

Electricity Optimization in a Community Using OpenCV and Machine Learning with Mobile Application

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Abstract

Optimizing the power is one of the basic need in growing development of electronic and electrical fields. With development of various fields leads to the increase in the demand of power directly or indirectly. The common factors helps in reducing the usage of power consumptions are the time and seasonality factors which is analyzed based on data over a period. The other factors which may be taken in consideration are the number people in a region and their characteristics like gender and age group. We can improvise the AI model using the above external factors. Once the model predict it update the expected amount of electricity required in transformer and send mobile notification to the authorized person and the person can track the energy usage in mobile for analysis.

Keywords

OpenCV Model, Machine Learning.

Introduction

Contribution of Artificial intelligence (AI) in the Internet Of Things (IOT) is immensely high in recent years. It helps to obtain meaning to the data obtained from the data

collected using the various sensor recordings. The electricity is one of the basic necessity of the human activities. The development in the technology increase the demand of electricity. Movement of eco -friendly targets more on converting the gasoline to electricity in turn increase the consumption of electricity. We since the demand and supply chain of electricity is not balanced and certain electricity production uses the natural resources like thermal coal and gasoline. Idea behind this is to optimizing the electricity consumption based on the range and number of people and their past historical records of various other contributing parameter. Based on the needs of the electric power supply for the community is regulated and to provide better regularisation of electricity for other industrial purposes. Based on the number of people and their using the demands are calculated and regularised.

OpenCv is used to capture and format the image of persons through surveillance cameras and the person information is obtained using Computer vision. Then the information is processed and Machine learning models are built based on the processed information.

The main objective of our idea are i. Improve the resource utilisation. ii. Create a dashboard to analyse the power consumption and take decision. iii. Since proposed model used the surveillance camera for getting the user information in the community we can use the information for other security reasons.

The mobile application uses to track the changes and help to understand the electricity flow and update the current load usage based on the understanding and to stop the addition of extra transformers if not needed.

Related Works

- Used the Artificial neural network algorithm for finding the optimised way of generating power generation using the resources[2][3].
- It takes weather in consideration to find the best renewable source for power generation[2].
- The EMD algorithm divides the time series model into granular IMF model and model residuals. Each IMF model and residual is trained with the LSTM model once all the models are trained summed to find the aggregated electricity demand.[1]
- There are two types of electricity interruptible and uninterruptible. The user uses the photovoltaic batteries and generators as backup power source.
- The Taguchi genetic algorithm trains with less epochs will reduce the total electricity usage than the normal standard algorithm.[4]

- Used two standard machine learning algorithms like Decision tree and Random forest to predict the electric consumption of US with standard dataset from an online repository., used to reduce the electricity theft[5]

Proposed System

The model uses an existing surveillance camera to detect the number of the person present in the particular apartment and their age group based on convolution neural networks using keras. The main feature of the model is to reuse the surveillance camera. It uses the standard Convolution neural network to retrieve the person information from the images. Build the model using the Stochastic gradient descent to predict the estimated the load the transformer can handle during the period of time.

The proposed model takes multiple features like the data features like month, day of the week, hour of a day, season, holiday, Human attributes like number of persons, their age group and their gender.

System Architecture

The proposed system architecture contains two module

1. Face detection module (IOT module).
2. Machine learning module (AI).

The IR sensor near the camera checks for the motion near the camera.

Once the motion occurs it trigger the following process.

The face detection module captures the image from the surveillance camera and processes it in an IOT raspberry pi board.

The Machine learning models performs multiple functionalities like,

- Getting the count of the people.
- Get the age group of the people.
- Get the gender of the person.

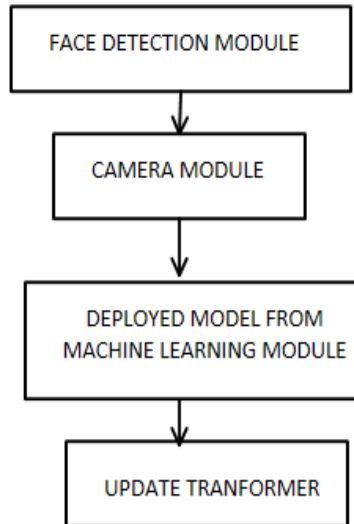


Figure 1 System Architecture

Face Detection Module

The face detection module comprises Raspberry pi with camera and Infrared sensors and CNN model.

The IR sensor checks the change in the motion near the camera.

If there is any motion then process the frame for a particular time interval then it uses the semantic segmentation to identify the number of humans from the image.

Once the frames are analyzed and the human data in the images are identified to get more details like gender and age using convolution neural networks.

We can group the age group of people into 6 predefined groups.

Group 1	Upto age 5
Group 2	5-10
Group 3	10-23
Group 4	24-30
Group 5	31-60
Group 6	60 above

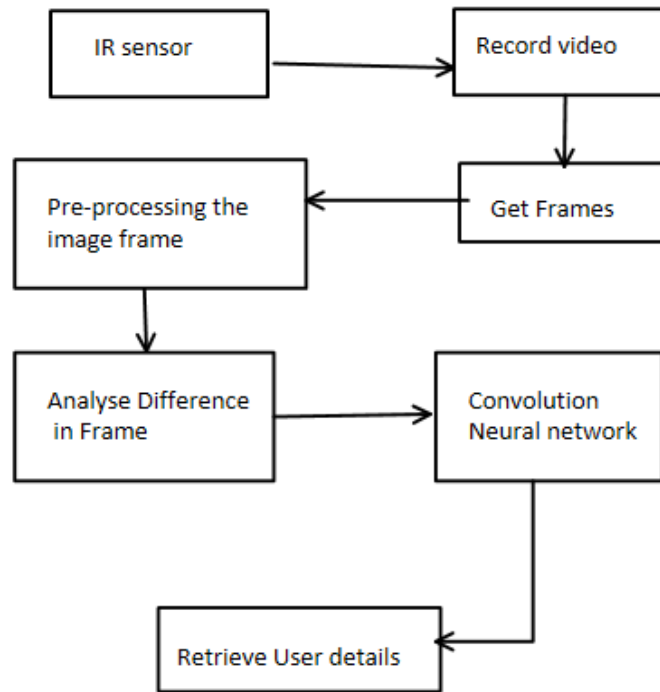


Figure 2 Face detection module architecture

Machine Learning Model

The historical data collected from the images are used as a feature along with other features like season, timing and weather details of the region.

The model is preprocessed by removing the basic seasonality effect. Removed the Noise data present in the model and trained with the neural network model.

The model follows normal stochastic gradient descent (SGD) neural network algorithm.

Stochastic gradient descent (SGD) is a recurrent way of optimizing the weight initialization of neural network models with the smoothness properties. It estimates based on the random records of the dataset instead of the complete dataset (actual gradient model), it is a stochastic approximation of GD optimization. Since this method uses the random selection of data instead of complete data it will be more efficient where there is more data to compute. It may give less convergence rate since it uses the less data but more time consuming.

Once the model is evaluated with the metric then it is deployed and tested with the hourly data based on it it will update the requirement needed for the model.

The mobile application is built to analyze the changes in a period of time. It helps to understand the trends in the usage of energy by various pictorial representation of graphs.

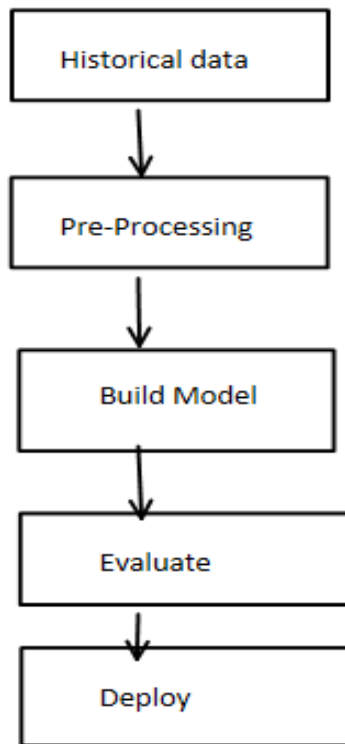


Figure 3 Machine learning module architecture

Process Pseudocode

If IR sensor changes == True
Step1: record Frames record_frames()
Step2: check for change in the frame
Step3: Get the number of faces
Step4: Get attributes of images
Step5: Run neural network algorithms(SGD)
Step6: Predict the expected electricity
Step7: Update the transformer.
Step8: Analysis through mobile application
Else:
Skip the process

Step1: record_frames()
Step1.1: Record the images in the surveillance camera using OpenCV.

Step 2: Check the change in frame (frames)

Step 2.1: Check the frames

Step 2.2:

Step 2.2.1: If frames are different:

Step 2.2.1.1: Movement occur

Step2.2.2: Else

Step2.2.2.1: It is a noise in Ir sensor

Step 3: Get the number of persons (frame)

Step 3.1: Read the frame and get the persons in the image

Step 3.2: Crop the image frame to get the person face from the image

Step 3.3: Return the person's face as a list of image matrices.

Step 4: Get attributes of images(List_of_human_face)

Step 4.1: Loop

Step 4.1.1: Read the image

Step 4.1.2: Get the gender of the image

Step 4.1.3: Get the age of the person in the image

Step 4.2: Return the total number of people and the age group of the person.

Step 5: Update the electricity details.

Step 5.1: Update transformers with the predicted result value

Step 5.2: Send mobile Notification to authorized person with the updated value.

Result and Discussion

The model which we build has created better accuracy than the others by considering more other external factors which helps to tune the model with better accuracy and general instead of overfitting the model with less fields. Most of previous algorithm use the traditional time series forecasting where we use the date time value with predicted value. The main drawback is it won't consider the other features while building the model.

The algorithm other than time series forecasting uses the internal factors as a features and use algorithm which prone to over fit the model Since the model uses the existing surveillance camera it done need any dedicated system for executing, only high end system required during the training of an model.

Conclusions

The image is the field where the most research is taking place. It is better to use image processing as a feature which may increase the accuracy and recognizing the usage based on the number of people and their characteristics is a valid scenario irrespective of taking the seasonality pattern alone in consideration it helps to take other parameters. This idea helps to reduce the Electricity consumption. It helps to analyse the need of energy based on it extra installment of transformer is done. The mobile application built used to control and monitor the whole energy consumption process through mobile.

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