Non Invasive Smart Energy Monitoring System

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Introduction

- Using energy efficiently in smart homes saves money,enhances sustainability and reduces carbon footprint.
- Consumer electronics, office equipment and other plug loads consume 15 to 20 percent of total residential and commercial electricity while not in primary mode. Much of this energy is consumed when these devices operate in low-power modes but are not actually in use.
- One way to reduce this unnecessary electricity consumption is to use a smart energy monitoring system.

Motivation

- The electricity bill generated by the electricity supply company can be often confusing as it does not explain the consumption of individual rooms or labs or cabins but instead, the bill provides a sum of all these as a whole. So this project as a whole tries to explain the power consumed individually by these sections.
- Predicting the possible power consumption is a very important job at hand as this helps to plan the consumption accordingly. Using different machine learning algorithms, these possible future values would be sought.

Objectives

- To design and develop a data acquisition system for measuring energy consumption
- To Visualize and forecast consumption usage with cloud computing
- To make energy monitoring smarter

Problem Statement

To design and develop a non-invasive smart energy monitoring system.

System Design

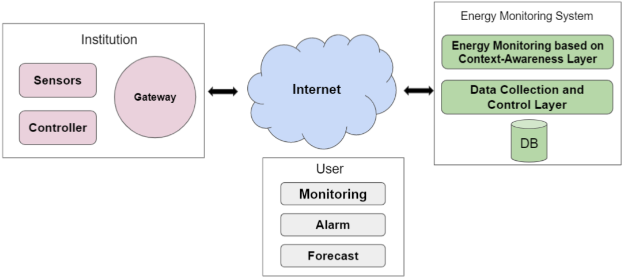


Figure: Proposed system design for the institution

Algorithm

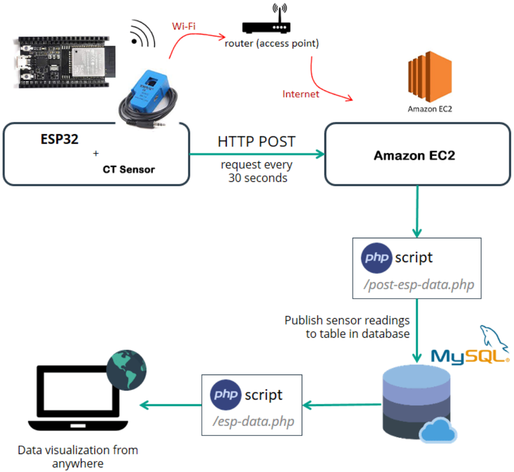


Figure: Configuration flow for the energy monitoring

Hardware Implementation

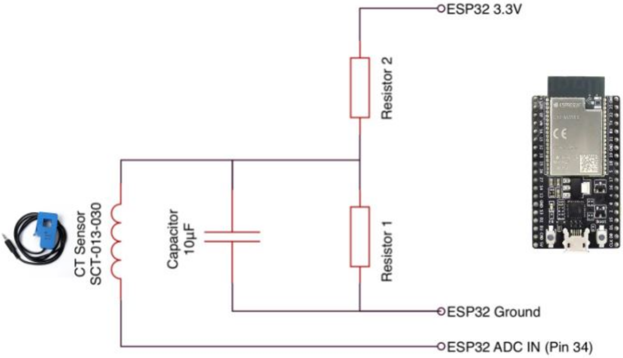


Figure: Circuit diagram

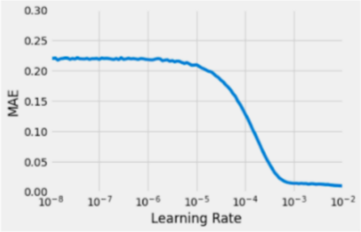
Forecast Model Implementation

- 3D tensor input shape
- Intermediate stacked LSTM layers
- Dropout layer
- Dense layer

Layer (type)	Output Shape	Parameters
lstm_20 (LSTM)	(None,90,60)	14880
lstm_21 (LSTM)	(None,60)	29040
dropout_10 (Dropout)	(None,60)	0
dense_19 (Dense)	(None,1)	61

Optimization

- **Power Saving**- In *Light sleep mode* the CPU is halted by turning off its clock pulses, while the RTC and ULP-coprocessor remain functioning.
- **Deep learning Hyper-parameter Tuning**-



MAE vs LR

Loss vs Epoch

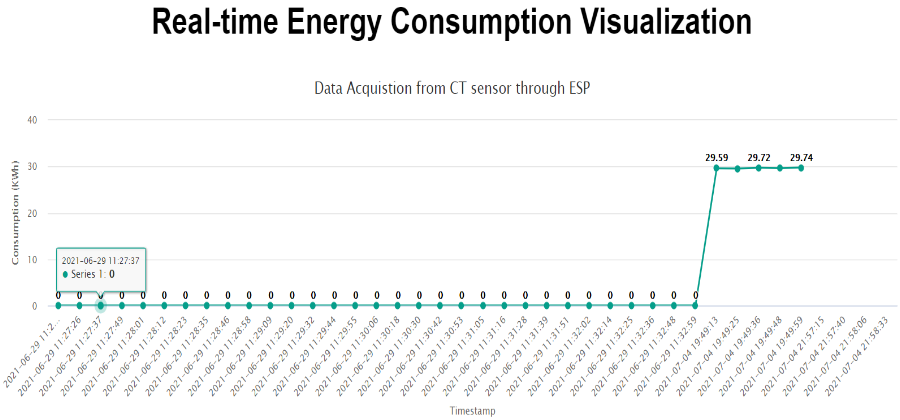


Figure: Real-time visualization of Energy Consumption

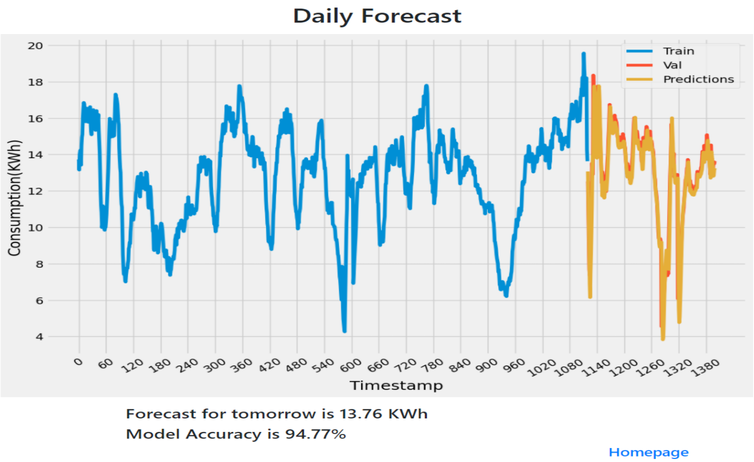


Figure: Web-app for Forecast model based on LSTM

Discussion on Results

- The hardware implementation requires a current sensor to measure the current consumption and a Node MCU to accept the values from the sensor and send the generated data to the database.
- The data acquired from the node sensor is of Time Series nature.
- The product conceptualized by the team has tremendous potential of visualizing the power consumption of a particular place with an accuracy of about 95%.

Future Scope

- Automatically recognize anomalies in the appliances based on their consumption pattern.
- Tweak the GraphQL API
- Integrate with Google Home
- Multiple model deployments providing versatile predictions.

Thank-You

Thank-You