**CARL Automation Algorithm**

CARL’s initial automation strategy is to turn oﬀ devices that are not needed in support of the current set of activities. To do this, ﬁrst identify all of the current activities then determine the devices that are used by these activities.

CARL系统最初的自动化策略是关闭所有支持当前活动集合不需要的设备。为了实现该策略，首先需要识别出所有的当前活动，然后决定支持当前活动中所需要的设备。

Determining the set of current activities presents a particular challenge when processing data in real time. Segmentation algorithms can be used to mark the begin point and end point for any particular activity. However, these typically process historic data in oﬄine mode. For real-time processing, a delay value is maintained for each activity class and device.

在实时处理数据时候，决定当前的活动集合是一个很大的挑战。分段算法可以被用来给特定的活动标记起始点和终结点。然而，这些算法都以离线模式处理历史数据。对于实时的处理，每个活动类和设备有一个时延值。

The delay value DelayAi represents the amount of time that has elapsed since a sensor event was observed that was labeled with activity label Ai. If the delay value for a particular activity is within a threshold number of time units then the activity is considered current. The delay value represents the amount of time that has elapsed since device Dj was observed changing state to ON. Each device Dj has an associated DeviceThresholdj that is used to prevent the device from being turned oﬀ seconds after the resident turned the device on, allowing new activities to be initiated before the device is evaluated by CARL.

时延值DelayAi代表了，从被标记活动Ai发生的传感器事件被观测开始，消逝的时间。如果该时延值在阈值DelayThreshold内，则认为该活动在当前活动集中。时延值DelayDj代表了，从观测到设备打开开始，消逝的时间。每个设备Dj有一个关联的阈值DeviceThresholdj，该阈值用来防止设备在居民打开设备数秒后就被关闭；从而，允许新的活动在设备被CARL系统评估之前被初始化。

Additionally, turning the device on with a double tap of the light switch informs CARL that the automatic decision to turn it oﬀ was incorrect and DeviceThresholdj should be set to LongThreshold.

此外，双击轻敲开关打开设备的操作，告知CARL系统自动关闭设备的决策是不正确的。并且，设备时延阈值DeviceThresholdj应该被设定到较大的阈值LongThreshold。

CARL Automation(A,D):

// A is the set of known activity classes

// D is the set of available devices

LongThreshold = DelayThreshold ∗ 4

for j = 1 to |D| : // set threshold for each device

DeviceT hresholdj = DelayThreshold

t =1

while observe new sensor event et :

CurrentActivities = ∅

CurrentDevices = ∅

// get activity label for sensor event

At = AR(et, A)

for i = 1 to |A| : // update times for each activity

expidite if Ai = At :

DelayAi = 0

else:

DelayAi = DelayAi + 1

for j = 1 to |D| : // update times for each device

if et == Dj and State(Dj,ON) :

DelayDj = 0

if et == DoubleT apOn :

DeviceT hresholdj = LongThreshold

else:

DeviceT hresholdj = DelayThreshold

else:

DelayDj = DelayDj = δt

for i = 1 to |A| : // get set of current activities

if DelayAi < DelayThreshold :

Append(CurrentActivities, Ai)

for j = 1 to |D| : // get set of current devices

if Dj ∈ Devices(CurrentActivities) :

Append(CurrentDevices, Dj)

for j = 1 to |D| : // turn off not-needed devices

if State(Dj,ON) and Dj ∈ CurrentDevices :

if DelayDj > DeviceT hresholdj :

ChangeState(Dj,OFF)

t+ = 1

Algorithm 1: Activity-aware device control algorithm.

Next, for each activity Ai, the algorithm maintains a probability distribution over devices whose status is ON. Devices with a suﬃciently great probability of being associated with Ai are left untouched when activity Ai is current. On the other hand, any device Dj whose status is not typically ON for any of the current activities is a candidate for CARL to turn oﬀ if is greater than DeviceThresholdj. The activity-aware automation algorithm is summarized in Algorithm 1.

对每个活动Ai，算法维护了一个开启设备的随机分布。在活动Ai为当前活动时，具有足够大概率与活动Ai关联的设备，会不关闭。而对于与当前活动关联不大的设备，CARL系统会把他们作为关闭的候选，当他们设备时延值超过阈值DeviceThresholdj时就会被关闭。基于活动感知的自动化算法在Algorithm 1中被概括。

A modiﬁcation to the algorithm was made after a brief pilot test with the resident. A guard statement was added to prevent CARL from turning oﬀ lights in the bathroom while the bathroom door was closed. There are no windows in the bathroom so unexpectedly turning oﬀ the light could present an unsafe situation.

算法在一个居民的试点测试后被修改。CARL系统添加了一个保护声明，来防止浴室的灯在浴室门关闭的时候关闭。因为浴室没有窗户，所有关闭浴室的灯会造成一种不安全的环境。