Smart Parking in Big Malls in the UAE

**Data Compilation and Accessibility**

It might be conceived that there is a shortage in the availability of parking slots due to the difficulties faced by visitors who try to locate a vacant parking spot. Furthermore, due to the shortage in energy supply and the subsequent rise in electricity bills, mall expenses have also escalated.

**Problems**

- Customers need an efficient way to inform them of available parking slots in real-time.
- The components in the proposed solution system should require low maintenance and are of low cost.
- Energy harvesting schemes are not employed to mall's advantage as a result of which resources are wasted.

**Solutions**

**Data Compilation and Accessibility**

- Zigbee End Devices: By utilizing the Zigbee PRO 2012 [1], information about available vacancies will be sent to routers.
- Zigbee Router: Through employing these routers, data gathered from the Zigbee End Devices will be routed to the nearest Zigbee Coordinator.
- Zigbee Coordinator/Gateway: Gathered data will securely be directed to a central computer using the Meshlium Xtreme ZigBee SN Gateway [2] to be processed and stored. It will then be made available to customers in real-time (Fig. 1).

**System Implementation**

- The sensors, which will be embedded in the superstructure layers, is covered by a layer of light weight aggregates that can tolerate high heat to avoid any damages to the sensors.
- The sensors are located in the most crowded areas of the mall, such as:
  i) The entrances of the mall.
  ii) The intersection points in the parking lot.
- The coordinator is placed at the beginning of each level and the router in a range of 30 meters.

**Energy Harvesting**

- Different energy harvesting schemes are employed at the parking area.
- Almost 10 Watts per step can be harvested from motion.
- Harvested energy can power parking electronic components (Table 1).

**Evaluation**

- Saving mall visitors time by displaying the shortest path to the empty parking.
- Using this system requires almost no maintenance as the components are highly durable (lifetime of 30 years).
- Harvesting 3 times more efficiently than solar power, which covers the installation costs of energy harvesting components in the long term [6].

**Table 1: Characteristic of energy harvesting tiles**

<table>
<thead>
<tr>
<th>Harvester Type</th>
<th>Price per piece</th>
<th>Area</th>
<th>Power Output</th>
<th>Display Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavegen® Kinetic Tiles</td>
<td>AED 245</td>
<td>0.18 m²</td>
<td>13.3 Wh/m² (max)</td>
<td>50 W</td>
</tr>
</tbody>
</table>

* Power output depends on frequency.

* Table 2: Parking system basic cost analysis

<table>
<thead>
<tr>
<th>Total Tiles Used</th>
<th>Tile Set Dimensions</th>
<th>Total Cost of Tiles</th>
<th>Total Energy Harvested*</th>
<th>Return over Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1080</td>
<td>1.5 m x 3.0 m</td>
<td>AED 264,114</td>
<td>14,738,100 kWh</td>
<td>AED 2,683,506</td>
</tr>
</tbody>
</table>

* Considering maximum 10,000 visitors each day of weekend and 4,000 visitors on week days over 30 years.

**References**


**Fig. 1**: Meshlium Xtreme Connection options [2]

**Fig. 2**: An example of the Smart parking application that will be implemented on smart devices.

**Fig. 3**: Piezoelectric energy harvesters: Kinetic Tiles [4] and Innovatech® Generators (right) [5].