A New Interplanetary Communication System to Reduce Time Delay

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ABSTRACT
In the present interplanetary communication, there is always a time delay and it increases with the increase in the distance. As electromagnetic waves are the medium of communication and these waves travel at the speed of light so it is difficult to reduce this delay. But the theory of relativity (time dilation) says that when an object travels at very high speed then time for that object moves at the slower rate as compared to the object which is at rest. So, on the basis of this principle, we establish robots in the orbit of the Earth and other planets and start rotating them at the speed of light. When these robots take part in communication then delay can be minimized because whole communication system is at the speed of light and time for this system will move at the slower rate as compared to Earth. In the present system of communication the whole system is not at speed of light, therefore this delay is occurring. Thus, by this proposed method this problem can be solved. This method has certain limitations but it can be still used very effectively for the different purposes.

General Terms
Communication and special theory of relativity

Keywords
Artificial intelligence, interplanetary communication, time dilation

1. INTRODUCTION
In interplanetary communication, time has a crucial role. "Humans are going to land on the Mars in few decades but still communication between the earth and the mars suffered by the time delay of typically 7 minutes to 21 minutes [1]." The main medium of communication is electromagnetic waves which travel at speed of light [2], [3]. However, communication always suffers by some time delay. "In 1905 Sir Albert Einstein proposed the special theory of relativity which gave a new direction to the physics. This theory is based on two main points, first- the laws of physics are same for all inertial systems and second- the speed of light in the vacuum is same for all observers, regardless of the motion of the light source [4]." By this concept, we can say that delay can be minimized if the whole system of communication is at (or nearly equal to) speed of light. But in the present communication system, the satellite transmits the signal to planet's surface (or vice versa) and both satellite and surface are not at speed of light [5], [6]. Therefore this delay is occurring. Due to this, we have replaced satellite with robots which are moving at speed of light around the planet. In this way, delay in interplanetary communication can be minimized.

This paper is organized as follows- Section II is mathematical background related to this method, Section III tells about the structure of communication system for reducing time delay, section IV explains the process of Communication by the system, section V is the result, section VI gives limitation of this system, section VII is the discussion and section VIII gives the conclusion.

2. MATHEMATICAL BACKGROUND
By Einstein's special theory of relativity (time dilation concept) - "When an object travels nearly equal to speed of light, time for that object moves slowly as compared to another object which is at rest or moving slowly [4], [7]." Mathematically it can be represented as-

$$\sqrt{1-\beta^2} \quad (1)$$

Where- $\beta = {}^{v}/_{c}$,

Here, $v =$ speed of any object and $c =$ speed of light [4], [8].

Above formula gives the rate by which time slows down for an object moving at the higher speed (near to speed of light). "If $v \approx c$, i.e. if $\beta = 0.99999$, then $\sqrt{1-\beta^2} = 0.0045$. That means if an object moves 99.999% of speed of light then the object's time progress at the rate of only 0.0045 the rate of another object which is at rest [4], [8]." So we can conclude from above explanation that – if a signal travelling from Mars to Earth suffers a delay of seven minutes for any person who is receiving it on the earth, but if the same signal is received by any object which is travelling at the speed of light (on or near the earth) then the delay will be-

Delay of 1 minute = delay of 0.0045 minute (due to $v \approx c$),

So, delay of 7 minutes = delay of 0.0315 minute or 1.89 seconds.

3. STRUCTURE OF COMMUNICATION SYSTEM FOR REDUCING TIME DELAY
In this system, we will use the robots which have intelligence equivalent to human. These types of robots can think and perform their task by themselves without any help or proper commands by the human. "According to Hans Moravec, these types of robots will be a reality as early as 2050 [9], [10]."

(Refer figure 1) In this communication system, we will establish one robot (say 'R1') in the orbit of the earth and another robot (say 'R2') in the orbit of another planet (such as Mars) for communication or signal transfer and start rotating both robots at (or approximately equal to) speed of light.

For revolution at such speed, we can use different methods. One of the methods for traveling nearly equal to light speed is proposed by Sir Stephen Hawking [11]. We can use the

concept of his future rocket for the revolution of the robot after some modifications [12].

4. PROCESS OF COMMUNICATION BY THE SYSTEM

Communication or signal transfer can be done in following different ways-

4.1 Robot 'R1' to Robot 'R2'

(Refer figure 2) The signal can be transmitted or received between robot 'R1' (around the earth) and robot 'R2' (around the mars). As both robots have artificial intelligence, they can communicate without any command or human presence. This type of communication helpful in sending and receiving images of the planet surface, weather report etc. By (1), we can write- typical delay in communication will be of 0.0315 minute or 1.89 seconds.

4.2 Mars Surface to Robot 'R1'

(Refer figure 3) Another way of communication which is possible is that- any person or robot (from the mars surface) can transmit the signal to robot 'R2' and then 'R2' sends it to robot 'R1'. Typical delay in communication will be-

[Assume time needed to transmit signal from mars to robot 'R2' is 1 second (worst case)]. By (1), we can write-

1.00 second (from mars to 'R2') + 1.89 seconds (from 'R2' to 'R1') = 2.89 seconds.

The data received by 'R1'can be stored in its memory and the data can be sent to the Earth for any type of future reference or for other similar purposes.

4.3 Earth Surface to Robot 'R2'

This communication will occur same as for Mars surface (Refer figure 4). The typical delay will be of 2.89 seconds. All the data received by robot 'R2' can be stored in it and can be sent to the Mars surface for future reference or for another purpose.

5. RESULT

By the above-proposed concept of the interplanetary communication system, communication will occur by reduced time delay. By this method, we can communicate deeper in space with negligible delay, which can be observed by Table 1[13].

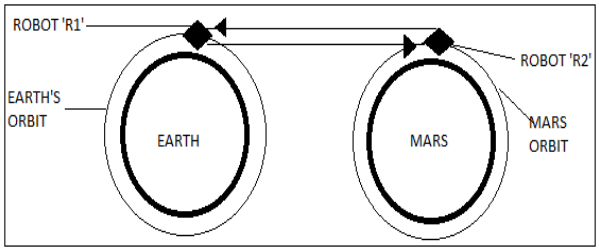

Figure 1: Concept of new interplanetary communication system

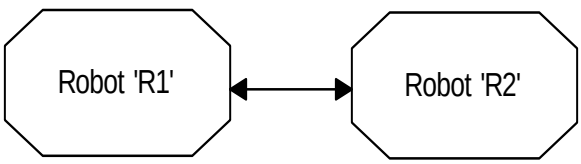

Figure 2: Communication between R1 and R2 robot

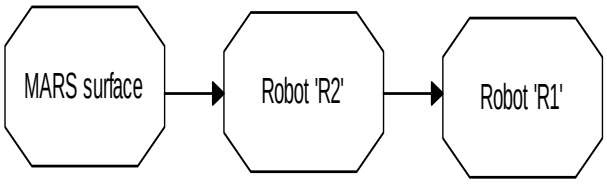

Figure 3: Communication between Mars surface and R1 robot

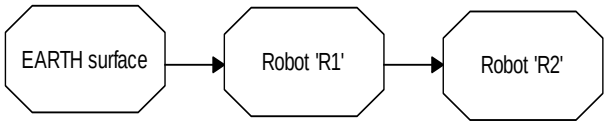

Figure 4: Communication between Earth surface and R2 robot

Table 1. Reduced delay by proposed system

S. No	Communication Between	Distance (in Millian Km)	Present Delay Time (Typical)	Reduced Delay Time (Typical)
1	Earth and Mars	55-378	7 minutes	1.89 to 2.89 seconds
2	Earth and Jupiter	590-970	43 minutes	11.61 to 12.61 seconds
3	Earth and Pluto	~5800	5 hours	81 seconds
4	Earth and Nearest Star	~9.5 million	4 years	6.57 days

Note- Calculation of reduced time delay is done by above given formula.

6. LIMITATION

Limitation of above process is that if we want to transmit the signal from Earth surface to Mars surface (or vice versa) directly, then it can't send with reduced time delay and the process of sending signal from mars surface to 'R1' and earth surface to 'R2' is unidirectional (one- way communication).

7. DISCUSSION

The time delay in the current process of communication is a problem which can't be solved easily. But the above-explained process, whose main principle is based on the theory of relativity, enables us to communicate with negligible delay. "But this method needs the advanced robot and motion in the speed of light and this may develop after 2050 (predicted) [9]." Therefore this method is applicable only after 2050's. There are some limitations of this system because Mars and Earth surface and all the things on them are not at the speed of light. Thus this limitation can be removed if we can design a system which only deals with the components which are at the speed of light. In this way, this method can be made applicable to any type of communication. Along with the limitations, this method can be useful in the following case-

- For knowing nature of the surface and the different surface phenomenon of foreign planets.
- For weather report or weather forecasting of other planets. This is essential in the case when there is any robot in an area of the foreign planet, in the case

of bad weather report we can come up with certain fast and accurate solution from the earth.

- For fast deeper space communication.
- This method is applicable in every field of interplanetary communication where time has crucial requirements.

8. CONCLUSION

Special theory of relativity can be used for fast interplanetary communication and communication in deep space. Thus, based on this principle we can develop various other effective methods of communication. There are some limitations of this system but these limitations can be removed by certain modifications. But along with these limitations, this method can be applicable effectively in various cases.

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