Waking up system

In my daily life I would like to incorporate a system that facilitates waking up in the morning. The objective would be to avoid oversleeping, while improving on the traditional method of "sound alarm"-based systems, which can be unnecessarily unpleasant. Here, I propose a possible solution to this problem combining sleep monitoring wearable devices with smart home technology, based on findings from the last few years.

Milici et al. [1] designed a wireless belt that fits at chest level. This belt carries a magnetometer (magnetic sensor that measures the direction, strength and variation of the earth's magnetic field [1]), a microcontroller (system that receives the information collected by the magnetometer) and a bluetooth module. This way, they are able to monitor breathing patterns and thoracic-abdominal movements while we sleep [1–3]. Building up on this design, and making use of nanotechnology, the system proposed here combines sleep monitoring wearable nanodevices with smart home technology.

This new design would use magnetoresistive nanosensors, which means that variation in external magnetic fields causes a variation in resistance against the passage of current [4]. It would consist of a multilayer system built as follows: ferromagnetic layer / non-magnetic or non-ferromagnetic layer / ferromagnetic layer [5]. Regarding the materials used, and since the sensor must be sensitive to the Earth's magnetic field, for the ferromagnetic layers, nanocrystals of magnetite (Fe_3O_4) could be used [6,7], and for the non-magnetic or non-ferromagnetic layer, chromium nanoparticles could be used [5,8]. This way, analogously to Milici et al. [1], the thoracic-abdominal movements would be monitored while we sleep based on the variations of the earth's magnetic field detected by the sensors.

The main components of the sleep monitoring system are described below [see (Akyildiz & Jornet, 2010 [9]) and (Nayyar et al. 2018 [10])] [Figure 1] [9].

The system is composed of multiple magnetic nanosensors. Each nanosensor is contained in a nano-node, which is a nanomachine that processes and transmits the signals. The nano-nodes would be placed by adhesion in the thoracic-abdominal area of the user. Multiple nano-nodes send the information to a nano-router. The nano-router aggregates the information and sends it to a nano-micro interface device, which makes communication with traditional communication networks possible. Finally, the information is sent to a web server through a gateway device. In the web server the implemented algorithms carry out any required checks, and the subsequent orders [11] (see [Figure 2] for an example of a possible algorithm). A microcontroller attached to the home's electrical system and to the web server, would order a series of actions to different devices present in the home (actuators), which would ultimately remove the need for alarm clocks, leading to a more pleasant awakening e.g. by raising the blinds, playing background music, preparing a cup of coffee or other configurable actions. Users can then configure the behaviour of this microcontroller through the use of a web interface [11].

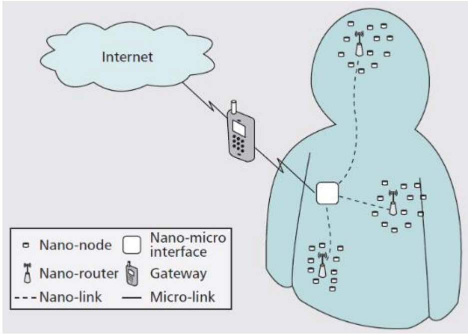

Figura 1.[9] Componentes en la arquitectura de red de *Internet of Nano-Things* [see (Akyildiz & Jornet, 2010 [9])].

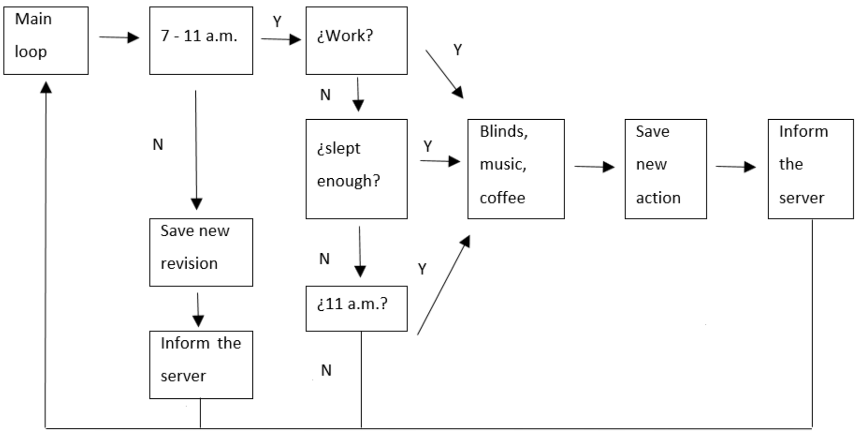

Figure 2. Possible flow chart [11] depicting the checks that the smart home system has to carry out and the subsequent actions.

Bibliography

(1) Milici, S.; Lazaro, A.; Villarino, R.; Girbau, D.; Magnarosa, M. Wireless Wearable Magnetometer-Based Sensor for Sleep Quality Monitoring. *IEEE Sens. J.* **2018**, *18* (5), 2145–2152.

(2) Kwon, S.; Kim, H.; Yeo, W. H. Recent Advances in Wearable Sensors and Portable Electronics for Sleep Monitoring. *iScience* **2021**, *24* (5), 102461.

(3) Murzin, D.; Mapps, D. J.; Levada, K.; Belyaev, V.; Omelyanchik, A.; Panina, L.; Rodionova, V. Ultrasensitive Magnetic Field Sensors for Biomedical Applications. *Sensors (Switzerland)* **2020**, *20* (6).

(4) Zhang, W.; Chen, A.; Bi, Z.; Jia, Q.; Macmanus-Driscoll, J. L.; Wang, H. Interfacial Coupling in Heteroepitaxial Vertically Aligned Nanocomposite Thin Films: From Lateral to Vertical Control. *Curr. Opin. Solid State Mater. Sci.* **2014**, *18* (1), 6–18.

(5) Yang, S.; Zhang, J. Current Progress of Magnetoresistance Sensors. **2021**.

(6) Lower, B. H.; Bazylinski, A. The Bacterial Magnetosome : A Unique Prokaryotic Organelle. **2013**, *4004*, 63–80.

(7) Suppiah, D. D.; Bee, S.; Hamid, A. One Step Facile Synthesis of Ferromagnetic Magnetite Nanoparticles. *J. Magn. Magn. Mater.* **2016**, *414*, 204–208.

(8) Chaudhary, J.; Tailor, G.; Kumar, D.; Verma, D.; Joshi, A. Synthesis and Characterization of Chromium Nanoparticles by Thermal Method. **2019**, No. April 2021, 10–12.

(9) Akyildiz, I.; Jornet, J. The Internet of Nano-Things. *IEEE Wirel. Commun.* **2010**, *17* (6), 58–63.

(10) Nayyar, A.; Puri, V.; Le, D. Internet of Nano Things (IoNT): Next Evolutionary Step in Nanotechnology. **2018**, No. January 2017.

(11) Serrano Ferriz, D. Diseño y Prototipación de Una Vivienda Inteligente Con Arduino y Java. **2015**, 78.