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Abstract

Sports & Health applications of a versatile electronic architecture for e-bikes: Preliminary study.

Eli Gabriel Avina-Bravo [1,2] *, Christophe Escriba [1], Franck Giraud [2], Jean-Yves Fourniols [1], Georges Soto-Romero [1]

[1] Affiliation 1; The Laboratory for Analysis and Architecture of Systems (LAAS-CNRS), University of Toulouse, 31077 Toulouse, France (e-mail: egavinabra@laas.fr; cescriba@laas.fr; pacco@laas.fr; gsotorom@laas.fr).
[2] Affiliation 2; TNP Consulting; 92200 Neuilly-sur-Seine, France. (e-mail: franck.giraud@tnpconsultants.com)

* Correspondence: (E.G.A-B.) egavinabra@laas.fr.

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Abstract

In recent years, e-bikes have proven themselves to be a good way to do a physical activity (Berntsen et al., 2017; Louis et al., 2012; Stenner et al., 2020) while performing an active mobility (Fishman, 2016; Heinen et al., 2010). Several studies have compared the e-bike physiological impact with regular cycling, running and walking (Bourne et al., 2018; Castro et al., 2019), concluding that this impact is lesser than regular cycling and running but superior to walking, thus helping the users to achieve their weekly activity goals. Performing a physical activity by themselves helps improve the overall health state, preventing the appearance of diseases and reducing the symptoms of some diseases (Barbosa et al., 2015; Das & Horton, 2012; Lee et al., 2012; Livingston et al., 2017; Mctiernan et al., 2019; Schuch et al., 2016; World Health Organization, 2020).

Those elements led to the creation of our electronic architecture, which recovers user's physiological data and uses it to adjust the electric assistance available on the bike.

During validation tests, three strategies of electric assistance were defined, resulting in different outcomes for the same test protocol.

The overall algorithm consists in separating the user's heart rate in different zones according to ESIE scale (Grappe 2009), being the highest, a zone where the user is at his maximum heart rate and producing the most muscular power (simulating a sprint), and the lowest zone being at rest with none or little rise in the heart rate. Five more zones were included in the middle of those two.
With the zones established, the system proceeds to analyze the measured heart rate and is classified into one zone, depending on the result and the strategy used, the electrical assistance is modified from no assistance at all (lowest zone) and all the assistance available (highest zone).

What the strategies do is they change how the assistance is given on the remaining five zones. The first strategy linearizes the electrical assistance available, meaning that

at the third zone the assistance will be 33% and 83% for the sixth.

Second one mimics a logarithm curve, which means that the electrical assistance is high from the first zones, i.e. at the third zone there is 76% and 96% for the sixth.

Third one does the same as the second but with an exponential curve, resulting in having a significant electrical assistance on the last zones, i.e at the third zone there is 3% and 42% for the sixth.

Preliminary tests for all strategies were performed on outdoor and indoor conditions. From the tests' results, conclusions were made about the use case of the second and third strategy. Since the second is more reactive to the heart rate fluctuation, its usage is preferable for users that do not exercise regularly or are recovering from an injury or surgery. The third one forces the user to really be on a physiological strain before having a big help, athletes or users with good physical condition can use this for training purposes.

Further works will concern the inclusion of healthy volunteers in a validation study prior to patients in a clinical study, in order to improve strategies with an individualization layer based on embedded artificial intelligence. Our electronic architecture would be able to recover medical data from patient, adjust training (rehabilitation) load and send messages to medical staff if session was normally completed.

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