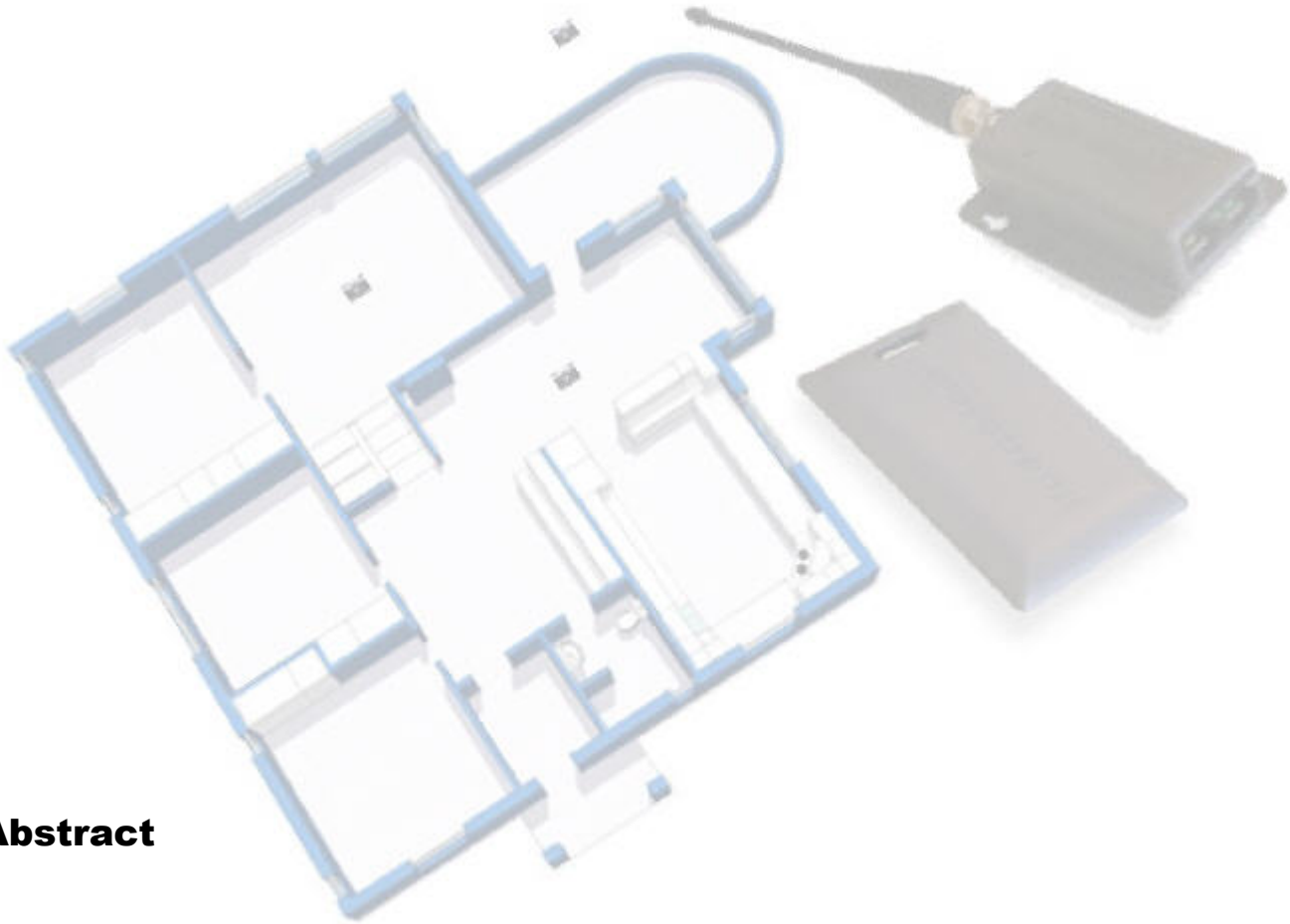
Personnel Positioning Module



Abstract

The Personnel Positioning Module (PPM) is a robust, centralized approach to RF based location tracking. The system is based on a grid of long range Personnel ID Readers that communicate with the Access Control System via RS-485 and are able to operate on any new or existing Ethernet LAN / WAN networks. The grid of readers can be discretely concealed in walls and ceilings and maintains a high level of performance in a wide range of conditions including variances in the number of obstructions and has the capacity to simultaneously read multiple tags.

Introduction

Using radio signal information from a grid of readers, it is possible to determine the location of a roaming assigned tag with close to a meter's accuracy. The centralized system allows the application to identify not only the ID of the tag but to bring up an individual personnel file and to observe the movement of the individual throughout the system's deployment period. (frequency of historic data 10-15 min intervals).

RF-based location tracking is a well-studied filed, and a number of systems based on wireless technologies exist. However, wireless systems use much less powerful readers and cannot approach the distance and accuracy available with the PPM. Most systems are brittle and only as good as the infrastructure they operate on. They suffer a break down in communication once fluctuations in electrical power occur or a large number of wireless access points may become unusable. The PPM uses flash memory controllers that retain all data after suffering an interruption in power and uses the more reliable Point-to-Point protocol over Ethernet.

The PPM's location tracking is based on empirical measurements of radio signal from multiple transmitters. Received signal strength can be used to estimate the distance of an individual tag from several readers in the grid. The three most powerful signals are isolated and a simple algorithm is used to triangulate the position of the individual tag. The use of more powerful readers provides our system with an advantage over most similar systems because we do not need to obtained detailed models of RF propagation due to each building's unique variances, making implementation much simpler.

Module Overview

The module is designed to collect data over a grid of readers separated by a radius of approximately 50 meters, the most effective reading range. At this range the system is most robust because it is not effected by the perturbations in RF signals caused by the movement of ID tags, opening and closing of doors, and other environmental conditions. The location estimation itself contributes greatly to the robustness of the system by the sheer nature of its simplicity. Once the reference point or the location of the reader has been established (r), the distance to the signature (s) of the ID tag can be calculated through this simple distance Metric.

$$\mathbf{M}\ (\mathbf{r}, \mathbf{s}) = \sum | \mathit{mean}\mathbf{R}(\mathbf{t})_{\mathbf{r}} - \mathit{mean}\mathbf{R}(\mathbf{t})_{\mathbf{s}}|$$

Module Overview (continued)

Given the set of signature distances collected over a 2-Dimensional coordinate plane (x, y), the location of the signature ID tag is then superimposed onto a graphic location with respect to the signature locations. Each floor of a facility has its own reference locations and therefore each facility is divided into a series of 2-Dimensional planes.

This calculation, as well as the entire system, is extremely resilient to information loss. If any singular reader transmits corrupt information to the central station, this information is immediately identified and is substituted by the next best and most reliable reader transmitting information about the same tag. This is possible due to the long effective range of the readers used, the distance error is nearly negligible up to a distance of 150 meters.