Machine Learning On Real-Time Data to Enhance Home Automation

Sameer Shaikh[#1], Ayyaj Attar[#2], Siddik Pathan[#3], Rukaiya Shaikh[#4]

[#] *Department of Computer Engineering, Savitribai Phule Pune University*
Ganeshkhind, Pune-411007, Maharashtra, India

Abstract— *Traditional home automation systems are mostly hard-coded or require manual automation plan generation by users. This requires interaction between a control system (an app) and the user, requiring quite some effort and time to be put in manual planning of the home environment. This project intends to explore combining ML and real-time usage data to generate personalized and time-variant home automation plans. These plans will save the user time and effort, leading to a smoother ML driven home automation experience. We collect streaming usage statistics from smart-home occupants and store it on a centralized server. Simultaneously, we also collect "external" data (which may consist of environmental factors like natural light intensity, wind speed, et cetera) which may influence occupants' usage behavior. These datasets are combined, with data timestamps as a unique identifying field, into a super-set. It's then fed into a Machine Learning system to correlate user habits with time of the day and the external factors. The correlation hence established will be updated as new data coming into the system in real time or if it crosses a certain percentile ratio threshold. This correlation will be used to generate personalized automation plans for individual occupants. Hence, by combining real-time usage data from a conventional home automation system and Machine Learning, we will be able to provide smoother and more comfortable environment to the users, as the burden of plan generation will be greatly reduced.*

Keywords — *machine learning, home automation, real-time analytics, simple reflex agent, learning agent, anomaly detection, activity detection.*

I. Introduction

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 behaviour. This involves data like weather data and traffic data. Most present-day smart homes use 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 suit all people. This rigidity in usability of present consumer automation systems forms the core of our problem. We intend to develop a software solution to this problem, which is centred on machine learning. This solution will be in the form of a learning agent that learns user habits by observation and anomaly detection.

II. Existing Techniques

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

A. Type-I: Centralized Electronic Control Based

These are the systems where 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 often mobile control interface to the user. An example of this can be found in contemporary smart home systems where the user needs to install purposefully designed smart switchboards and smart appliances that can be controlled wirelessly by a central interface in the form of a smartphone application.

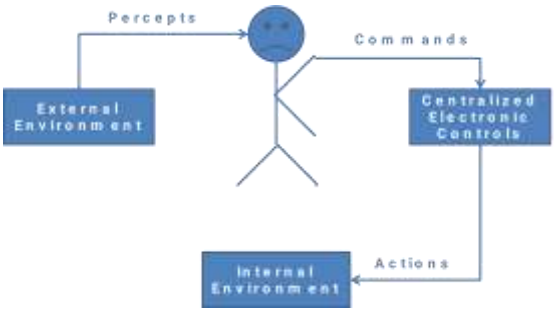

Figure 1: Type-I Automation System

These controls 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.

B. Type II: Simple Reflex Agent Based

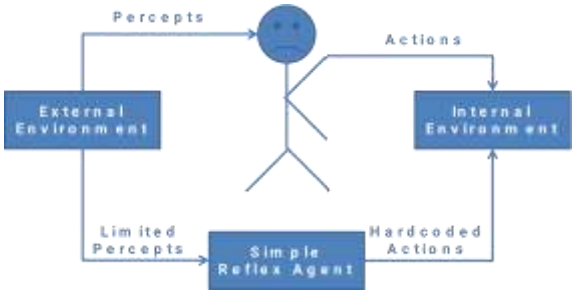

Figure 2: Type-II Automation System

These are the more autonomous type of systems. A reflex agent is employed in these systems to sense some parameters from the external environment. These parameters are then used to decide the value of a corresponding internal parameter of the smart home. The correlation between the external and internal parameters has to be configured manually by the manufacturer or the user. This also means that these systems are very rigid, and extreme variations in the external factors may not have a configured corresponding reflex and the system may report a failure or choose a non-optimal default reflex – depending on its design.

III. Our Contribution

Taking the limitations and inefficiencies of the above mentioned types into consideration, we came up with a novel solution – a Machine Learning Based automation system. Such a system will act autonomously by reading external parameters and behaviour patterns of the user in real time and correlating the two to create a behaviour 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 the user a sense of true automation by mimicking the user's habits.

The system design of this approach can be well represented by the following figure:

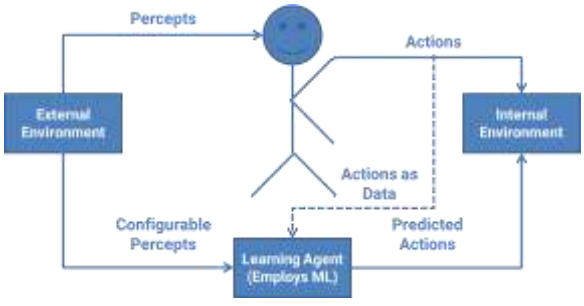

Figure 3: Machine Learning Based Automation System

This represents the functioning of the learning agent within the home environment. The agent will sense the external environment using it's sensors, while being simultaneously fed with the actions performed by the user. These actions are then correlated to the state of the external parameters, which help the agent learn the user's habit given a set of external state parameters.

It is pertinent to note the similarity between the functoining of the agent and the actoins of the agent. Just like the user gets influenced by the environment to act in a certain way, so does the agent – once it learns to mimic the user.

IV. Results

We have thus formulated a smart home automation system that will make use of machine learning techniques to process collected usage data. This system overcomes the limitations of previous automation systems, by learning from previous user-generated events in correlation with measured external parameters.

V. Conclusions

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 Temporal Difference based Reinforcement Learning running on current data. More data will lead to better prediction of potential user action which will help us lead more comfortable lives. Physically challenged people can also benefit from such systems which will eventually make them more independent, as more and more data gets collected to predict such users' habits. The impact of this technology on human lives will be deep and possibly every human-machine interface in the future will have some form of machine learning powered intelligent assistance. Changes 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, many current technologies aim to provide basic level medical assistance using machine learning systems.

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