sNOoze: A Novel Mattress System For Snooze Prevention

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Abstract

In this paper we present sNOoze (Figure 1) (a name reflecting “NO to snoozing"), a novel snooze-prevention device. It is a mattress featuring an alarm which the user can only disable by getting out - and staying out - of bed. If the user returns to bed after disabling the alarm, the alarm will sound again.

Snoozing is a negative health behaviour associated with poor health outcomes and sleep quality [8]. Whilst various smartphone apps and devices have been developed to prevent snoozing, no existing solution prevents the user returning to bed after deactivating the alarm, as sNOoze does. The device could be particularly useful for those who struggle to get out of bed in the morning.

Trials showed that users responded favourably to the product, with 100% of respondents agreeing that sNOoze would help them get up in the morning.

Author Keywords

Snoozing; Sleep; Mattress; Bed; Alarm

CCS Concepts

•Human-centered computing → **Human computer interaction (HCI); Sound-based input / output; Auditory feedback;** *User studies;*

Figure 1: A member of our team showcasing sNOoze

Introduction

Studies have shown the negative health impacts of snoozing [8]. Despite this, many people struggle to resist the urge to snooze their alarms in the morning, when the option is offered by their alarm device.

There exist a number of products (both smartphone applications and physical devices [1, 3, 5, 2, 4, 6]) which attempt to combat morning snoozing, by requiring the user to perform some task in order to disable the alarm. A key oversight of these products is that there is nothing to stop the user returning to bed after they have completed the task.

We have developed a novel device to prevent snoozing while addressing this oversight: sNOoze. With sNOoze, the user must get out of bed to disable the alarm. If the user gets back into bed within 30 minutes of the alarm time, the alarm will sound again. After development, we carried out an evaluative study of users' experience when using sNOoze, as well as ascertaining its suitability by asking questions about users' snoozing habits. We used a Likert scale questionnaire to evaluate the intuitiveness of use of both the device and the accompanying application.

Related Works

Snooze Prevention

There are a variety of smartphone alarm applications that aim to prevent the user from simply snoozing the alarm and staying in bed. Alarmy [1] is an application that requires the user to take a photograph of a chosen location in order to mute the alarm, forcing the user to get out of bed. The application I Can't Wake Up [3] requires users to solve a mathematical equation in order to turn off the alarm. The issue with these applications is that there is nothing to stop the user from completing the required task and then getting back into bed.

There also exists physical devices that aim to prevent snoozing. The Ruggie [5] device requires that the user stands on a touch sensitive rug in order to turn off an alarm. The Clocky [2] is an alarm clock on wheels which races around the room when the alarm starts, requiring the user to catch it in order to disable the alarm. These two devices suffer from a similar issue to the previously mentioned phone applications: there is nothing to stop the user from getting back into bed after they have stood on the Ruggie or caught the Clocky. sNOoze does not have this problem because there is an extended time period after the user disables the alarm during which the alarm will sound again if they get back into bed.

Smart Mattresses

There are a number of smart mattress devices currently on the market. The Pod [4] by Eight Sleep learns the temperature at which the user sleeps best, and actively adjusts its own temperature to match this. The SleepIQ [6] by Sleep Number is a smart mattress that tracks sleep patterns at night and displays this data on a smartphone app, and allows adjustment of firmness through the application. Currently existing smart mattresses focus on sleep tracking and

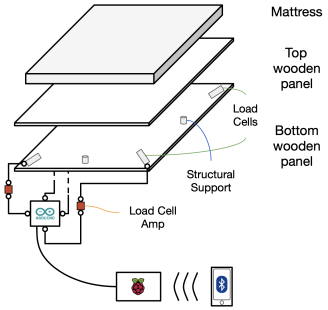

Figure 2: An outline of the sNOoze hardware structure, showing the connections between the electronics and the physical bed

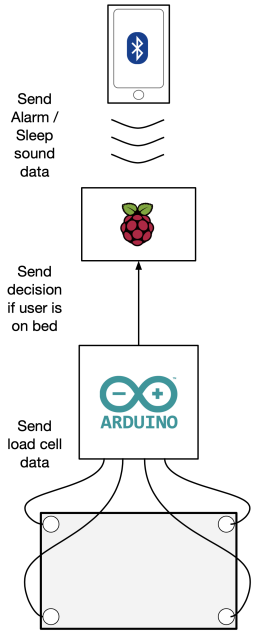

Figure 3: Information flow between the bed, Arduino, Pi and the phone

temperature/pressure adjustment, and not on waking the user up, as sNOoze does.

Sleep Device Research

Research into sleep-related devices tends to be strongly focused on tracking and improving the quality of sleep as opposed to preventing snoozing. Matsui et al [12] propose an eye mask sleep tracking device which can classify sleep as REM or non-REM using an array of infrared sensors to detect eye movement. Chen et al [7] describe a device that tracks heart and breathing rate during sleep without requiring uncomfortable wearables, using an array of ceramic piezoelectric sensors embedded in a Mattress. Hoque et al [9] propose a system which uses small RFID enabled accelerometer devices called WISPs attached to a mattress to track body position and movement during sleep. Liang et al [11] describe a piece of software which analyses the effect of factors including social life, exercise, diet and occupation on sleep outcomes. Landry et al [10] propose an alarm system which additionally provides information such as traffic alerts and weather forecasts to aid the user in daily decisions.

Design

Our initial idea was to use pressure pads to determine if a user is on the bed. These would be placed on top of, or embedded within a mattress. However, we quickly determined that placing pressure pads on top of the mattress would be vulnerable to damage and cause discomfort to the user, whilst pressure pads embedded in the mattress would be unable to robustly detect the presence of the user through the mattress material.

Therefore, instead of pressure pads, we settled on using load cells (a type of strain gauge) to determine the presence of a user on the bed. It was immediately apparent that since a mattress lacks rigidity, placing the load cells within or directly under the mattress would be ineffective. We thus used two wooden panels to build a rigid structure under the mattress within which the load cells are placed.

We use an Arduino Uno to interface with the load cells and a Raspberry Pi, and used an Android app to communicate the alarm times to the Raspberry Pi.

Our final prototype design (Figure 3) can be divided into four main sections: the bed, the Arduino, the Raspberry Pi, and a mobile app. A cross-section of the design can be seen in Figure 2, showing component positions, and the connections between them.

The bed (bottom of Figure 3) consists of a small mattress, two wooden panels, four load cells and accompanying load amps and some structural supports. The wooden panels are used as the mattress alone would not provide the rigidity required for measuring strain with the load cells. The two wooden panels are attached by four load cells, placed at each corner. The load cells are angled such that the panels cannot shift over each other. Each load cell is connected to HX711 amplifiers which then connect to the Arduino. On the bottom panel, four small plastic supports that are slightly smaller than the gap between the panels were screwed in to prevent the top panel from bending too much when a user puts their weight on the mattress. The mattress is placed on top of the top panel.

Upon turning on the Arduino (Figure 3, 2nd lower box), it calibrates for the current strain on the load cells. It will then continuously take in raw data from the load cells and send a binary decision on whether there is someone on the bed to the Raspberry Pi, which is connected via USB.

The Raspberry Pi (Figure 3, 2nd upper box) contains server

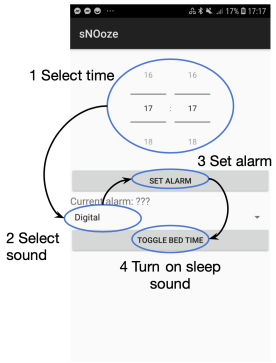

Figure 4: A screenshot of the sNOoze app, annotated to show the steps taken to choose and set an alarm, as well as toggle soothing sleep sounds

and alarm scripts, written in Python, and a database. The database simply contains the alarm time, the alarm sound being used and whether the sleep sound is playing. The alarm script uses information from the Arduino and the database to play and stop the alarm and sleep sounds when appropriate. The server communicates with the mobile app via Bluetooth.

The mobile Android app (Figure 3, top) enables the user to set the alarm time, to set the alarm sound they want, and to toggle the sleep sound. The phone must pair and connect with the Raspberry Pi by Bluetooth.

Walkthrough

Using sNOoze is simple and intuitive. The user first connects their smartphone to the sNOoze mattress using Bluetooth. They then use the sNOoze mobile app (Figure 4) to select an alarm time and sound. Optionally, the user may use the app to play a soothing sleep sound. Once the set alarm time is reached, the selected alarm sound will play from the mattress speakers, interrupting the soothing sleep sound if it is playing. To end the alarm sound, the user must get out of bed. If they re-enter the bed within 30 minutes of the alarm time, the alarm sound will play again until they re-exit the bed.

Study

In order to gauge the feasibility of sNOoze, we demonstrated the mattress to a group of users, receiving feedback from 8 participants, which included a mixture of undergraduate and postgraduate students, University of Bristol academic and non-academic staff, and other visitors to the university. This allowed us to get an insight into users' first impressions, their current sleep habits and snoozing behaviour, and whether or not they would use a mattress with an alarm built in to reduce snoozing behaviour in the morning and improve their wake-up routine.

To get a full insight into user perception of the sNOoze system, we gathered both qualitative and quantitative data during the study process by interviewing people when they approached the stand. The participants were shown the app, and were then invited to lie down on the mattress after setting a test alarm so they could test the functionality. After the user disables the alarm by exiting the bed, they could then test the alarm's reactivity to pressure being reapplied, to see if the alarm successfully reactivates when the user re-enters the bed. We had the participants filling in a twenty question Likert scale questionnaire which asked questions about information presentation and clarity, perception of the sNOoze interface and design choices, and general satisfaction with the system. Qualitative data and informal suggestions were obtained about participants' normal waking up behaviour, such as how long they stayed in bed before getting up in the morning, whether they regularly use an alarm clock, and if so, how regularly they use their alarm's snooze function. We observed user interaction with sNOoze during the demo process, and recorded any questions participants had about the app or mattress functionality. We also asked users what other features they think the sNOoze system could benefit from to further reduce snooze duration, and make the wake to getting-up transition easier.

Results

Quantitative results

We asked the 8 participants a series of questions about their snoozing behaviour, how difficult they find it to get up in the morning, and their perceptions of the mattress and app. 100% of people agreed or strongly agreed that the sNOoze mattress system is easy to use, that it could help them get up in the morning, and that the interface and de-

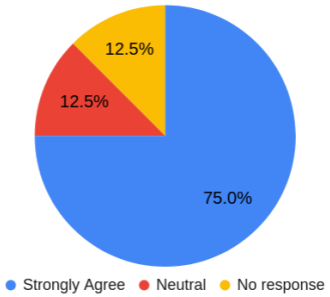

Figure 5: Pie chart to show % of people who found the information available to them allowed for the correct usage of sNOoze

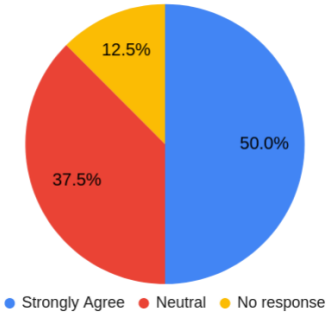

Figure 6: Pie chart to show % of people who found organisation of information on sNOoze system intuitive and clear

sign of the system was pleasant. Figure 5 shows 75% of participants agreed that the organisation of information on the system was intuitive and clear. Looking at Figure 6, only 50% of users strongly agreed that the information available to them facilitated them using mattress correctly, indicating that the app could benefit from enhanced user communications and instructions.

Qualitative results

Participants in general expressed difficulty in waking up in the morning. When asked about amount of time spent in bed before getting up, answers ranged from two minutes to 2-3 hours, indicating great variability in snoozing behaviour within the participant population. Every participant stated that they would benefit from an alarm system that helped them get up in the morning, suggesting a gap in the market for mattress technology that assists in the wake to getting-up transition. Participants made suggestions for further functionality within the system, such as including lamps and lights that turn on with the alarm sound, an activity-based task that engages the user physically, and vibration in the mattress to make the alarm more multisensory. Users also suggested introducing a 'weekend mode' to give the user more control over the alarm, as well as including the capacity for sleep tracking to gain greater insight into sleep quality.

Future Work

In the current prototype version of sNOoze, the device is external of a mattress, and the electronics are outside of this device. In a final version, the entire device would be inside a mattress, which simply needs to be powered on to be ready to use.

There are a number of additional features that could be added to sNOoze. The readings from the load cells could be used to implement a sleep tracking function, whereby users could view the quality and duration of their sleep in the smartphone app, similar to the functionality provided by existing smart mattresses such as The Pod and Sleep IQ.

The system could be modified to allow two users sleeping in the same bed to set an alarm each. The load cells would be used to determine whether one or two people are in the bed. The earlier alarm would be deactivated when one person gets out of bed, and the later alarm would be deactivated when both users are out of the bed.

A SAD lamp could be included which turns on 30 minutes prior to an alarm sounding, and increases in brightness up to that time, simulating sunrise, and making it easier for the user to get out of bed.

sNOoze could be used to augment the effectiveness of existing solutions [2, 3, 1], and possible future solutions in the field. The community could use sNOoze as inspiration for considering the bed itself as a tool to help the user wake up, not just a tool for sleeping. We also show that this can be done relatively cheaply.

Existing devices and applications provide encouragement to users to get out of bed. In addition to this functionality, sNOoze addresses the issue of users returning to bed after disabling their alarm. The combination of these systems could be a more engaging, and possibly more effective, solution. For example, sNOoze could be combined with the Alarmy app [1], which makes the user go to a different room and take a picture to disable their alarm. sNOoze on its own would only cause a user to get out of bed and stay up. The inclusion of an activity, as provided by Alarmy, could thus help kick-start a user's day and engage their brain. We are not aware of any existing devices which provide both these functions at once.

sNOoze aims to improve sleep health via snooze prevention, ignoring other angles such as sleep tracking and sleep comfort improvement. To address this, sNOoze could be combined with other devices. For example, a smart eye mask [12] can be added to additionally track REM sleep. Alternatively, combining a smart bed [4] with sNOoze could improve sleep comfort.

Conclusion

We have introduced sNOoze, a novel snooze prevention device which addresses an important shortcoming of existing solutions: that they feature no method of preventing the user from returning to bed after the alarm is initially deactivated. Our user study illustrates that the product resonated with those it was demonstrated to: many people struggle with snoozing behaviour, and there is a clear market for sNOoze.

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