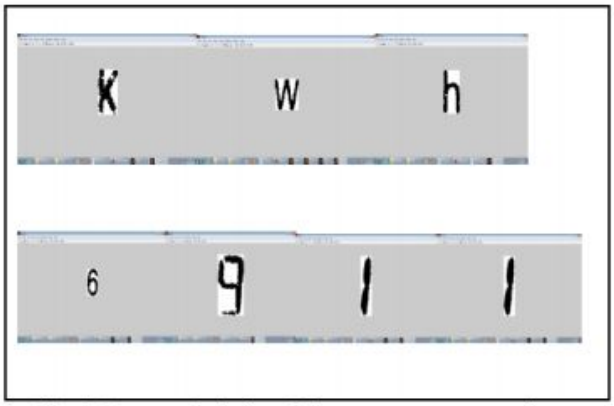


Fig.5. Extracted digits of the energy meter reading.

Research Paper 8

- In this paper, sample real time image processing applications of OpenCV are discussed along with steps.
- Some of the main image processing techniques are :
    - Image Filtering
    - Image Transformation
    - Object Tracking
    - Feature Detection
- The modules of openCV for image processing applications are given below
    - CORE module contains basic data structures and basic functions used by other modules.
    - IMGPROC module contains image processing related functions such as linear, non-linear image filtering and geometrical image transformations etc.
    - VIDEO module contains motion estimation and object tracking algorithms.
    - ML module contains machine-learning interfaces.
    - HighGUI module contains the basic I/O interfaces and multi-platform windowing capabilities.

- The primary interface of OpenCV is written in C++
- There are now full interfaces in Python, Java and MATLAB.

Research Paper 9

- This paper addresses the opportunities and current trends of computer vision applications in all emerging domains.
- Types of imaging as per electromagnetic band with corresponding applications

S. No.	Band of electromagnetic spectrum	Type of imaging	Broad Area	Applications
1.	Radio	MRI (Magnetic Resonance Imaging)	Computer-aided diagnosis	Diagnosis and Treatment planning [45]
2.	Microwave	Ultrasound imaging, Radar Tomography	Computer-aided diagnosis, Agriculture	Diagnosis and Treatment planning, Tumor ablation [102], Physical properties of food [53, 93], Assessment of moisture content [44], structural health monitoring [114], defect detection
3.	Infrared	Thermal imaging	Surveillance in the non-visible spectrum [16]	Surveillance through infrared camera [59], Monitoring of temperature pattern [4], 24/7 monitoring of human and vehicles [50], Structure health monitoring [28]
4.	Visible	Visible imaging	Surveillance, identification of humans and objects,	Face recognition [17], object detection [54], document handling [8], Motion tracking, Automatic character recognition, Texture Analysis [100]
5.	Ultraviolet	Fluorescence spectroscopy	Food and agriculture	Detecting anomalies in fruits and food [13, 97], fruit sorting [25, 74]
6.	X-ray	X-ray imaging, CT, CBCT	Computer-aided diagnosis, agriculture	Diagnosis and Treatment planning [99], seed analysis [90, 90]
7.	Gamma	Gamma Imaging	Computer-aided diagnosis	Diagnosis and Treatment planning, Cancer identification [92]

- Various opportunities in field of image processing

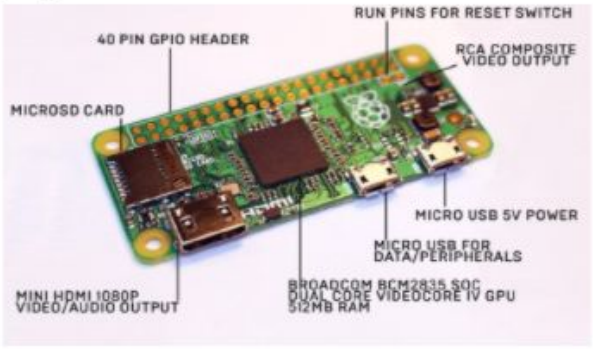
S. No.	Research area	Opportunity	Modality
1.	Medical Diagnosis and Treatment Planning	Volumetric segmentation [18, 80]	3D
		Region of interest segmentation [64, 89]	2D
		Automatic detection of landmarks [37, 38]	2D, 3D
		Automatic registration and fusion [29]	2D, 3D
		3D surface reconstruction [58]	2D, 3D
		Tumor/cancer detection [64, 89]	2D, 3D
		Superimposition of facial structure [43]	3D
2.	Agricultural sector	Seed analysis and grading based on X-ray image [5, 90]	2D, 3D
		Automatic seed grading system based on visible spectrum [27]	2D, 3D
		Automatic fruit, pulse, rice grading system [12, 57, 73]	2D, 3D
		Categorization of plants [21]	2D
		Disease detection in plants [103]	2D
		Automatic monitoring of plants [96]	2D
3.	Monitoring applications	Surveillance through infrared imaging [50, 113]	2D
		Fault detection in machinery using thermal imaging [113]	2D
4.	Disaster Management application	Prediction of land sliding using image registration in sensitive areas [55]	2D
5.	Underwater Image Processing	Automatic classification of marine species in underwater imaging [101]	2D, 3D
6.	Others	Multiple image fusion [54, 87]	2D, 3D
		Exploration of hyperspectral images [85]	2D, 3D

Research Paper 10

Raspberry Pi Zero W

Pi Zero W is another flagship device of Raspberry Pi. Launched to the end of February 2017, the Pi Zero W has all the functions as of the original Pi Zero but with the added functionality of wireless connection. The Raspberry Pi Zero W consist of 1GHz, single core CPU, and 512MB of physical RAM.A mini HDMI and micro USB port and micro USB power supply, HAT compatible 40-pin GPIO header, a CSI camera connector, an 802.11 b/g/n wireless LAN, Bluetooth 4.1. Raspberry Pi has its own operating system called the Raspbian OS with other distros such as Ubuntu mate, KALI Linux etc. Raspberry Pi also bears various programming languages like C++, Python, SQL, HTSQL and JAVA. The Raspberry Pi Zero W has various power modes [6]: Home automation system using Raspberry Pi Zero W 219

Figure 2 Raspberry Pi Zero W (see online version for colours)



• RUN mode: the CPU and the ARM11 core gets activated

.

• Standby mode: the main cores clocks are switched off. The components of the CPU that execute instructions are stopped but the core is still active.In this mode, the core can be activated again by rocess-generating a unique call to the CPU, known as an interrupt. This mode is called as 'wait for interrupt'.

• Shutdown mode: the Pi Zero W is off.

• The dormant mode: only caches are powered ON, while the rest of the core is powered down.

References

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8. **Link:** https://www.researchgate.net/publication/301590571_OpenCV_for_Computer_Vision_Applications

9. **Link:** https://journals.agh.edu.pl/csci/article/view/3163/2326

10. **Link:**

https://www.researchgate.net/publication/341109161_Home_automation_system_using_Raspberry_Pi_Zero_W