RHYTHM CONSPICUITY FACTOR

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1 INTRODUCTION

Aim of this paper is to define a parameter to quantify the rhythm conspicuity of one light.

Visual observations have showed that conspicuity is better for :

- instantaneous switching on/off (Leds more conspicuous than incandescent lamp)
- quickly series of flashes (VQ(9) rhythm more conspicuous than Q(9) rhythm)

Rhythm conspicuity factor has to take into account :

- the shape of each flashes,
- number and duration of flashes

In that case, rhythm conspicuity factor doesn't take into account :

- synchronisation
- colour
- luminous intensity

2 MATHEMATICAL DEVELOPMENT

To quantify rhythm conspicuity, we need to introduce :

- for instantaneous switching on/off : a shape of flash conspicuity parameter
- for quickly series of flashes : a group of flash conspicuity parameter

<u>Shape of flash conspicuity</u> :

We have $I_n(t)$ instantaneous normalized luminous intensity

$$I_n(t) = I(t)/I_{MAX}$$

with $I(t)$ luminous intensity versus time t
I_{MAX} maximum of luminous intenty

Shape of flash conspicuity, $C_e(t)$, depends on speed of variation of $|I_n(t)|$: $\left|\frac{dI_n(t)}{dt}\right|$.

First hypothesis :

$$\frac{dCe(t)}{dt} = \frac{1}{A}\left[\left|\frac{dI_n(t)}{dt}\right| - Ce(t)\right]$$

with A time constant of vision inertia

So

$$C_e(t) = \int_0^t \frac{1}{A} \left| \frac{dI_n(u)}{du} \right| e^{-\frac{t-u}{A}} du$$

<u>Group of flash conspicuity</u> :

Group of flash conspicuity, $C_g(t)$, depends on speed of variation of $C_e(t)$.

Second hypothesis :

$$\frac{dC_g(t)}{dt} = \frac{1}{B} \left[C_e(t) - C_g(t) \right]$$

with *b* time constant of vision inertia of group of flashes

So

$$C_g(t) = \int_0^t \frac{C_e(u)}{B} \; e^{-\frac{t-u}{B}} du$$

<u>Rythm conspicuity</u> :

Rythm conspicuity factor , C_t , is defined as maximum of $C_g(t)$.

So

$$C_t = \frac{1}{N} MAX \left[C_g(t) \right]$$ with *N* a normalization factor

3 APPLICATION

For A = 0.2s
B = 2s
N = 0.394

- Rythm Q(9) : 9 flashes in 15s
  - → Traditionnal light : C_t = 6.5
  - → LED light : C_t = 7.6

==> A LED light is more conspicuous than an incandescent lamp

- Rythm VQ(9) : 9 flashes in 10s
  - → LED light : C_t = 10

==> A quick sequence of flashes is more conspicuous than a slow sequence of flashes.

4 DISCUSSION

Rhythm conspicuity factor, as defined here, shows difference of conspicuity between :

- a LED shape of flash and an incandescent shape of flash
- a quick sequence of flashes and a slow sequence of flashes.

In that case, rhythm conspicuity factor is different than a probability of perception. The question is not if the user is able or not to see the light, but if it takes 1 second or 1 minute to see the light.
Rhythm conspicuity factor could be an help to define characteristics of a light. For example, if luminous background is important, we have to multiply intensity by 10 or we must have a rhythm conspicuity factor higher than 7.

Rhythm conspicuity factor depends on three parameters A, B and N. Complementary visual observations are essential to quantify these parameters.

There are other parameters which would be integrated in conspicuity factor. More important are :

- synchronisation : synchronisation wouldn't really modify probability of perception. It only takes more time to locate the light. To include synchronisation effect, one way would be to multiply the rhythm conspicuity factor by 2 or more (defined by visual observations)

- Intensity and density of luminous background : It would be difficult to take it into account because it's a different study for each AtoN (it depends on luminous background, distance between background and observer, distance between AtoN and observer). The simple and useful model is the actual model (to multiply by 10 or 100 luminous intensity).

- Colour difference between luminous background and AtoN : a difference of colour between AtoN and background could be easily calculated. The problem is to define colour coordinates of colour luminous background.