# A Medication Adherence Monitoring System using Smartwatch

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***Abstract*— Poor medication adherence rates threaten an individual's health and cause a substantial amount of medical costs annually in the United States. In order to improve medication adherence rates and provide timely reminders, we developed a smartwatch application that collects data from embedded inertial sensors to learn a series of motions that occur during a medication intake. We applied machine learning algorithms using distributed systems for enhancing scalability.**

## I. System Overview

In 2010, patients in the U.S. spent $295 billion for prescription medicine, while the medication non-adherence rates were between 25% and 50%. Low medication adherence rates cause between $100 and $300 billion annually, representing 3% to 10% of total health care costs in the US. Furthermore, the low medication adherence rate can increase hospital readmision rate and potentially cause a social and economic burden for the patient and their family. This may include higher copayments for the patient and even higher costs for employers to maintain healthcare coverage [1]. There have been many studies to improve medication adherence rates using low cost and wearable sensors [2], [3]. In order to enhance usability and scalability of the system, this study utilized Android Wear 2.0, Apache Spark and Amazon Web Service (AWS) (Figure 1).

In this study, we utilized LG Watch Sports which is the first Android watch running on Android Wear OS version 2.0 where applications can operate independently without a smartphone. As LG Watch Sports supports a cellular connection, data can be directly transmitted to the data storage without being synchronized to a smartphone. It also includes various sensors including three axis accelometer, gyroscope, photoplethysmogram (PPG) heart rate monitor sensor, near field communication (NFC), while it is less obtrusive than smartphones or other wearable devices. The developed application is activated by the NFC smart tag attached on a medication bottle and collects activity data for training and testing a model.

As the embedded sensors collects high frequency multivariate data, the system requires scalable data storage, data processing engine and also algorithms. The collected data is transmitted to AWS Simple Storage Service (S3) and

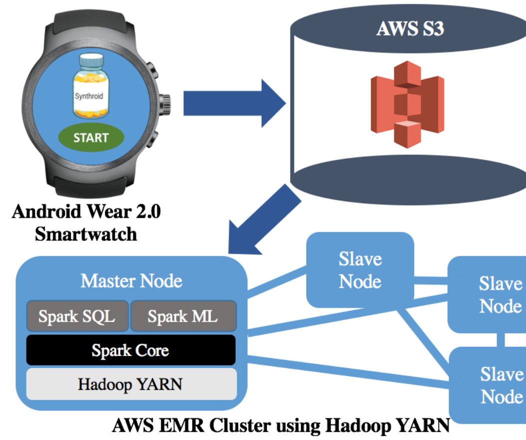


Fig. 1: MediWatch - A medication adherence monitoring system.

analyzed by using Apache Spark and its machine learning libraries. On distributed computing, a MapReduce job splits the data into smaller chunks into different partitions and a map task such as filtering and sorting jobs processes it in a parallel manner. The output of a map task becomes an input of a reduce operation which performs a summary operation. Apache Spark extends the MapReduce model for efficient data sharing and combines structured data processing and machine learning all in a single framework [4]. Apache Spark is installed on AWS Elastic Computing Cloud (EC2) nodes managed by AWS Elastic Map Reduce (EMR) cluster using a Hadoop YARN (Yet Another Resource Negotiator) cluster manager for further scalable data processing.

Extracting features from the collected data, we applied machine learning algorithms including random forest and validated the system scalability and accuracy.

## References

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