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Using Learning-as-a-Service To Enhance Home Automation

Design and Implementation of a LaaS Server for In-home Usage

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Abstract — *This paper details an attempt at implementing a special SaaS Server that provides Machine Learning service to client application(s). We first create a Learning Service which is then utilized to predict future actions that the user may perform. We've also developed an ad-hoc control interfacing system for the user, consisting of buttons related to various connected devices. This interface is implemented as a webapp that is served up by the controller (for which we're using the Raspberry Pi). It interacts with the LaaS Server to store and analyze the collected user actions. Prediction regarding the next action is requested by the controller to the LaaS Server. This prediction, when received, is applied instantaneously to the connected devices. Thus, it forms a real-time analysis-and-prediction system. This system works by collecting usage statistics from the user and some emulated external factors that may influence the usage of the system. These collections are then analyzed for correlation between individual device states and corresponding external influencing factors. This process is repeated every time a new entry is added. The correlation previously established is then updated in real time at each new entry. This correlation is in the form of a prediction model that is used to generate predictions. The controller instantaneously acts upon the predictions to change the device states, thus reflecting the user's usage pattern and providing a sense of true automation.*

Keywords *- software-as-a-service; learning-as-a-service; internet of things; machine learning; raspberry pi; home automation.*

I. INTRODUCTION

A This project aims to enhance the home automation experience by collecting usage data from the user and applying prediction algorithms on it to predict the next step the user may take. Furthermore, external data will also be collected and correlated with the usage data in order to determine what external conditions may influence the user's behavior. This may involve data like weather data and traffic data.

Present-day smart homes are using simple reflex agents for automation. Simple reflex agents are non-flexible and can work with limited perceptions and hard-coded actuation rules. These rules may not necessarily suit all users. This rigidity in present consumer automation systems forms the basis of our problem. This project is intended to be a software solution to this problem, which is centred on machine learning. This solution will be in the form of a Learning-as-a-Service Server which learns user habits by observation and correlation.

II. EXISTING TECHNIQUES

Modern home automation systems in the consumer market have evolved into one the following two categories, or a combination of these two:

I.1 Type I: Centralized Electronic Control Based

These are the systems in which all conventionally electrical switching and regulating mechanisms are integrated into a single "smart" electronic device. In simpler terms, the electrical components are hidden behind electronic hardware that provides a simplified, compact, and mobile control interface for the user. An example of this can be found in contemporary smart home systems where the user installs purposefully designed smart switchboards and smart appliances that can be controlled wirelessly by a central interface in the form of a mobile device application.

Such systems may also provide some low level automation in the form of time-based planning by the user; the user may design and save plans to turn specific appliances on or off at specific times, and keep them so for a specific length of time.

I.2 Type II: Simple Reflex Agent Based

These systems are more autonomous in nature. A reflex agent is employed in these systems to sense some external environment parameters. These parameters are then used to decide the value of a corresponding internal parameter of the smart home. Such a correlation between the external and internal parameters has to be configured manually by the user. This also implies that these systems are extremely non-flexible.

III. PROPOSED SYSTEM

Considering the limitations and inefficiencies of the above mentioned types, we came up with a novel solution – a machine learning based home automation system. This system will act autonomously by reading external parameters and behavior patterns of the user in real time and correlating the two to create a behavior model of the user. This model will help the system make a more educated guess about the user's next action which it will perform on encountering similar external parameters again. It will thus give a sense of automation by copying the user's habits

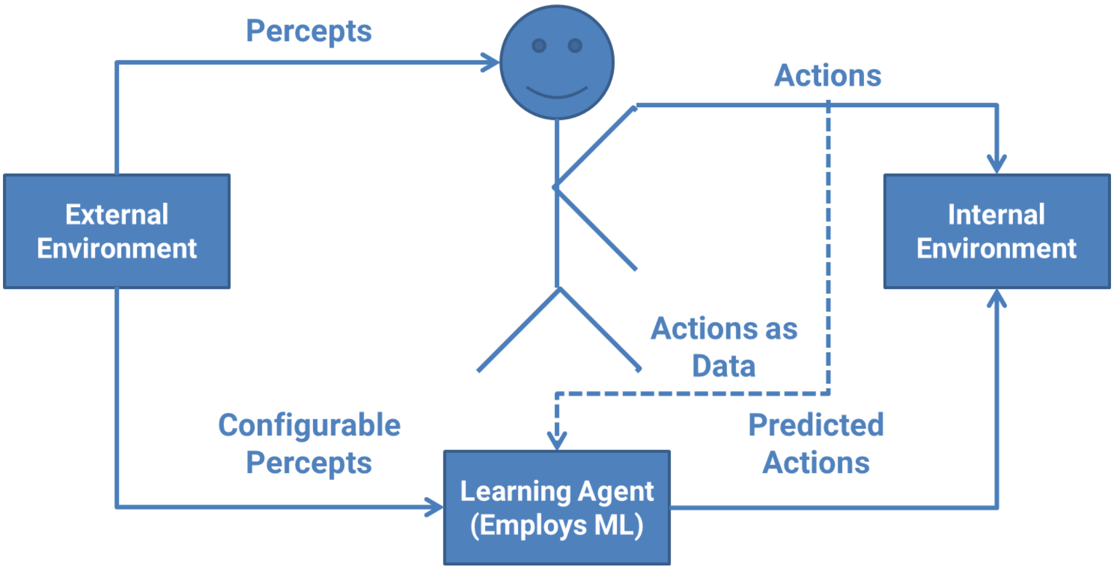

Figure 1: System Architecture

The activity diagram for the system is as below:

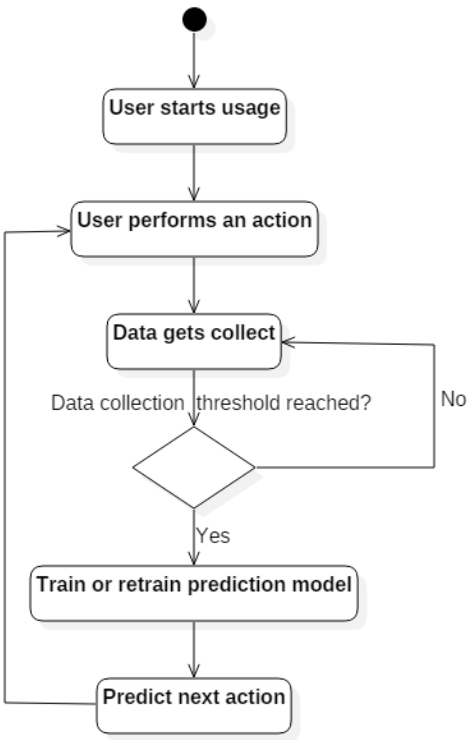

Figure 2: Activity Diagram for the Proposed System

We intend the software to be divided over two tiers: the interface and the LaaS Server. The user is served up a web interface to the smart devices connected to the Raspberry Pi over a conventional TCP/IP network. It will be possible to view the states of individual devices and change them. Such usage of the system can happen even in the absence of the Machine Learning Service. That is to say, the first tier consists of an independent interfacing system that enables the user to control connected smart devices, and this may optionally utilize a usage-prediction-oriented machine learning service if it is available.

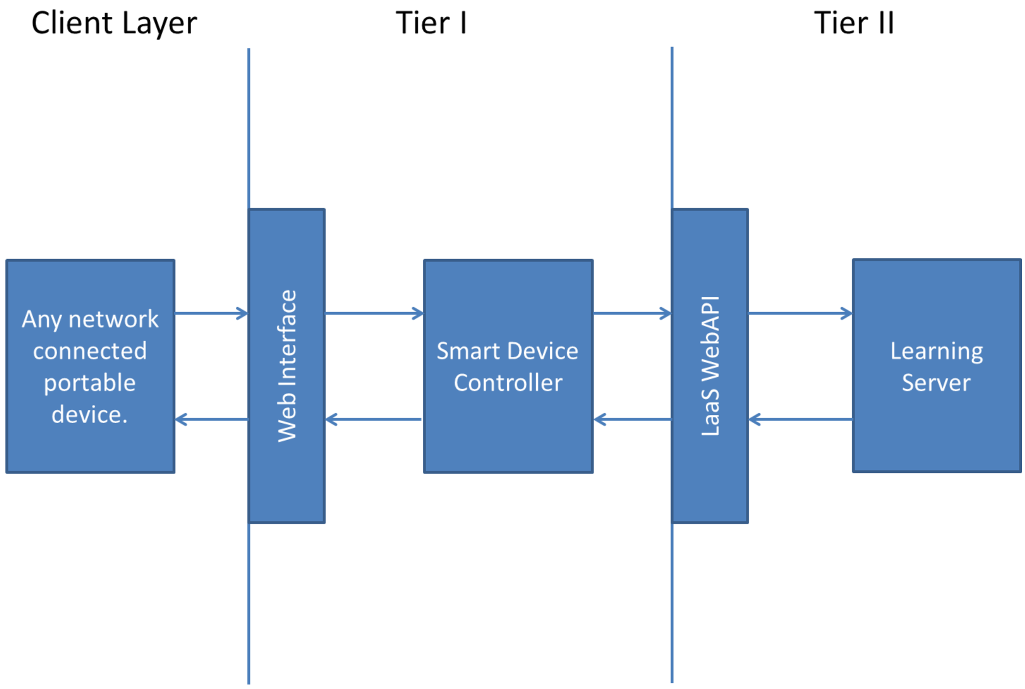

Figure 3: Overview of Tiered Components and their Interfacing

The second tier consists of a special case of SaaS (Software-as-a-Service), called LaaS (Learning-as-a-Service). This service is intended to provide proper WebAPI for the tier one application to communicate with. Data can be sent by the tier one application to the LaaS service using this API, which will then be processed continuously to generate predictions for individual devices. These predictions can also be requested by the tier one application so it can apply it in real-time to the smart environment it is providing an interface to. Non-availability of the services in this tier will not affect the user interfacing system implemented in the first tier, except for the unavailability of predictions.

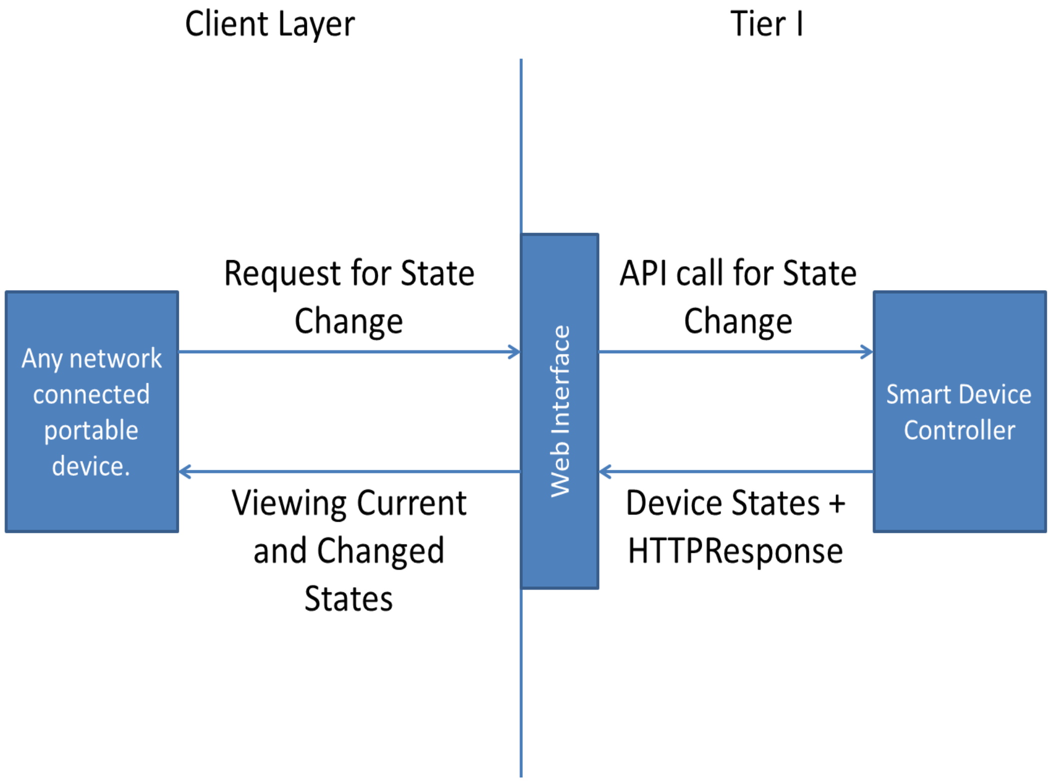

Figure 4: Interface between Client and Tier I

IV. RESULTS

Following are the screenshots of the control menu from the user's device.

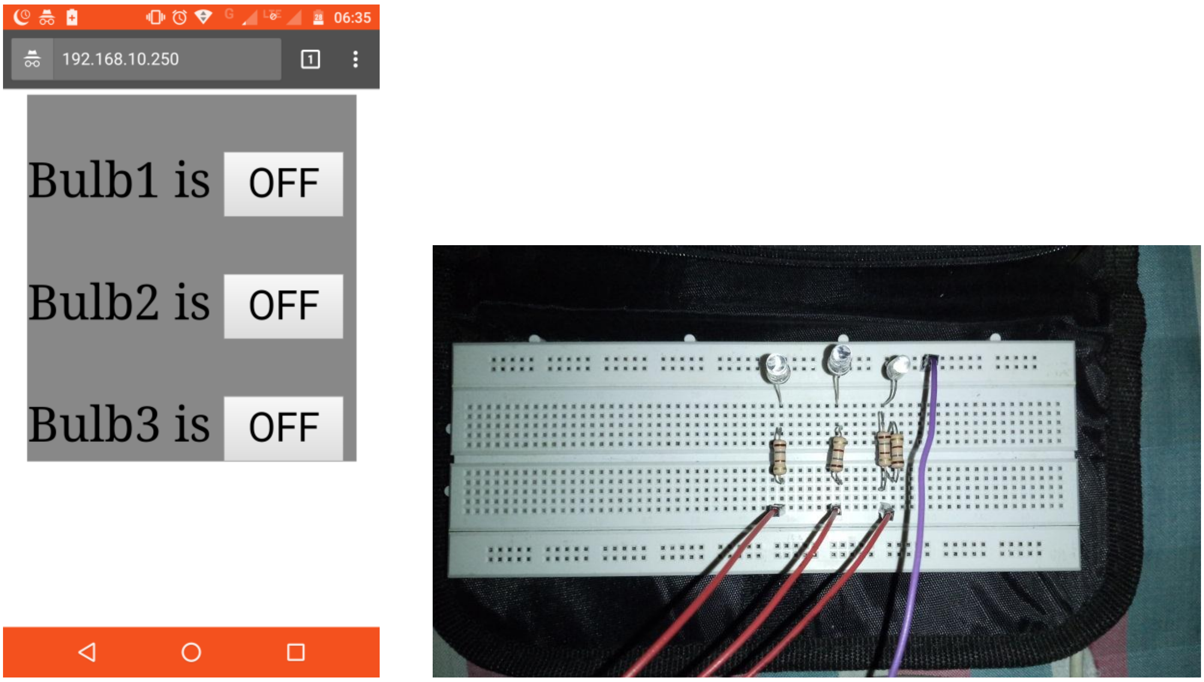

Figure 5: The menu as it will be displayed to the user and an ad-hoc setup for demonstration

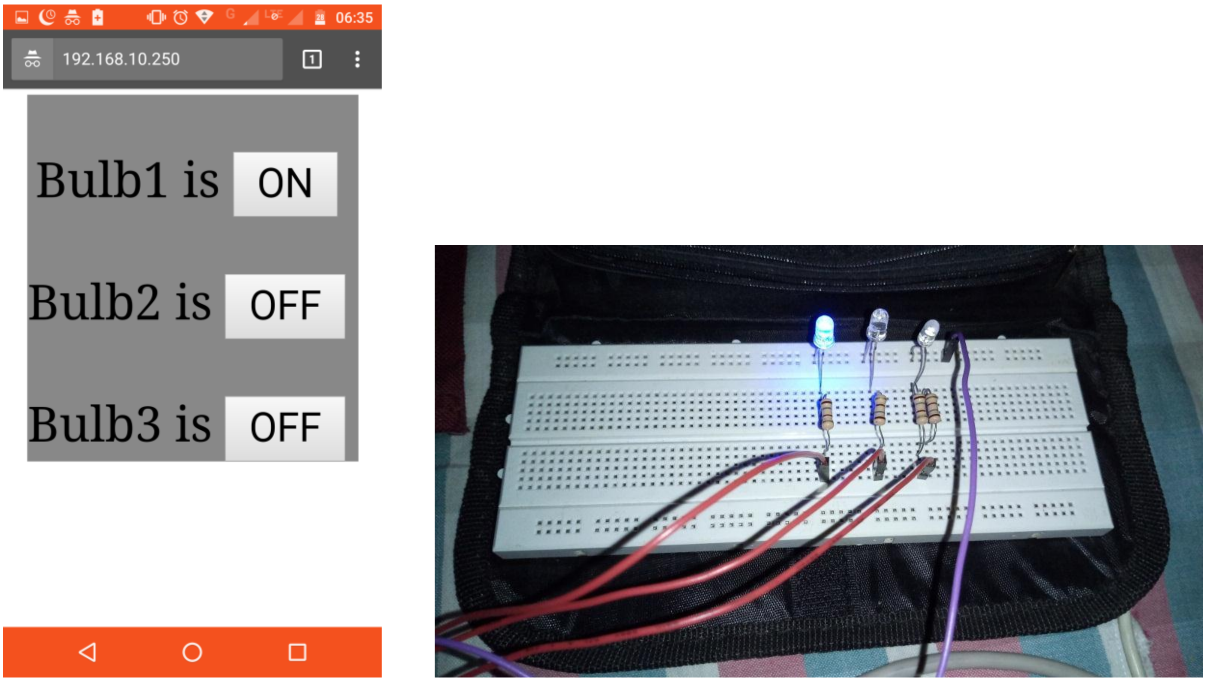

Figure 6: Action and effect of switching Bulb1 on

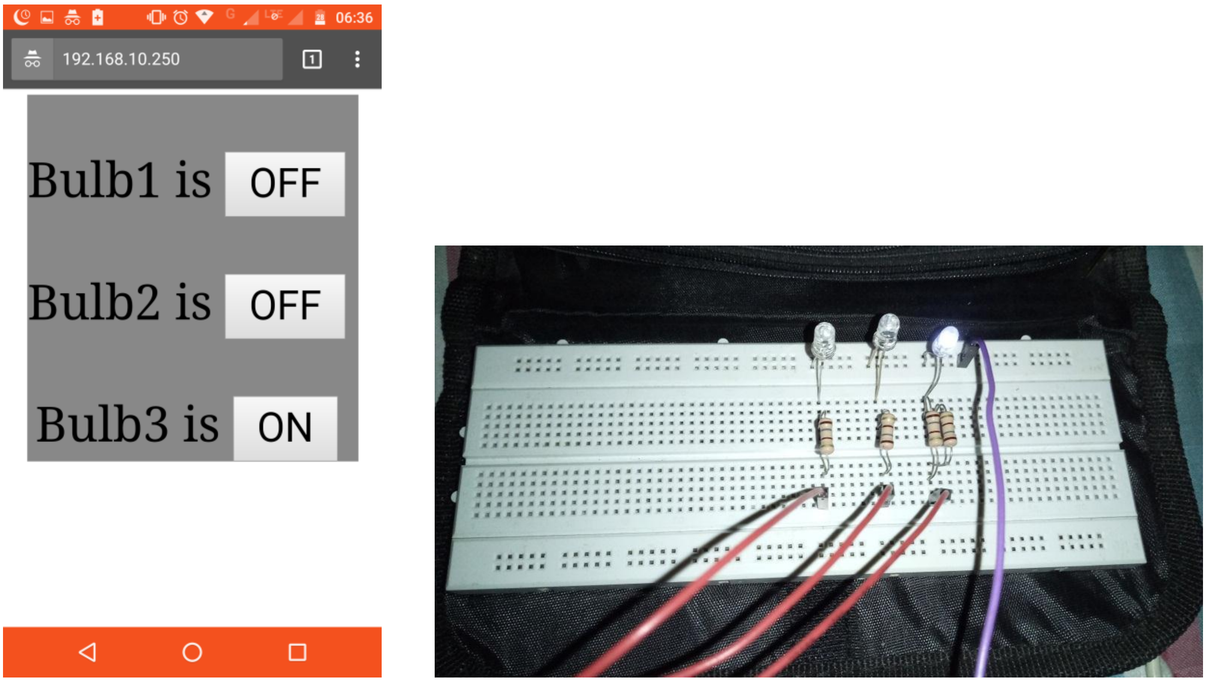

Figure 7: Here Bulb3 can be seen switched on, while other bulbs are off

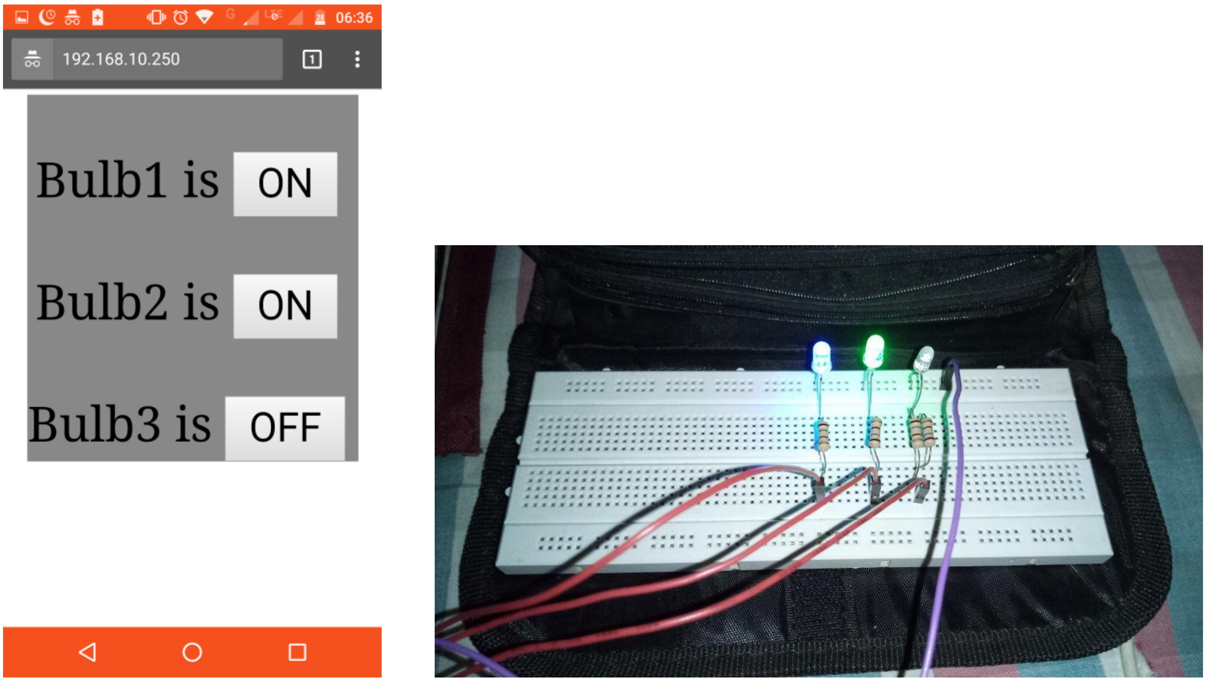

Figure 8: Both Bulb1 and Bulb2 are switched on

V. CONCLUSION

With the rise of Internet of Things and more powerful computers, we will be able to achieve Utopian homes using Smart Automation powered by Machine Learning Algorithms of higher complexity than Logistic Regression that is used here. More data will enable better prediction of potential user actions which will help us lead more comfortable lives. Physically challenged people can also benefit from such systems, as it can make them more independent. The impact of this technology on human lives will be deep and it is speculated that every human-machine interface in the future will have some form of machine learning powered intelligent assistance. Changes detected in user habits can also be used to predict a lot of other things about the user such as the user's physical and mental health. In fact, there are many medical technology products today that aim to provide basic level medical assistance using machine learning systems.

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