

Control System Based on Similitude with Electric Drives in Order to Reduce Accidents Caused by Bad Weather

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Abstract

One can notice a huge similitude between the graphics and the relations that define the functioning services for electric drive machines, including the intermittent unconventional short time service, and the development probabilities of heating - cooling processes of sportsmen, who come across bad weather, especially cold weather. The paper presents relevant examples that illustrate the use of similitude in calculations and in the creation of a material base in order to avoid accidents caused by cold weather. These accidents may lead to amputations of fingers or hands of sportsmen that practice alpinism, people working in exploration fields, construction sites, etc.

Key words: *similitude, electric drives, mountain.*

General Presentation of the Application Field of the Method, of its Utility and Possibility of Putting it into Practice

The problem has occurred within the context of 2 factors:

- a) the author's long time interest in the field of electrical drives;
- b) the author's hobby: mountaineering and alpinism.

Accidents caused by bad weather are frequent. We are going to examine the case when the element that causes the accidents is the cold weather, a situation frequently met in alpinism and tourism practised in wintertime, expeditions, working places located outside, etc. The consequence of the exposure to the cold weather are frost bites, that can end up by amputating the limbs or even death. This situation occurs mostly to alpinism practised in wintertime, which is why the examples will refer especially to this case. The author suggests the use of the similitude to electric drives systems, which emphasises the need for an interdisciplinary research with a group of specialists in: electric drives, medicine, electronics and information technology.

The present paper continues and develops the general ideas mentioned in [5].

The final purpose of this paper is the reduction of accidents.

Its utility is obvious; the possibilities of putting it into practice result from the following text.

The General Method of Solving this Problem and Necessary Explanatory Elements

The practice of technical – social – economical, even sportive activities must go on without endangering the health and life of those who practice them. Thus, in the areas exposed to cold weather, even wind, limitations must be imposed regarding the minimum temperature for the human body. It is obvious that when activities may lead to over passing of the maximum temperature, restrictions may be imposed regarding the limitation of temperature in the other direction as well.

In the calculations needed for establishing relations that illustrates how this functions, it is necessary to remind that the function of electric drive is characterised through 8 function services:

S1 – continuous; S2 – short term; S3 – periodically intermittent; S4 – periodically intermittent with a start time; S5 - intermittent with a start time and electric braking; S6 – non interrupted with periodically intermittent load; S7 – non interrupted with periodically electrical braking; S8 - non interrupted with periodical change of revolution.

The author has studied and published the results for a non conventional service composed of the intermittent service and the short-time service, named by the author the intermittent short-time service (SISD). The author has calculated the necessary relations for putting it in practice, as well as the graphics and the relations with the main reports and parameters. It was noticed, as a very important conclusion, that the variation graphics of the temperature varies similar to variation diagrams of temperature during the movement of alpinists. These situations are presented in chapter 3, illustrating true stories. At the end of chapter 2, several relations are given which show these similarities and which form the basis of a first variant of the driving system based on similitude, presented in chapter 4.

As for the temperature variation in a simplified case, this may occur just like in Figure 1, useful for the notations.

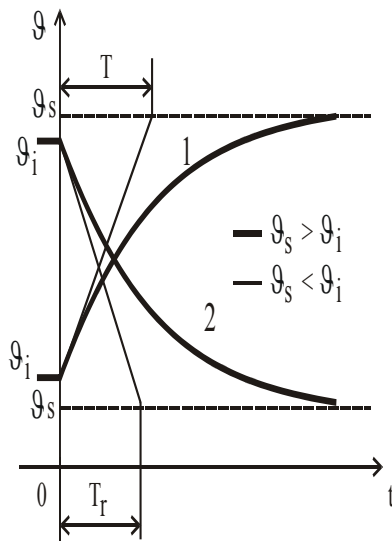


Fig. 1. $\Theta = f(t)$ in case S1

The temperature variations, of a sportsman, for example, as well as the parameters are calculated starting from the equation of thermal equilibrium that is:

$$P_p dt = cm d\Theta + hS\Theta dt \quad (1)$$

P_p - the lost power [W];

c - specific heat [J/kg $^{\circ}$ C];

m - the body's mass, [kg];

h - coefficient of transmitting the heat [J/m 2 $^{\circ}$ C·s];

S - the surface through which the heat escapes;

By dividing with hS , then Tdt we have:

$$\frac{d\Theta}{dt} + \frac{\Theta}{T} = \frac{\Theta_s}{T} \quad (2)$$

where, noting

$$T = \frac{cm}{hS} \quad (3)$$

we get a time constant of the heating or

Moreover, marking

$$\vartheta_s = \frac{P_p}{hS} = a \cdot P_p \quad (4)$$

we get the stationary over temperature ϑ_s ,

Finally, we have:

$$\vartheta = \vartheta_s \left(1 - e^{-\frac{t}{T}} \right) + \vartheta_i \cdot e^{-\frac{t}{T}} \quad (5)$$

If $\vartheta_i > \vartheta_s$, the cooling process takes place. If, on the contrary $\vartheta_i < \vartheta_s$, the heating process takes place.

One can notice that the number of parameters needed for the calculation is big: $t, h, S, \vartheta_s, \vartheta_i, T, m, c$,

$$\vartheta = (t, h, S, m, c, T, \vartheta_s, \vartheta_i) \quad (6)$$

fact which complicates the issue of choosing the system, but it does not cancel it. I would like to mention that the number of parameters that must be taken into consideration becomes smaller, considering that there are 3 connection relations: [3,4,5].

Examples Taken From Real Life that Support the Importance of the Studied Issue

There can be many examples, but I will only choose the most important ones. Thus, in March 1983, a team formed of 8 alpinists affiliated at Sportive Club Politehnica – Timisoara started the crossover of Fagaras Mountains in winter. This counts for obtaining the 1st category for a sportive. We have started from Cabana Suru (at that time it was not burnt). The weather was pretty bad, but our enthusiasm could have overpassed any obstacles, even bigger ones than weather. We have passed over Cabana Podragu and we were heading towards Hartopul Ursului (Figure 2), when suddenly a powerful noise could be heard. Looking up, I saw a long split in the soft snow. Some of us yelled "Avalanche!!!" and we started running along the slope. In vain!!

I managed to move my foot only 1/4 meter when the falling snow made me slide towards the valley. The skiing sticks were torn out from my hands by a huge force that pulled me out of the snow twice. My luck was that the avalanche stopped when I was above the snow. I realised that I was helpless in front of it! I looked around, still confused because of the unwanted "transportation", and I noticed that some of our colleagues were missing. We got reunited and began to call the others. No answer ... just a terrifying silence. I remembered how, during the "dragging down" by the avalanche, in just a few seconds my whole life passed in front of my eyes: my whole family, including my 2 children: Adrian (now 37), a dynamic full of life, who enjoys driving cars, even from the age of 10, a great skier and swimmer and Angelica (now 46) a beautiful young lady, a good musician with a special talent for violin.

Slowly, the team got reunited, but 3 colleagues were missing indeed. We could hear a mild moaning: it was Andrei, a strong, intelligent and full of life young man. We started to dig. I looked around and I see a glove. I wanted to pick it up, but it was on ... a hand!! We called for Iacob and he answered. Together with 2 more colleagues, we started digging.

We were symmetrically divided: 3 of us were looking for one missing colleague, 3 for the other. Suddenly I notice that one of my friends was using the ice pick. "Put away the ice pick" I told him, "you are going to pull out his eyes!" We finally found both of our missing friends: Novac Iacob, having the highest category a sportive can have and Beleaue Andrei, a 1st class sportive.

This event can be included as development and similitude within S2 service. The danger grows when the maintenance time grows, and it may become catastrophic when it turns into S1. Figure 1 shows the place where the avalanche took place.

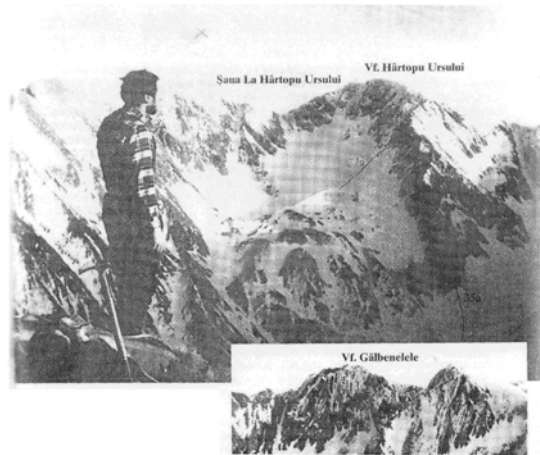


Fig. 2. Făgăraș. Hârtopul Ursului

Moreover, I would like to present a second example which took place in Piatra Craiului. In order to make more convincing the examples presented in this article, it is worth mentioning that the author himself has practised alpinism for 30 years within the “Sportive Club Politehnica” – Timisoara, once called “Politehnica” University of Timisoara, where he had good results as a sportive. He participated to several alpinism contests, (the final of the national contest), one of these contests taking place in Piatra Craiului in 1974, when the author finished on the 3rd rank. His partner was a remarkable graduate of the Electrotechnical Faculty in Timisoara, eng. Balmez Nicu Stelian, presently in the USA (LA), working for a big company. It was a cold day, -15°C in the morning and -10°C at noon; I started climbing first, according to an understanding between my partner and I. I climbed for about 15 m and I could feel my hands freezing. I anchored myself in the wall, then I told Balmez that my hands were freezing. A few minutes later, I started climbing again. My hands were freezing again after no more than 10 meters. This happened again and again. It is useless to tell the readers that we were climbing in winter without wearing any gloves. My hands become red and painful. The freezing action happened over and over again until the hands became hot and no longer froze. The variation graphic of the temperature and the author's calculations are presented in [2, 3]. In order to give a reference point about how the relations change and the parameters grow, you can find below the calculations and the functional dependence compared to the formulas in paragraph 3.

$$\begin{aligned} \mathfrak{G}_{fn} = \mathfrak{G}_s \left[1 - \exp\left(\frac{t_f}{T_f}\right) \right] \left\{ 1 - \exp\left[-\left(\frac{t_f}{T_t} + \frac{t_p}{T_p}\right)\right] + \exp\left[-2\left(\frac{t_f}{T_t} + \frac{t_p}{T_p}\right)\right] + \dots + \right. \\ \left. + \exp\left[(n-s)\left(\frac{t_f}{T_t} + \frac{t_p}{T_p}\right)\right] \right\} \end{aligned} \quad (7)$$

$$\mathfrak{G} = (t_f, t_p, h, S, m, c, T_f, T_t, \mathfrak{G}_s, \mathfrak{G}_i, n) \quad (8)$$

Where t_f and t_p are the function and pause times and T_f and T_p are the according thermal constants of time.

In the same time, in a different climbing route, another team finished the route, when one of the 2 partners started suffering from frost bites. What did he do? He didn't stop. The results of that decision left permanent marks for the rest of his life.

Several examples can be given. Here's one that can be placed in S2 but not yet S1. I have completed the route called Creasta Arpăselului in Făgăraș Mountains in 17.03.75 together with 2 very good alpinists: Ilyes I. and Luzan E. While walking, our hands started to freeze.

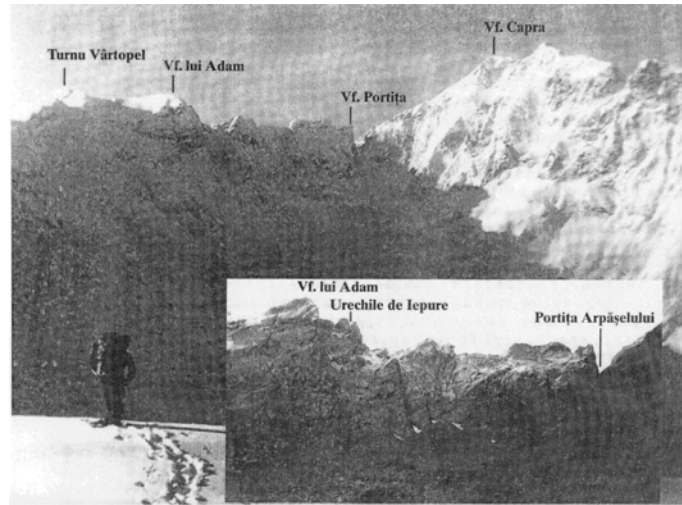


Fig. 3. Făgăraș. Creasta Arpăselului

Driving System Based on Similitude

It's remarkable the similitude between the authors studies graphics and the practically lived for not trying to make a control system based on similitude.

For this reason, it is necessary previous study for: the specific aspects of the relations applications; the determination of the time constants; the determination of the variation limits for times t_1, t_2, \dots ; the representation of the characteristic family $f(\theta)$; set out the necessary information on the base departure, set out the communication level and the necessary apparatus; forming an interdisciplinary team.

The system presented by the author can be seen in Figure 4

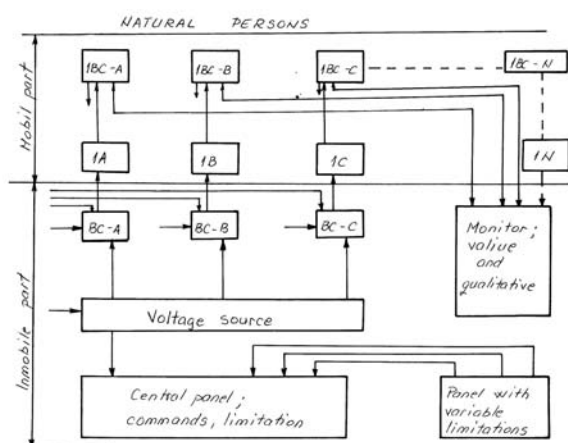


Fig. 4. The main structural scheme of the driving system using the similitude method

We stopped in Zona Urechilor de Iepure to order to warm up our hands. This was done right on time, but it was very painful. Still, as a consequence of this event, side effects followed: I have very sensitive hands. I would like to mention that Creasta Arpăselului was considered at that time the most difficult passage in winter.

Another event, at international level: conquering the first 8000 m peak in Himalaya – Anapurna – in 1952 by Hersog and Lachenal. Huge victory, huge sacrifices: Hersog had his fingers amputated, while Lachenal had his toes removed.

It contains: A, B, C, ...N, - physique persons 1A, 1B, 1C, ..., 1N – switches; 1BC – command block; BC – command block voltage source; central panel, commands, limitation, variable limitations panel; monitor value and qualitative.

Conclusions

We consider that the paper illustrates an issue of major importance, as it focuses on reduction of accidents caused by cold weather, especially in the areas covered with snow and ice. This aspect is of interest especially in the field of alpinism, exploration activities, etc.

The necessity of approaching this problem by similitude is justified by using real examples and a probability is invoked;

It is necessary to continue the development of a deep theoretical basis in order to solve this issue in detail in practice.

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Controlul sistemelor pe baza similitudinii cu funcționarea mașinilor electrice în scopul reducerii accidentelor provocate de vremea rea

Rezumat

Se contată o asemănare mare între graficele și relațiile care definesc serviciile de funcționare la mașinile de acționare electrică, inclusiv cel neconvențional intermitent de scurtă durată cu probabilitățile de desfășurare a proceselor de încălzire – răcire ale sportivilor supuși interperiiilor, în special frig. Se arată exemple semnificative pentru această asemănare, care atestă folosirea similitudinii în calcule și crearea unei baze materiale pentru evitarea accidentelor datorate frigului, care pot conduce la situații grave cum ar fi amputările degetelor, mâinilor etc. la sportivi care practică alpinismul, personalului angrenat în exploatări, pe șantiere exterioare ș.a.