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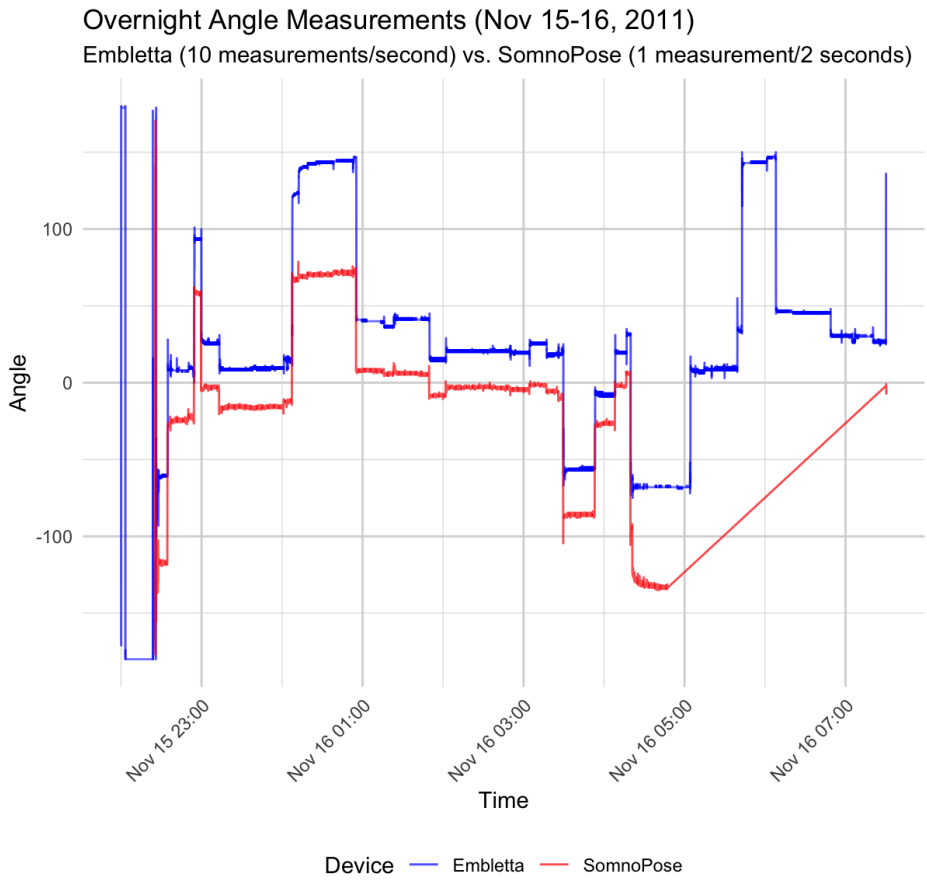
September 9th, 2025
S&DS 4250
Case Study 2

Introduction:

The purpose of this analysis was to compare a promising new iPhone/iTouch App (called SomnoPose) to a customized medical device (called the Embletta), mechanisms used to monitor sleeping position. After analyzing data from two test subjects over 6 days, we were able to create plots that match the sleep data from the Embletta device to the SomnoPose data by time. Further analysis is required to determine if the SomnoPose data is a suitable replacement for the Embletta device; however, based on our initial data analysis, we have drawn the initial conclusion that the SomnoPose data accurately compare to the Embletta device data, making it a suitable, cost-efficient option for those looking to gather information on sleep data.

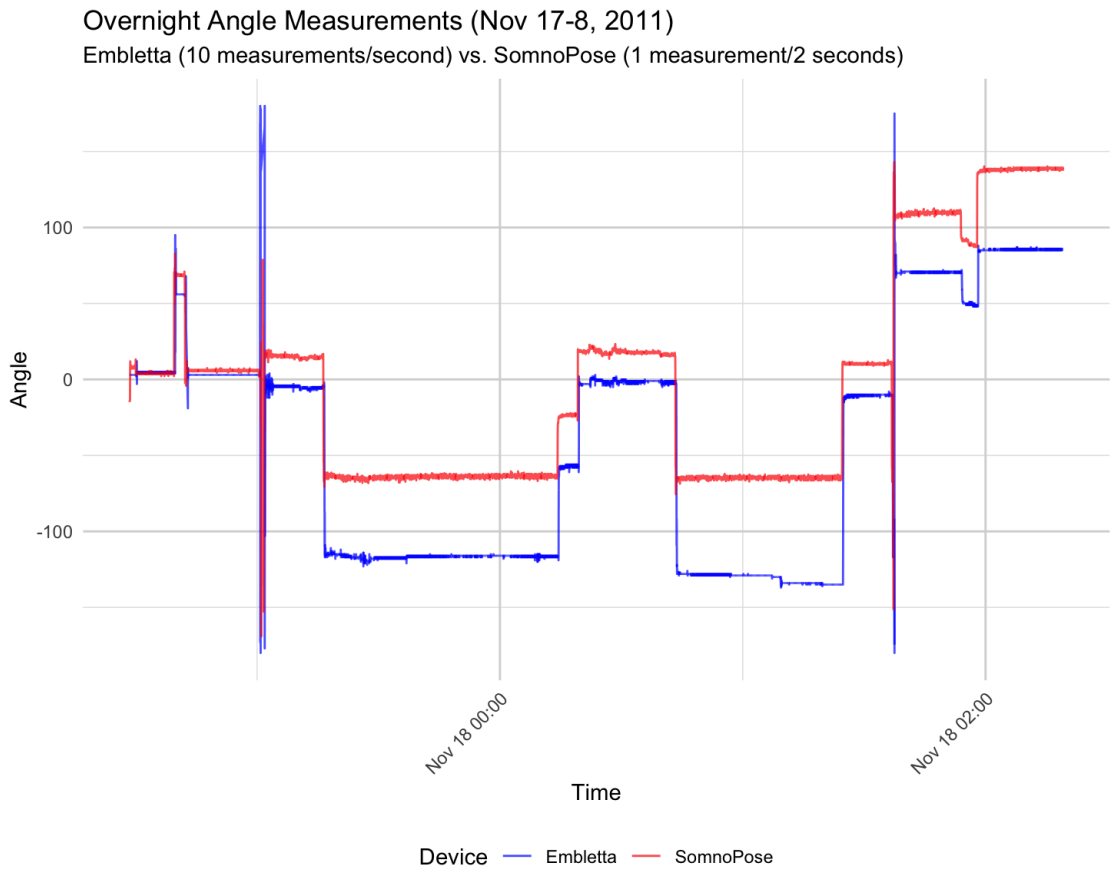
We created 6 plots (one plot per night of sleep) to visually analyze the similarities between the two devices. This required us to match the time stamps of the data as closely as possible, which varied by night and how the data was captured. We used data for the nights of November 15th, 17th, 18th, 19th, 23rd, and 24th. Below is a more thorough explanation of the plots we created for each night, and the decisions we made to create these.

November 15th:



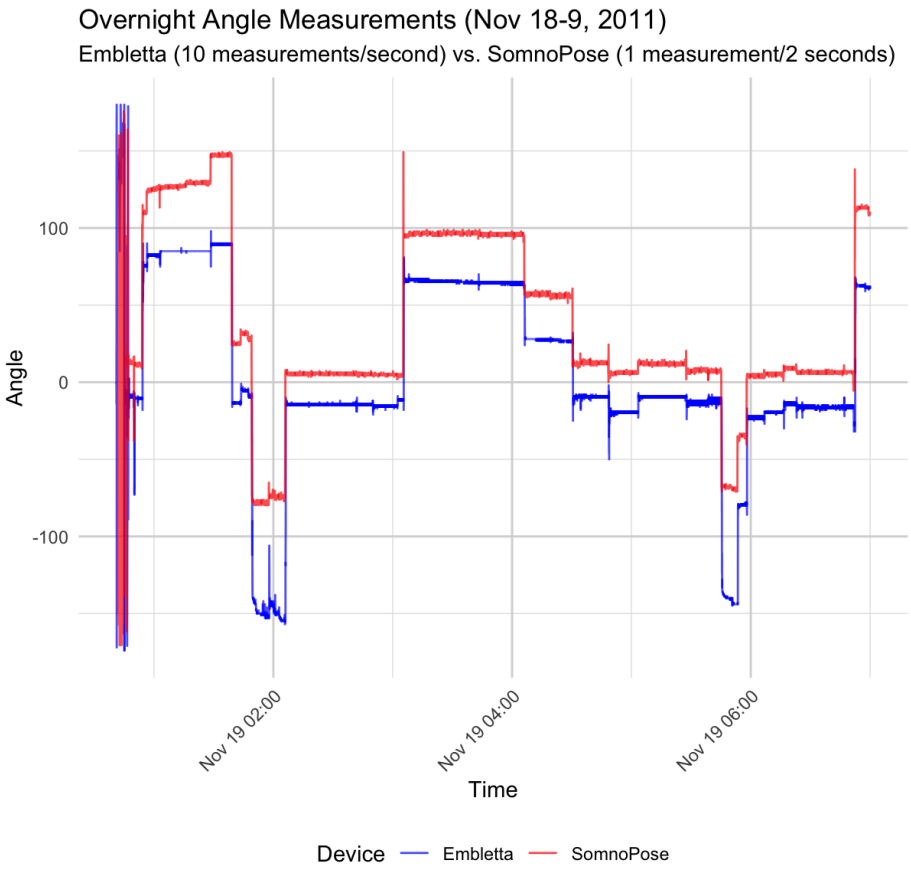
For sleep data from the 15th, 23rd, and 24th, we needed to match the times of the two devices. Our process consisted of creating a threshold to determine "peaks" (or troughs) in sleep angle, identify the observations for which these peaks (or troughs) occurred, and assigning date-time stamps that aligned with each other for each device. After this process for November 15th data, we generated the above plot, showing strong similarities in the data patterns when the time stamps are aligned.

November 17th:



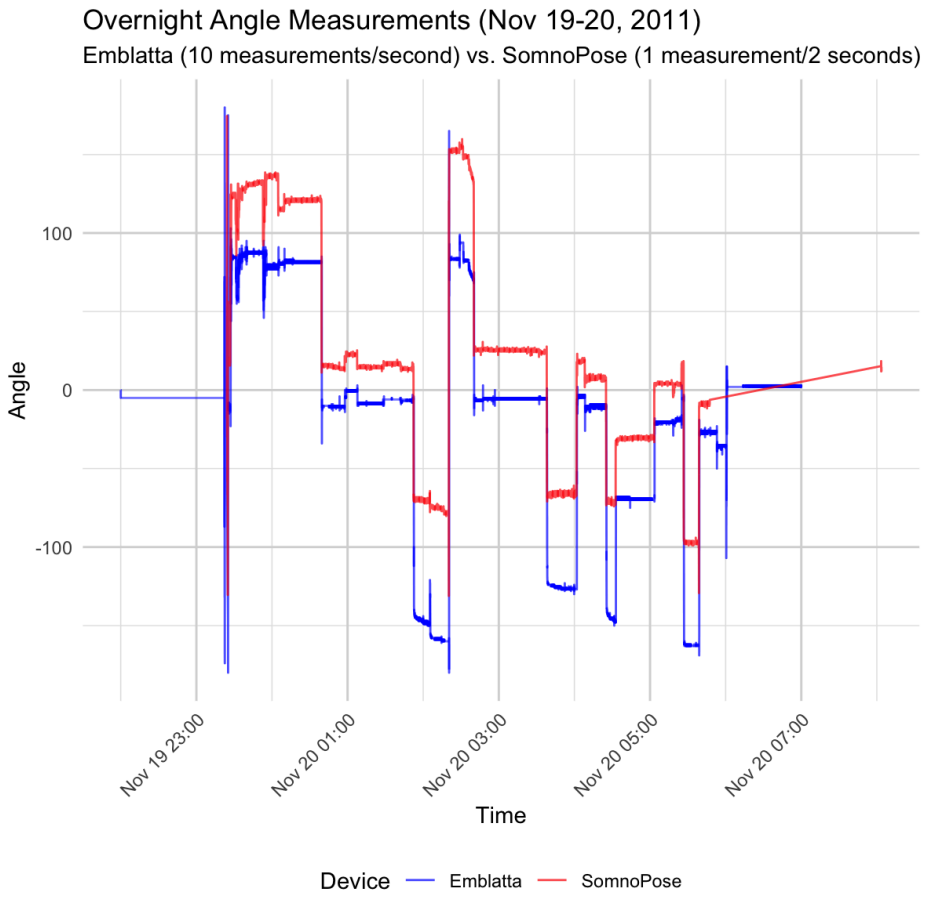
The data from November 17th was the least populated out of all 6 days. For November 17th - 19th, the devices were started and stopped at defined times (e.g. 10pm - 7am for the Embletta device for all 3 days). To generate an analyzable plot, we only used data during times for which both devices were recording. As a result, we were only able to use data lasting until 2:19am; however, we see that the pattern of the two sleep tracking systems remain almost identical.

November 18th:



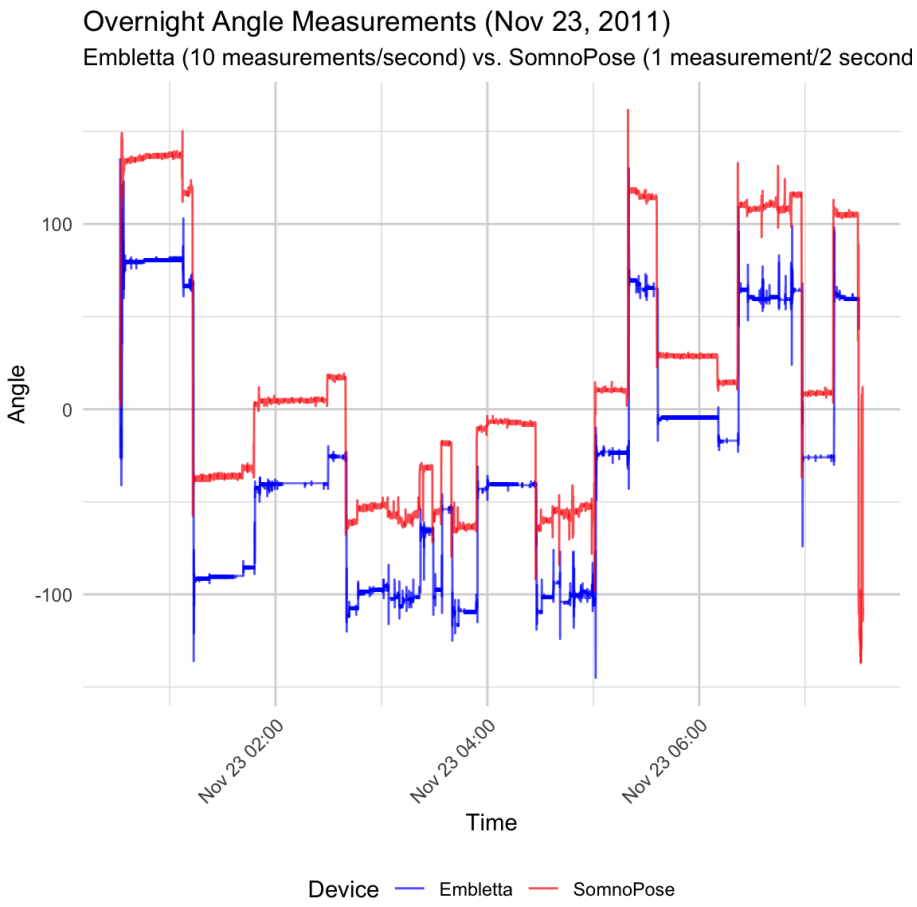
For November 18th data, we followed a similar process as with the November 17th data – we chose to only plot data with corresponding time stamps that overlapped. As an additional piece of analysis, we tested the process for generating a correlation value between the two data sets. After averaging the Embletta data values for every 2 seconds, we received an approximated correlation of 0.8389. This strong correlation value in addition to the clear similarities in line shape once again demonstrates strong similarities between the two sleep tracking mechanisms.

November 19th:



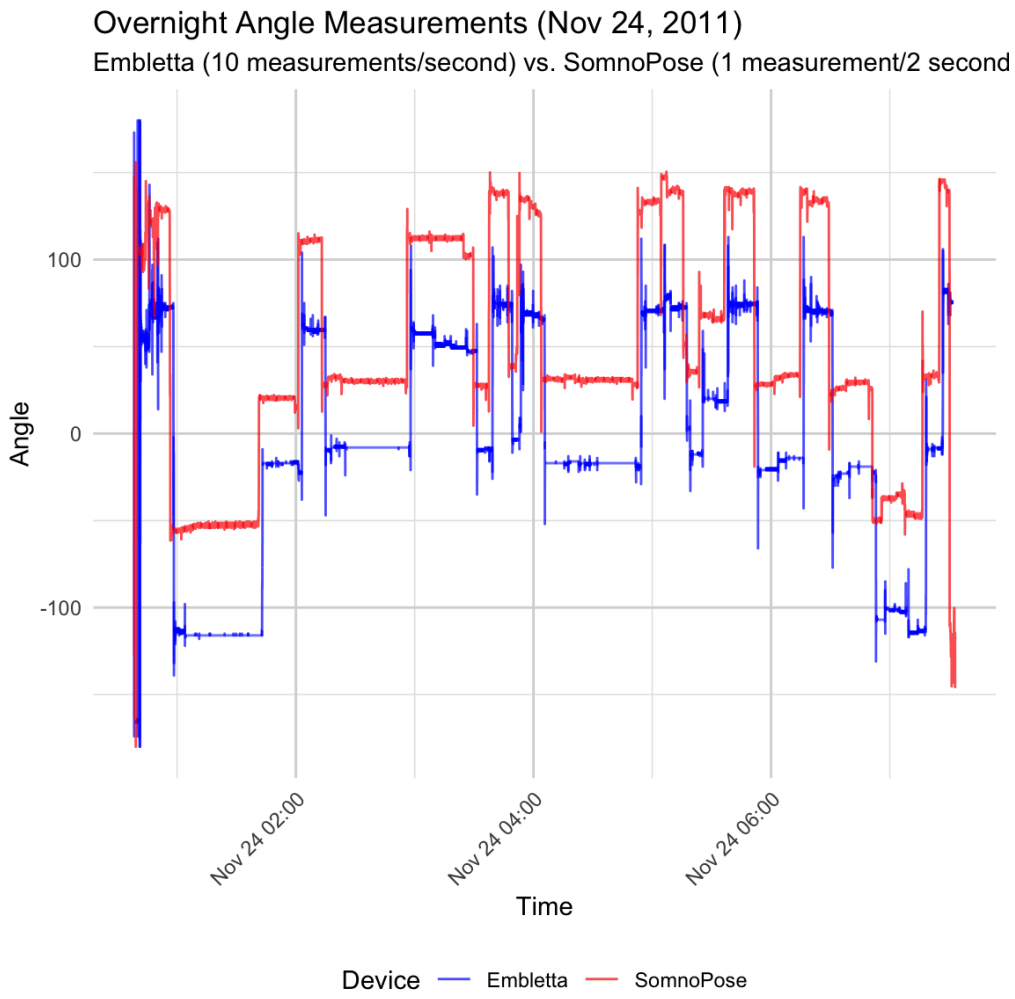
After matching the time stamps for data between the two devices on the night of November 19th, we generated the above plot. This provides further evidence that the two sleep tracking mechanisms behave similarly and move with each other, even if the more angle extreme values are not exactly the same.

November 23rd:



As previously mentioned, for November 23rd data, we initially needed to match up time stamps for the data by looking at peaks and troughs. Additionally, based on initial plots of the data for November 23rd and 24th, we believe that the two devices (the iTouch for the Somnopose data and Embletta device) were worn on opposite sides of the body, given that the plots for each device looked almost opposite from each other. To counter this, we multiplied the angle vector for the Embletta data by -1 to orient the devices equally, resulting in the above plot. We believe this may have been prevalent in only the 23rd and 24th data due to the change in test subjects – it is possible (and seemingly likely) they wore the two devices differently than the previous test subject, thus generating different plots. After accounting for the orientation shift, the above graph demonstrates our continued belief that the SomnoPose data's shape closely resembles the Embletta data's.

November 24th:



We proceeded similarly as with the November 23rd data by creating a threshold value to properly try and match the timing of when the Embletta device started recording sleep angle data. We then followed the same procedure of multiplying the angle vector for the Embletta data by -1 to counter the offset orientation. After following these steps, the above plot was generated, leading to similar results of closely matched lines between the Embletta data and SomnoPose data.

Preliminary Conclusions:

From our pilot study and visual analysis, we concluded that the SomnoPose app is a cost-efficient replacement for the Embletta device. Our plots show a very strong relationship and similarity in movement between the two sleep tracking systems, demonstrated by the near parallel shape of the plots. Though the Embletta device has more granular data for body orientation, the overarching shape and pattern of both lines closely resemble each other.

We noticed that differences in the data arise when sleep angles are rather extreme. We believe this is a result of the positioning of the devices on the test subjects, rather than differences in the intrinsic nature of each sleep tracking system. Thus, our initial conclusion is that the SomnoPose app is a viable substitute for the Embletta device.

Future Analysis:

This pilot study provides valuable preliminary insights into the similarity between the SomnoPose app and the Embletta device for sleep position monitoring. Through visual comparison of the sleep data across multiple nights, we observed generally comparable patterns in sleep position measurements between the two devices, suggesting that the more affordable SomnoPose app may serve as a viable alternative to the expensive Embletta device.

However, to definitively establish SomnoPose as a valid replacement device, future analysis should include more rigorous statistical assessments. Correlation analysis will quantify the strength of the linear relationship between the two devices' measurements, providing objective evidence of their similarity. We ran one correlation analysis for November 19th for a preliminary test of the two devices' linear relationship, and found it to be fairly strong. Additionally, Bland-Altman analysis – a standard approach for comparing medical devices – will help identify any systematic bias between the devices and establish limits of agreement, determining whether observed differences fall within clinically acceptable ranges.

Additionally, further knowledge on the necessity of granular sleep orientation data might impact our preliminary conclusions. If intra-second shifts in sleep orientation have significant effects on sleep quality, then the Embletta device is much better suited to track one's sleep. For the SomnoPose app to be considered a viable option to track sleep, a threshold must be established to determine whether or not the data for the two systems are correlated enough.

These statistical methods and further insights will provide the robust evidence base needed to confidently recommend SomnoPose as a cost-effective substitute for the Embletta device in sleep research applications, supporting more accessible and widespread sleep position monitoring studies.