The impacts of lifestyle choices on energy usage and the environment are increasingly becoming more noticeable and discussed in society. As a result, research resources are being directed toward green technology, environmentally-friendly building designs, and active demand response within the smart grid. In this paper, we look more closely at the user side of sustainability and ways ubiquitous computing may aid in reducing energy consumption. In particular, we design a machine learning-based intervention to promote energy-efficient, sustainable behavior through home automation.

当今社会，人们生活方式的选择对于能源、环境的利用发挥着越来越重要的作用。因此，当今研究的关注点集中于绿化技术，环境友好的建筑设计，以及智能电网中的需求侧相应。本文着眼点在于：用户侧可持续能源利用以及普适计算方法的应用，能帮助居民节能。值得指出的是，本文设计了基于学习的家庭自动化能源管理系统。该系统旨在实现家庭能源的经济运行与可持续使用。

In 2010, the United States consumed 97.722 quadrillion btu of energy, a 300% increase from 1949 [12]. The growth of energy usage is not entirely due to manufacturing plants and automobiles. In fact, the residential sector is responsible for 16-50% of energy consumed worldwide [7]. A utility bill provides insights about monthly whole-building consumption, which leaves homeowners to guess at the reasons for an unusually high or low bill. Earlier studies reveal that home residents reduce consumption by as much as 15% in response to simply viewing raw usage data [4] and indicate that widely-varying residential behavior can influence usage by as much as 100% in a single house [10].

在2010年，美国消耗了97.722千兆英热的能源；较之1949年，增长了3倍[12]。能耗的增长并不是完全由大规模发电站和汽车造成；实际上，居民能耗占世界总能耗的16-50%[7]。月账单提供给用户整个建筑内的能耗。用户通过月账单，可以推测造成账单账目高低的原因。早期的研究揭示：居民可以通过简单浏览粗略的使用能源数据调整家庭能源的使用，节省能耗大概15%[4]；并且，多变的居民行为变化可以极大影响单个家庭中的能源使用[10]。

This paper hypothesizes that activity recognition techniques can be used to provide energy-efficient automation in a smart home environment. This type of automation makes use of behavior analysis and ubiquitous computing to reduce energy consumption, while still supporting a resident’s everyday activities. To validate this hypothesis, CARL (CASAS Activity-based Resource Limitation), a smart home automation technology was designed and implemented to control devices in the home. CARL utilizes a real-time activity recognition algorithm [8] to identify current activities being performed by the resident from sensor data in an instrumented smart home.

本文假定活动识别技术，可以在智能家庭的环境中提供能源经济自动化运行。这种类型的自动化在支持用户的日常活动的同时，利用了行为分析和普适计算的方法来减少能耗。为了验证假定，本文设计并实现了一个智能家庭自动化系统（CARL，即基于活动的资源限制技术），来控制家庭中的设备。CARL利用了实时活动识别的算法[8]，结合智能家庭中部署的传感器的数据，来识别当前居民的活动。

Electrical device usage distributions are estimated for each activity, and any devices not associated with the current activities may be turned off by CARL to reduce energy consumption. The utility of CARL is demonstrated in one of the smart home testbeds available as part of the CASAS (Center for Advanced Study of Adaptive Systems) smart home project at Washington State University. An evaluation of CARL is based on activity recognition accuracy, effectiveness at identifying devices to turn off, and energy consumption with, and without, activity-aware automation.

对于不同的活动，电器设备的使用分布被进行了预估。为了达到节能的目的，C任何与当前活动不相关的设备都会被CARL系统关闭。CARL系统的功效性在一个智能家庭的实验平台上体现。该实验平台是华盛顿州立大学一个智能家庭项目，CASAS（自适应系统高级研究中心）的一部分。CARL系统的评估主要基于以下几点：1）活动识别的准确度，2）识别关闭设备的准确性，3）与未使用该系统的能耗对比。