1. **Problem Statement**
   1. **Historical Introduction**

One of the first device ever to measure a person’s pulse rate, the often associated rubric of vital measuring, was the lie detector. John Larson was credited the invention of the lie detector in 1921. The lie detector revolutionized history by using other sensors, such as pulse rate and respiration rate, in a single system [4]. Fast forward 61 years, and Polar released the first ever wireless heart rate monitor in 1982. Though touted as wireless, there was no wireless communication interface, it simply did not require wires to give instantaneous measurements of pulse rate. Since then, fitness trackers have evolved considerably, introducing more activity measurements, better ways of viewing data, and more accurate or convenient measurement techniques.

From the first lie detector model to the latest fitness wearable, these vital measurement devices share a core philosophy of purpose. All of these devices examine obvious and easy to measure characteristics of physical bodies to determine obtuse and difficult to quantify measurements. The original lie detector took the measurements of pulse rate and respiration to determine the elusive quality of honesty. Modern fitness wearables take even more physical statistics into account and yield helpful insight into subtle categories such as injury recovery, exhaustion levels, and fitness progress tracking.

Modern health tracking wearables now exist in abundance, however, the vast majority of them run on Bluetooth. While Bluetooth is great for individual portability and for connecting to almost any device, it is susceptible to interference when around many Bluetooth devices, it must be connected directly to the host by protocol, and it has limited range. Zotikon avoids these weaknesses by making use of a different wireless interfacing protocol. Zotikon devices connect over a 15 channel mesh network system that improves its communication in environments laden with interference, increases its range and reliability, and even lowers power consumption in many situations. This allows coaches to easily communicate with and monitor an entire team’s worth of Zotikon devices simultaneously and accurately in many different environments and situations. From an indoor basketball game surrounded by thousands of fans on interfering devices to an expansive soccer field where players are great distances away, Zotikon is equipped and ready to meet any challenge.

* 1. **Market and Competitive Product Analysis**

Zotikon would primarily be used by competitive athletes or teams to monitor their health as they train for anything from high school competitions to the Olympics. The NCAA reports that there are over 460,000 college athletes competing in 24 different sports every year [3]. The US Bureau of Labor Statistics reported in 2014 that there were 13,700 professional athletes in the United States [1]. Five hundred and fifty eight athletes were chosen to represent the US in the 2016 Olympics [2]. With so many athletes trying to gain a competitive edge, there is a high demand for health monitoring systems to make sure athletes get the most out of their training.

A similar system to Zotikon is made by Polar. Polar offers a team based health monitoring system with wearable chest straps that relay the heart rate of the athlete back to a tablet for the trainer to watch in real time. Polar uses Bluetooth to connect its devices to the tablet. It also has software to send the data saved during the training session or game back to a desktop whenever the trainer chooses. Polar’s use of Bluetooth limits the range at which trainers can receive the heart rate data reliably. Polar also has limited software to support a user friendly experience. The software they use to export data simply takes a screenshot and saves it as a PDF. This forces a trainer to manually enter the data into another program to be able to process the raw data. Polar charges more money for any other software to help process data. Zotikon will offer a larger transmission range with its software defined radio as well as free, more user friendly software to use to analyze the data gathered during a game or practice.

Garmin also produces a similar product. Garmin offers an individual based monitoring system designed for an athlete to track their health on their phone. Garmin also uses Bluetooth to transmit the data to the mobile device. It is limited because the software does not allow the mobile device to track multiple athletes at the same time. The wearable device comes only in a wristwatch, which means athletes could not wear it during a game. Zotikon will offer a team based monitoring system that uses software defined radio, which will still be useful for individuals. They won’t necessarily have to have their mobile device in their hand while training with the range the software defined radio provides. Zotikon will be a wearable chest strap that will allow athletes to wear under their jersey during games.

* 1. **Concise Problem Statement**

Professional trainers for competitive athletes continually seek to improve athlete performance during training and competition but lack the ability to conveniently and accurately monitor the essential performance indicators or a method to analyze performances post-exercise. Zotikon provides real-time monitoring of those indicators and presents them to trainers to allow for advanced, adaptive workouts and finely-tuned recovery periods and, upon completion of the exercise, the information is available in common data formats for further analysis.

The Zotikon system performs these monitoring functions with an athlete-worn device and communicates them real-time to a trainer’s station where members of a training staff can carefully monitor the athletes’ performances. The athlete-worn device collects the essential performance indicators - heart rate and movement data. Collection of the indicators persists regardless of sweat or physical contact. Because this system is designed for use on common athletic courts and fields, the athlete-worn devices communicate nearly line-of-sight with the trainer’s station over the required distance for common courts and fields and withstands the harsh electromagnetic interference (EMI) that exists in sporting arenas. Due to a mesh networking backbone, the devices are able to communicate much farther if enough devices are present in the transmission path. The system at the trainer’s station allows real-time access to all the performance indicators on each player being monitored and includes algorithms to assist with player performance analysis and overstress warnings. It also allows the training staff to export the data from an event to common data formats for post-processing analysis.

* 1. **Implications of Success**

Zotikon enables coaches from many disciplines to more personally and precisely train athletes. Coaches can see athletes' real time physical performance data and adjust coaching accordingly. Zotikon records this data to provide an overview of the athlete or team's performance over time. If a player gets injured or falls ill, causing his or her performance to drop during recovery, coaches can use Zotikon to maximize an athlete's improvement while limiting the athlete to a safe level of activity. For example, an athlete might have recently recovered from a severely sprained ankle. Inability to train may have caused the athlete’s physical fitness level to suffer. A coach would compare the player’s heart rate and movement data, which reflect fitness, before the injury to data collected after the injury and aim to bring the player back to pre-injury fitness while also allowing the coach to record recovery time. During this process, the coach would see when the athlete becomes unsustainably exhausted, allowing the coach to give tactical breaks as needed to improve fitness recovery times.

This functionality has the ability to impact the performance of athletes everywhere. A successful launch of Zotikon would see use of the system within both college and professional sports leagues. With the information provided by the Zotikon system, athletes will be able to push their bodies to the limit. If an athlete knows the limit, proper training and exercises can raise those limits. Athletes could see the progress of their fitness over time. In turn, this would produce athletes with a skill level never before seen by previous generations of athletes.

References:

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