Performance of the Open Source PineTime Watch as a Seizure Detector
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Background

When Open Seizure Detector was originally released in 2015 (https://www.openseizuredetector.org.uk/?m=201504), it worked with the relatively low cost Pebble watch and a basic Android phone, so it was possible to make a complete seizure detection system for about £100.
Unfortunately Pebble was bought by the larger Fitbit company, which stopped making the Pebble watches in 2016 (https://www.openseizuredetector.org.uk/?p=846). The connection reliability of the new Fitbit smart watches was not good enough to use as a seizure detector, where high connection reliability is essential.

During 2017 we looked at the possibility of making our own watch with a microcontroller and an accelerometer chip (https://www.openseizuredetector.org.uk/?m=201705) to remove our reliance on external manufacturers), but by the time we had manufactured circuit boards and cases in the low volumes needed for Open Seizure Detector, it would have worked out quite expensive to build. We also considered using Android Wear devices, but these were expensive and had poor battery life at the time.

In 2019 the Open Seizure Detector project transitioned to using Garmin smart watches, which provided similar functionality to Pebble, with the addition of heart rate monitoring, and better battery life (https://www.openseizuredetector.org.uk/?p=1134), and had very good bluetooth connection reliability. The disadvantage of Garmin watches though is the cost with the price approaching £200 for a compatible watch. Although this is lower cost than a commercial seizure detection system such as the Empatica Embrace, the cost is high for people on low incomes, so a lower cost alternative is preferred.

The PineTime watch (https://pine64.org/devices/pinetime/) is an open source watch, so it is possible to develop software for it without reliance on other companies (https://www.openseizuredetector.org.uk/?p=2099). PineTime is also a low cost device (about £35 imported into the UK). We modified the InfiniTime (https://wiki.pine64.org/wiki/InfiniTime) firmware for the watch to make it compatible with OpenSeizureDetector, and have had a working version since early 2024. This initial version was tested by beta testers to debug issues with the watch firmware and Android phone interface to it. Version 4.2.11 of the OpenSeizureDetector Android app was released in February 2025 to provide PineTime support to all users.

As part of the testing of the PineTime seizure detector we switched from using a Garmin VivoactiveHR to the PineTime watch for our 'production' seizure detector for our son in May 2024. This note summarises our experiences with it over the last year, and assesses the seizure detection reliability derived from the data we contribute to the Data Sharing system and is included in the Open Seizure Database.

Connection Reliability

We initially tried to use PineTime on the lowest cost hardware that we could – the PineTime watch itself, plus a Motorola G13 phone running the Android Go operating system. This got us to a system which cost less than £100 in total. It initially worked very well, but after a couple of months the connection reliability decreased and the watch would disconnect from the phone if Benjamin was lying on the watch. After a few experiments swapping both the PineTime and the phone for spares I could not decide if it was an issue with the watch or the phone (I suspect it is a

problem with the Bluetooth radio on one of them), so we switched to a spare PineTime and a Samsung A20e phone. The connection reliability has been very good since then.

We have had the occasional (every few months) watch crash where the watch does not connect automatically to the phone when we take it upstairs (the phone is permanently installed in Benjamin's room) and the watch displays 'ERR – COMMS' and the phone shows 'FAULT'. These have been solved by re-booting the watch (pressing and holding the watch button until the pine cone logo appears).

So, once we had got over the initial problem with the Motorola phone (or our first PineTime watch) disconnecting, the connection reliability has been almost as good as we observed with Garmin watches.

Seizure Detection Reliability

About the time that we started using PineTime, Benjamin started having more partial/focal seizures where his arm would make a low frequency 'flapping' motion rather than the higher frequency shaking associated with tonic-clonic seizures. The OpenSeizureDetector algorithm was not set up to detect these movements, so it did not generally alarm, and we were not able to assess the reliability for tonic-clonic seizures. We were however keen for these 'flapping' movements to be alarmed, so we added a low frequency, high amplitude 'flap detector' algorithm in Version 4.2.11 of the Android app. We have been using that version since July 2024, so have based the analysis on the period July 2024 to the end of June 2025.

During the period, the database contains reports of 16 tonic-clonic seizures. On closer inspection though some of these are very close together, indicating that they are different parts of the same seizure, so we have removed these duplicates to give a better indication of the true detection reliability. This reduces the number of Tonic-Clonic seizures to 13. Of these 13 seizures, 11 alarmed correctly as shown in Figure 1.

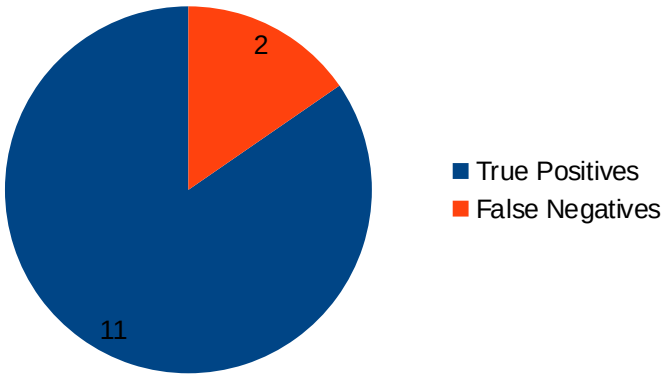

Figure 1: Open Seizure Detector Performance, User 39, Tonic-Clonic Seizures Jul-24 to Jul-25

Of the two seizures which did not alarm, one generated a warning and the other did not register at all. The notes for one of the failed detections suggest that the watch arm went stiff, but did not shake, and for the second (described as a small tonic-clonic) that the arm was pushing the watch into the mattress, which will have dampened out the movements.

Even with these two failures the tonic-clonic seizure detection reliability over the period was 85%.

Over the same period there were 11 ‘Other’ seizures recorded which are mostly partial/focal seizures with arm ‘flapping’ movements. 9 of the 11 seizures generated alarms, giving a detection reliability of 82%, even for these harder to detect seizures.

This means that the seizure detection reliability for PineTime based on movement detection is good, and is comparable to that observed for Garmin devices.

Note that this user does not use heart rate alarms for seizure detection because he wears his watch over his clothes, so the heart rate signal is poor. Other users have reported good detection reliability using heart rate alarms. Observation of the heart rate measurement from PineTime suggests that it is more prone to interference from movement than Garmin devices, so it is expected that Heart Rate alarm detection will not be as good as for Garmin devices.

False Alarms

One of the main downsides of the OpenSeizureDetector algorithm is false alarms. It will alarm for a variety of repetitive movements such as brushing hair, brushing teeth or scratching etc. We only use the system on a night, so this is less of a problem for us, but we still experience of the order 2 false alarms per day. This is sometimes significantly higher depending on the wearer’s behaviour. The false alarm rate is comparable to that observed using Garmin watches.

Conclusions

- The PineTime watch has proven to be reliable after initial teething troubles with connection reliability with one particular phone/watch combination.
- The real-world seizure detection reliability based on movement detection is good with 85% detection reliability for tonic-clonic seizures, which is comparable to that observed for Garmin devices.
- The heart rate alarm function has not been tested, but it is expected that the PineTime peformance will not be as good as for Garmin devices.
- False alarm rate remains high (of the order 2 false alarms per day), but this is comparable to that observed with Garmin watches.