On Observation of Incremental Form of Time

Suraj Deshmukh

February 2020

1 Introduction

The Special Theory of Relativity introduces us to the effects of observing the spacetime coordinates from different frames of reference. In this paper we will introduce the concept of Incremental from of time and the effects of relativity on them.

2 Incremental forms of Time

From the special theory of relativity we adopt that Time is what the clock reads. if we place clocks at each point in the entire Cartesian coordinate system, then in a general view at each individual point at any instant the clock will read the same. This means all clocks read the same at any given instant. We assume a perfect synchronization in clocks. But observation differs at each individual point. it suggests us that a single observer cannot observe two distinct Cartesian points at once. Thus we will treat every observer to observe a single body at a given instant. since all clocks are synchronized, any increment t observed in any one clock leads to an increment in all other clocks. we claim a principle: that the Algebric sum of increments of time entering and exiting the stationary Cartesian coordinate equal zero. using appropriate sign convection we may write it as:

$$t_{in} - t_{out} = 0 \tag{1}$$

The principle is limited to stationary points, preferably it can be applied to non stationary points, by rephrasing that the algebraic sum of time entering and exiting the coordinate is non zero.
As the coordinates remain stationary with the incoming of increments all coordinates must not change their values i.e. under the principle of increments the coordinates are invariant. we will now represent each coordinate w.r.t. an observer at origin 0, we will limit our work only in one dimension and assume all coordinates to be non-luminous.
Consider a system of single observer at origin O, consider it to be Luminous and beings its observation by sending a light pulse at the speed c. say a time t_{obs} passes. this implies that the light has reached a distance $H = ct_{obs}$. consider

any point at a distance $x \leq H$. For x to be observed, the light must retrace the path and come back to the observer. say t_i is the time spent to illuminate the coordinate then to make it till the observer a time $t_r = t_{obs} - t_i$ will be remaining.
after illumination light has traveled a distance $\alpha = H - x = ct_r$ say a distance R is required to be covered so that light from x reaches the observer then $R = H - 2x$. Thus we may interpret, if $x = H/2$ the light reaches the observer completely. if $x > H/2$ light has already reached the observer. if $x < H/2$ light has still to cover a distance before it reaches the observer.
Time for which x is actually observed is

$$t_x = \frac{H - 2x}{c} \tag{2}$$

we know clock reads a time $t_{obs} = \frac{H}{c}$ clearly in the equation we may write,

$$t_x = t_{obs}\left(1 - \frac{2x}{H}\right) \tag{3}$$

defining x in terms of time we get:

$$x = \frac{c}{2}(T_{obs} - T_x) \tag{4}$$

Here T_{obs} counts the total time of observer while T_x is the total time for which the coordinate x was actually observed, it is a clock made by the observer for the observed coordinate. The clock of observer has increment t_{in} and clock build up by observer has a increment t_{out}. This is our new representation of coordinate. clearly from the equation we may see how adding the increments does not change the coordinate. for instance adding t_{in} to T_{obs} and t_{out} to T_x and applying the principle of increments we get the same coordinate back and it must. If it does not it suggests that the coordinate is not stationary. we will indeed see this when we will apply the special relativity.

3 Application of Galilean Relativity

Before we apply the lorentz transformation, I would like to show how it looks like under Galilean relativity. Consider that the coordinates of observed object are dynamical, say the object moves with a velocity v as seen from the observer. we have $x_{dyn} = x + vt_{in}$, before we proceed take a look at the fact, say $x_1 = \frac{c}{2}(t_{obs} - t_x)$ after the addition of increments $x_2 = \frac{c}{2}[(t_{obs} + t_{in}) - (t_x + t_{out})]$ which is same as, $x_2 = x_1 + \frac{c}{2}(t_{in} - t_{out})$ this is simply $\Delta x = \frac{c}{2}(t_{in} - t_{out})$ clearly if $\Delta x = 0$ it implies $t_{in} = t_{out}$. as such $\frac{2\Delta x}{c} = t_{in} - t_{out}$ but from Galilean relativity, $\Delta x = vt_{in}$ putting this we get

$$t_{in}\left(1 - \frac{2v}{c}\right) = t_{out} \tag{5}$$

This is the relation between the increments under Galilean Relativity. clearly at $v = 0$ our principle is conserved.

4 Application of Special Relativity

Using the Lorentz Transformation $x = \gamma(x' + vt'_{in})$ hence $x - x' = \gamma x' + \gamma v t_{in} - x'$ and $x - x'$ represents the change in increments and we get,

$$t_{in}\left(1 - \frac{2v\gamma}{c}\right) = t_{out} + \frac{2}{c}x'(\gamma - 1) \tag{6}$$

the term $\frac{2}{c}x'(\gamma - 1)$ is based on initial condition, if x'=0 initially then the term vanishes. For smaller velocity $\gamma \approx 1$ and the equation reduces to Galilean relativity. same way if $v = 0$ we get back our principle.

5 conclusion

From the Assumption of Non-luminous coordinates and the incremental principle we see how the addition of increments in the clocks of observer and the observed object differs as the object gains velocity.