Considerations with Counting Activity using the EPAC – EnOcean People Activity Counter

1. Purpose

This paper discusses the function of the EnOcean People Activity Counter (EPAC) and possible deployments. It talks of problems and solutions for more meaningful data.

2. Description

What the EPAC does:

- measures the number of activities within the last 2 minutes with a resolution of 1 second (people activity count) and reports this number approximately every 2 minutes via a D2-15-00 EnOcean telegram. It also reports a heartbeat at approximately one (1) hour of inactivity. The count counts to 65535 then rolls over. This was done incase a notification was missed, the number of counts would not be lost.
- EPAC covers an area of around 30 sqm. To reduce coverage an application note is provided for 3D printing of suited lens covers (incl. 3D printing data).
- Provides data that can easily be used to develop heat maps or of an area, usage density.

What it does not do:

- Provides no correlation between sensors.
- Provides no correlation between activities and absolute number of people in the room.

3. Theory of operation and discussion of algorithms

The EPAC reports the number of triggers via a PIR sensor measured every second and is reported at 2 minutes intervals. This data is used in conjunction with the knowledge of room layout, sensor placement, ingress and egress, and typical room capacity.

Using these data one can make a model of usage for the particular area.

Use Case 1. Room

Since we know that the sensor sends a heartbeat on the hour when there in no occupancy we can set the counter to zero.

Person enters conference room and is preparing to setup a meeting:

Starting the counter at zero a person enters the conference room and an EPAC triggers and we have occupancy and then as the person moves about the room we receive numbers from our sensors every two minutes giving a certain number from specific sensors based on their movement.

As the meeting starts, the door may open again and as people enter the room, again knowing EPAC placement and room topology, we start receiving data from our sensors. These counts will peak until people have settled down for the meeting upon which we see a

drop in the counts. As an option, adding door sensors to a room may help with heuristics. Perhaps tracking door sensors we can determine if someone is late or dropping off refreshments for the meeting. Upon close of the meeting we see the numbers increasing as people prepare to egress and once everyone has left we again see numbers drop to zero for a few minutes and tells us no one is left in the room.

Use Case 2. Hallway/Building Entrance

Person enters hallway:

In **Figure 3.** we see a typical hallway. Depending on the Hallway topology and placement of the sensor, the activity count can be expected to correlate well with the number of people passing through and could be aggregated over short or longer periods of time. One could count the numbers reported ever few minutes or over a day, for example.

4. Physical deployment

Device resolution relates directly to ones ability to count accurately. Partial room coverage cannot give a full picture of room occupancy. Complete coverage of sensing fields will offer the best chance for accurate detection. This however, be dictated by cost and need for accuracy.

We will use two examples for deployment ideas. One, a room where accuracy of people counting is the highest need, and two, a hallway example that will show fairly high count accuracy but need fewer sensors and a less complicated algorithm.

Deployment for a room where high accuracy is important

Below we see two different deployments for a room.

In the first room one can see significant area with incomplete coverage, where motion will not be detected. When one considers ingress and egress from the room, complexity to the system increases and the ability discriminate individuals becomes quite challenging.

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Figure 1 We see that there are significant holes in the space of interest in this example. Activity tracking becomes difficult as it becomes difficult to track individuals as they move about.

We see in this example that the room has full coverage, with as few dead zones as possible. Ingress, and egress are known and can be used as datapoints for the algorithm.
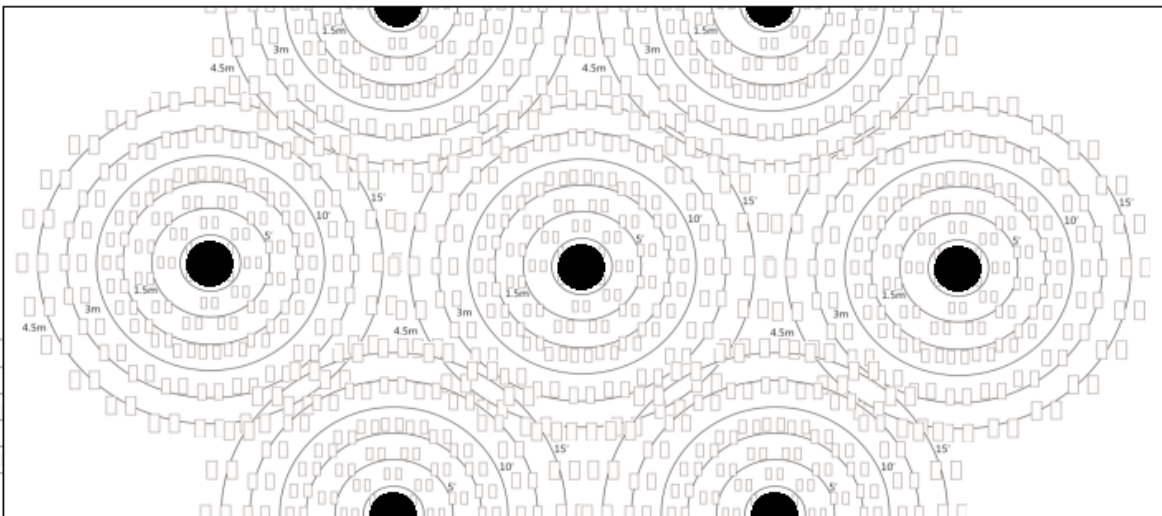

Figure 2 The example above would render meaningful data when individuals move from one sensor cover to the next.

Example: Deployment for a hallway

Since a hallway is typically used for getting from one place to another in the building this becomes a simpler case of tracking the number of individuals who pass through at any give point.

The number of sensors can be reduced and depending on the need, data can be interpreted for directional usage of the hallway. In addition other sensors can be used such as the

EnOcean Door/Window contact sensor (EMDCU) and include door opening/closing to the aggregate data thus rendering an accurate data set for pass through.
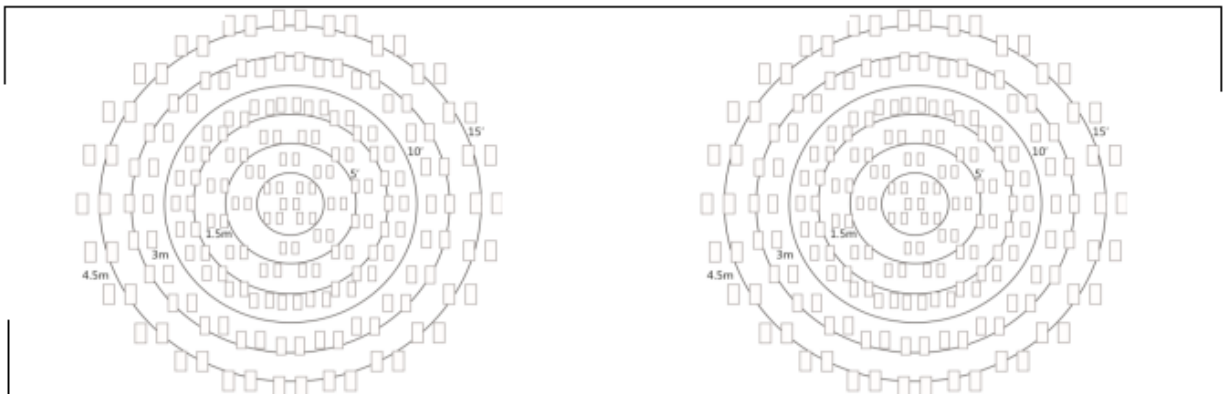

Figure 3 Hallway example

5. Heat Map Example

The term "heatmap" is a data visualization technique that tracks something, we track occupancy signals that are triggered by motion.

From our well covered room from **Figure 2** above we will show what a heat map might look like and how we might render this map. This will be a map of room usage over what a full day might look like.

Example

As people move through the sensors during the day we receive counts from sensors and collect them in an additive fashion. At the end of the day we summate these numbers and have a known map of the room as we see in **Figure 4.**
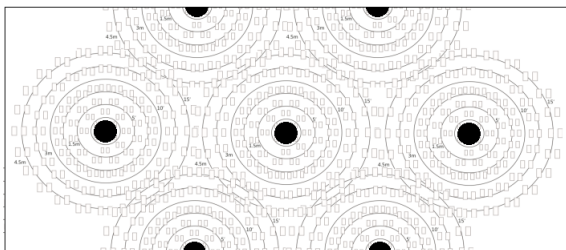

Figure 4 Layout of sensors example

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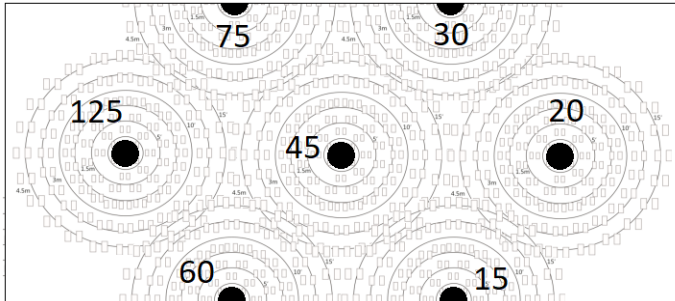

Figure 5 example of data collected, overlayed on room

In **Figure 5** we see the data collected from our sensors overlaid upon the image now as an example visualization. We now feed this in to a charting package capable of generating a heat map:
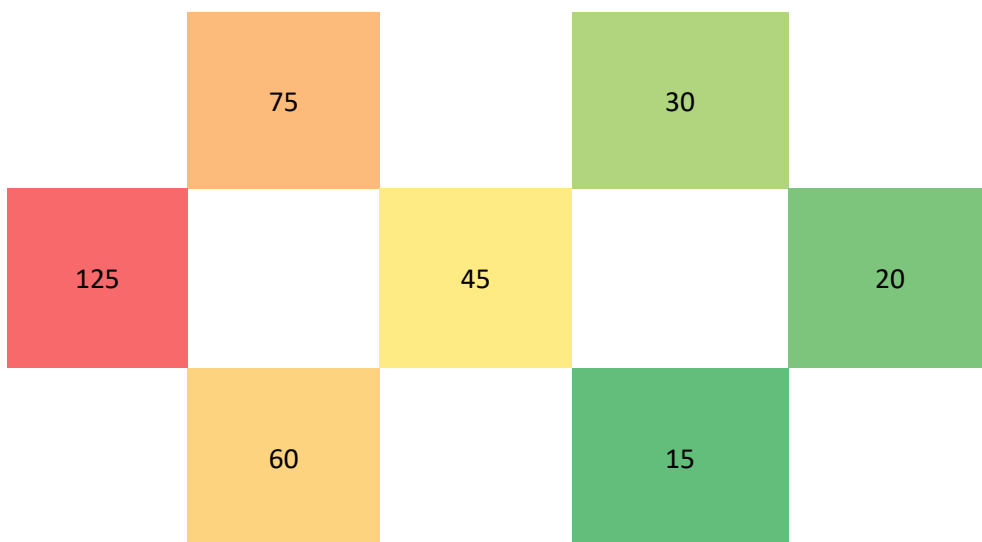

Figure 6 Heat map generated based on usage

Notes on the above:

- The example above shows time usage over a day, of course this could be broken down into smaller time periods based on the need of the application.

- Excel was used as an efficient means of demonstrating data and the resolution of the output is small based off of 7 sensors. Increasing the sensor density and the usage of a statistical package for charting would render different results.

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Algorithm Example

```
If (CurrentSensorCount  > PreviousSensorCount) then
CurrentActivity = (CurrentSensorCount – PreviousSensorCount) * RoomAdjustmentFactor
Else if (CurrentSensorCount  < PreviousSensorCount) // the counter rolled over
CurrentActivity = ( (CurrentSensorCount + 0xffff) – PreviousSensorCount ) * RoomAdjustmentFactor
```

6. References and Resources

User manual

https://www.enocean.com/de/produkte/enocean_module/ceiling-mounted-occupancy-sensor-eosca-oem/user-manual-pdf/

Application note for 3D lens printing

https://www.enocean.com/fileadmin/redaktion/pdf/app_notes/AN701_EOSC_Lens_Cover_2 2102018.pdf

3D data for 3D printing of the lens

https://www.enocean.com/de/produkte/enocean_module/ceiling-mounted-occupancy-sensor-eosca-oem/EOSCx_3D_2D-Data_2017-06-30_03.zip/

D2-15-00 EEP (EnOcean Alliance Link)

http://tools.enocean-alliance.org/EEPViewer/profiles/D2/15/00/D2-15-00.pdf