UEE693

Capstone Project

Remoulding an existing house into a Smart Home

Investigating Group

101504114 Satyam Kumar
101504119 Shubham Gupta
101504120 Stuti Sidhu
101504122 Swanav

Supervisor
Dr. Mukesh Singh

1819ODDSEM

Electrical and Instrumentation Engineering Department
Thapar Institute of Engineering and Technology

Contents

1 Declaration

We hereby declare that the project entitled Remoulding an existing house into smart home is an authentic record of our own work carried out in the Electrical and Instrumentation Engineering Department, Thapar University, Patiala, under the guidance of Dr. Mukesh Singh during 7th semester (2018).

Date:

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101504119 Shubham Gupta
101504120 Stuti Sidhu
101504122 Swanav

Faculty Supervisor:

Dr. Mukesh Singh
Associate Professor

2 Aim

The project aims to manage and control existing devices through a Home Automation Unit accessible over the internet. The project aims to increase the energy efficiency of a household by converting primitive devices into smart devices and managing them using a self-evolving deep learning model.

3 Literature Survey

3.1 National Status Review

- Archana N. Shewale, **"Renewable Energy Based Home Automation System Using ZigBee"**, International Journal of Computer Technology and Electronics Engineering (IJCTEE), 2015

  Archana N. Shewale describes the methodology of renewable energy based home automation in which two things are consider one is energy consumption and another is energy generation. In this, ZigBee is used for monitoring energy consumption of home equipment and power line communication (PLC) is used to monitoring energy generation.

- S. Anusha, **"Home Automation using ATmega328 Microcontroller and Android application"**, International Research Journal of Engineering and Technology(IRJET), 2015

  S. Anusha describes the design and development of a remote household appliance control system using ATmega328 microcontroller and android mobile through GSM technology.

- J. Chandramohan, **"Intelligent Smart Home Automation and Security System Using Arduino and Wi-Fi"**, International Journal of Engineering and Computer Science, 2017

  J. Chandramohan provides a low cost-effective and flexible home control and monitoring system with the aid of an integrated micro-web server with internet protocol (IP) connectivity for access and to control of equipment and devices remotely using Android-based smartphone application. generation.

3.2 International Status Review

- Debraj Basu, **"Wireless Sensor Network Based DSAda Smart Home: Sensor Selection, Deployment and Monitoring"**, IEEE, 2013

  Debraj Basu details the installation and configuration of unobtrusive sensors in an elderly person?s house - a smart home in the making - in a small city in New Zealand. The overall system is envisaged to use machine learning to analyze the data generated by the sensor nodes.

- Byeongkwan Kang, **IoT-based monitoring system using tri-level context making model for smart home services"**, IEEE International Conference, 2015

  Kang discusses about acquisition and analysis of sensor data which are going to be used across smart homes. It proposed an architecture for extracting contextual information by analysing the data acquired from various sensors and provide context aware services.

- Jeya Jeya Padmini, **"Effective Power Utilization and Conservation in Smart Home Using IoT"**, IEEE International Conference, 2015

  Jeya Jeya Padmini discusses about effective power utilization and conservation in smart homes using IoT. It uses cameras for recognizing human activities through image processing techniques.

- Pranay P. Gaikwad, **"A Survey based on Smart Home System Using Internet of Things"**, IEEE International Conference, 2015

  Pranay P.Gaikwad discusses about challenges and problems arise in smart home systems using IoT and propose possible solutions.

4 Need Analysis

The currently available solution and research exhibit these features

- The existing market solutions provide on/off switching of the devices. The available solutions provide comparatively lower energy efficiency and also require human intervention to achieve desired conditioning of the environment.

- Some of them also use unsuitable technologies like Power Line Communications, Bluetooth and Ethernet etc. From the present analysis of the existing solutions for automating a room environment, the technologies used suffer from a number of drawbacks. So, these protocols are limited in functionalities when used by an end user in real life.

5 Objectives

- To detect changes in the environment of rooms using different sensors.
- To develop plug and play device control techniques to manage home appliances.
- To optimize energy consumption to increase the efficiency of the household.
- To design a central processing hub for management of modules and execution of control algorithms.

6 Novelty

Higher levels of controllability can be achieved through individual device level control such as for an AC the temperature, modes, swing, fan speed etc. can be controlled. Load optimization will be carried out from the evaluation of the usage patterns of the individual devices thus increasing the energy efficiency.

7 Methodology

7.1 Energy optimization algorithm formulation

7.1.1 Study of decision influencing parameters

7.1.2 Design of a deep learning model

7.2 Home Automation Unit design

7.2.1 Design of the software for the Home Automation System

All the sensor aggregator modules and the retrofit modules need a central hub for their communication and management. The HAS will receive the inputs from the sensors and give an optimized output to the modules after processing it using the aforementioned algorithms. The HAS will run atop it providing functionalities like adding new devices, removing devices, defining rooms, adding sensor aggregator units and plug and play smart device conversion modules.

7.2.2 Development of a user interface to enable user interaction with the system

Applications will be deployed on the market places for the most common mobile platforms, App Store for iOS and Play Store for Android. A cloud-based web app will also be

deployed for users to operate from laptops and desktops. The user will be able to use these apps to connect directly to the server hosted on the Home Automation Unit in their homes without any middleware services ensuring their security and privacy.

8 Deliverables

- Sensor modules to collect room environment parameters.
- Plug and Play actuator modules to control household devices.
- Load Optimization Algorithm based on deep reinforcement learning models
- Home Automation Unit to manage the devices and execute control algorithms and associated mobile applications.

9 Associated Subjects

UTA007 Computer Programming-I Fundamentals of functional programming

UTA009 Computer Programming-II Fundamentals of object oriented programming

UTA011 Engineering Design-III Embedded system design using sensors and microcontrollers

UEE301 Direct Current Machines and Transformers Study of transformers

UEE505 Analog and Digital Systems Study of analog and digital systems and their interoperability.

UEE401 Alternating Current Machines Study of the single phase induction motors

UEE504 Power Electronics Use of switches to control device output in an efficient manner

UEI404 Digital Signal Processing Fundamentals Use of DSP techniques to process signal from sensors and other devices

UEI609 Fundamentals of Microprocessors and Microcontrollers

UEI501 Control Systems Use of closed loop systems to eliminate errors in a system

UEE801 Electric Drives Application of Power electronics to control AC Drives

10 Interdisciplinary Works

This project consists of extensive multidisciplinary efforts. The Load Optimization algorithm will be generated using a Deep Reinforcement Learning model which is primarily a topic of interest in Computer Science. The wireless communication among the sensors, devices and the HAU are subjects of Electronics and Communication Engineering.

11 Software Used

Provided by college

- MATLAB
- LabVIEW
- Multisim and Ultiboard

Open Source

- Tensorflow
- Node.js

12 Hardware Used

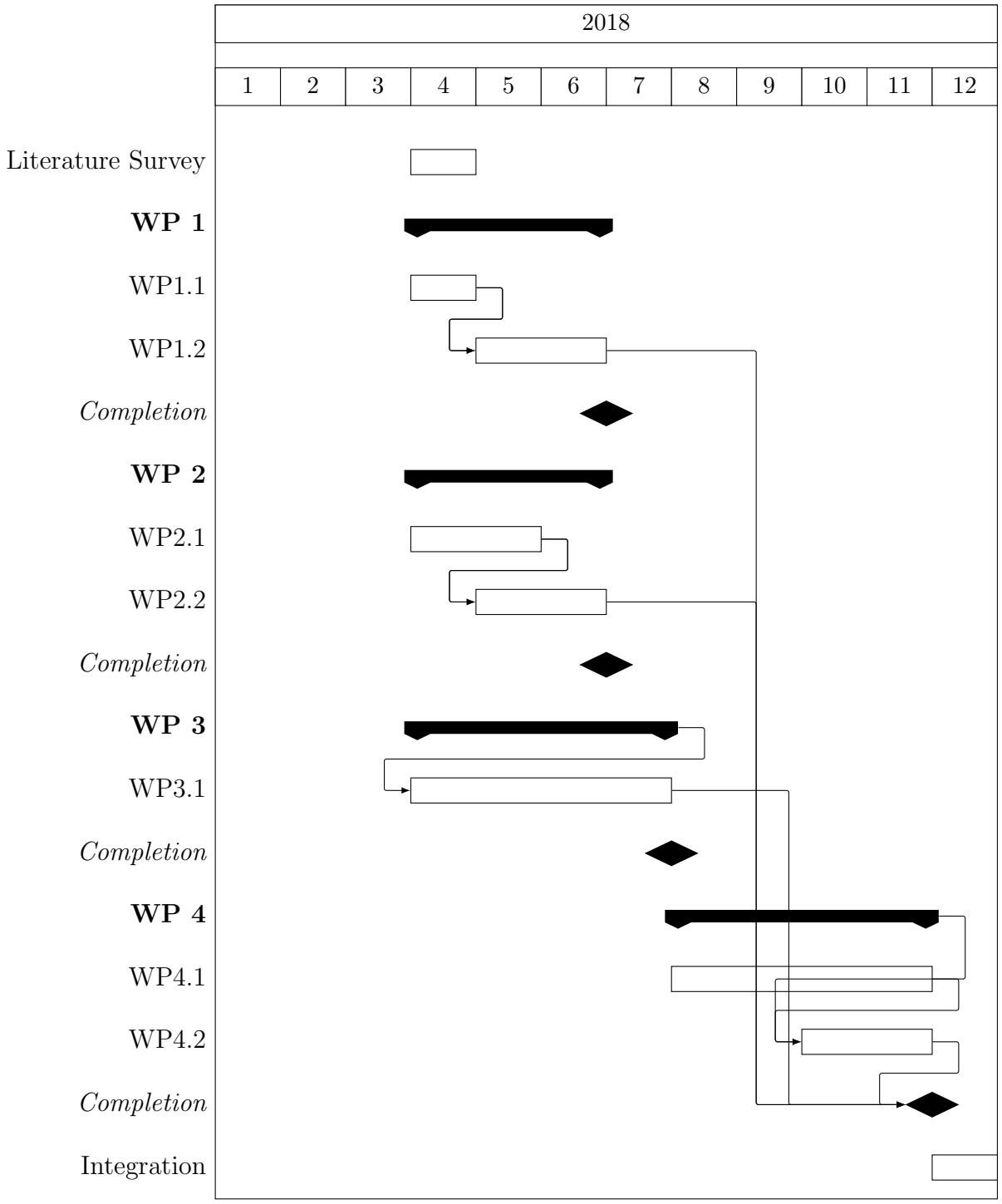
- PCB Prototyping Machine
- Digital Storage Oscilloscope
- Function Generator
- Multimeter
- Soldering station
- Mobile Phone

13 Real-world compliance

13.1 Engineering Standards

13.2 Realistic Constraints

14 Work Schedule



15 Proposed Budget

Item	Specification	Quantity	Amount	Manufacturer	Justification
Raspberry Pi 3 Model B	64-bit ARM-v8 processor 1.2GHz 1GB RAM	3	7,185	Raspberry Pi Foundation	Central Processing Hub
TP-Link Archer C20 AC750 Wireless Dual Band Router		1	1,499	TP-Link	Wifi Router to establish the network around the house
esp8266 Wifi Board	GPIO SPI SDIO I2C	5	1,045	Espressif Systems	Wifi Board for wireless modular connectivity
ATTiny Microcontroller	1 timer 2 PWM Channel 4 Channel ADC inputs Watchdog	10	540	Microchip Technology	Microcontroller for controlling the PnP Devices
ATMega328P Microcontroller	8 Bit 32 KB Flash Advanced RISC Architecture 20 MHz CPU Clock 3 Timers 6 PWM	10	1,240	Microchip Technology	
Relay	Current: 16A Coil Voltage: 5V	20	1,440	Amazon*	Switching the primitive devices
DHT11 Humidity and Temperature Sensor	Voltage: DC 5V Digital Output Humidity Range: 20-90RH Temperature range: 0-60	10	860	Evelta*	Sensors for developing Sensor Aggregator modules
HC-SR501 PIR Sensor		2	858	Evelta*	
GY-30 Light Intensity Sensor		10	1,150	Evelta*	
Jumper Wires		5	1,160	Amazon*	Prototyping
Breadboard		10	1290	Amazon*	

Printed Circuit Boards		20	400	J. B. Electronics	
Philips Base B22 9-Watt LED Bulb		1	669	Philips	Consumables for developing control methodology for PnP Modules
Crompton Hill Briz 1200mm Ceiling Fan	Sweep: 1200mm Bearing: Double ball bearing Blades: 3 Speed: 370 RPM	3	4,347	Crompton Greaves	
Circuit Components			2,500	J. B. Electronics	Capacitors, MOSFETS etc. required to develop driver circuitry for PnP and Sensor Aggregator modules
Miscellaneous Expenses			5,000		Contingency reserve expenses
Total			**30,034**		