

# Hyper loop Transportation System

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**Abstract:** Standard ways that are being used for the transportation of commuters or any kind goods are railways, roadways, waterways, and through airways. Cost of these transportation methods are generally depends on the certain factors like distance, luxury, size, fragileness, etc. when the following factors are considered, transportation sometimes becomes very costly and unaffordable for many individuals. By keeping all the factors in mind and also some other factors like time, speed, efficiency a new mode of transportation system got invented. It was first proposed by Elon Musk in 2012 as fifth mode of transportation. He called it Hyperloop. Hyperloop is quick economical for commuters and merchandise. The idea of Hyperloop has been open sourced by musk and his company to take the ideas and further develop them. The design of Hyperloop is generally described as vacuum- tube train design. Hyperloop is a packed tube or system of tubes along which a pod will travel freely against the air resistance carrying people or goods at a high velocity while being efficient. The original version of Hyperloop is consist of less pressure tubes into which a pod travels on air bearings by linear induction motor and axial compressor through the vacuum. This high velocity transportation system is having some important characteristics that are immunity to weather, collision free, twice the speed of a plane, low power consumption, and energy storage for 24-hour operations. This system mainly goes into loops that are why it's called Hyperloop. When the early design of Hyperloop was published it described one potential design, purpose, passage and cost. According to the developed Hyperloop design, the pod will accelerate at a high velocity by making use of a liner induction motor and air bearings it will float through the tubes on supporting tracks above or below the ground to avoid any kind of disturbance. Ideally Hyperloop is very energy efficient, noiseless and self-governing compare to existing mode of transportation.

**Index Terms:** E.D.F jet motor, levitation, pressurized air, streamlined lift, vacuum tube.

## I. INTRODUCTION

Hyper loop concept comes under the fifth mode of transportation that was proposed by Elon musk in the year 2012. Hyperloop is quick economical for commuters and merchandise. The idea of Hyperloop has been open sourced by musk and his company to take the ideas and further develop them.

**Revised Manuscript Received on May 06, 2019**

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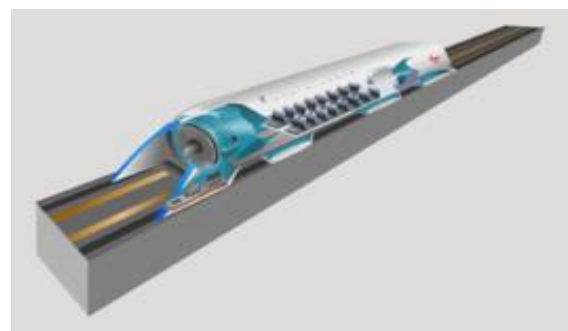
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Generally, Hyperloop is consists of number of tubes sealed together Throughout the required distance either straight or in a loop formation constructed above the ground level or below the ground level.

This vacuum- tube train structure of Hyperloop will always be having a capsule or pod floating freely inside it. This pod will travel freely against any kind of air resistance at a very high velocity. Tracks will also be present inside the tube and the passengers sitting inside the pod that will travel at airline speed along packed tube structure that are pressurized by using the axial compressor. The pod will also be floating freely in the presence of vacuum slashing the traveling time where it gets levitated by using electric propulsion and magnetic levitation. Generally, a pod is consists of an electrical driven input fan and axial compressor which will be attached at the front end of the pod. This setup is mainly used to transfer high- pressure air from the front side to back of the pod so that it can move freely without slowing down. The levitation of the pod inside the packed tube under partial pressure is very similar to how pucks are levitated above an air hockey table. The linear induction motor is used for accelerating and decelerating the velocity of pod for each section of tube route. A passenger pod floating inside the tube can easily accommodate 28 commuters. After various researches it is found out that by making use of Hyperloop as our fifth mode of transportation the journey times can be slashed by half or more than half.

For this the first potential route was constructed between Los Angeles and San Francisco. The concept of Hyperloop feels like a science fiction but this concept of Hyperloop is now on edge of becoming reality with number of companies coming towards with new concepts every day and company like virgin Hyperloop one started constructing their own designed Hyperloop in countries like UAE, India.



**Figure 1 Hyper loop**

## II. LITERATURE SURVEY

Submit Ahmed Hodaib, Samar F. Abdel Fattah (May 2016), in his published paper had discussed a prospective observational of partially levitating pod within the aerodynamic vacuum system using high pressure air bolster among non- identical condition of nature. Point of this entire study is to get a conventional design of a structure into which the linear induction motor can be fitted so that the required amount speed as well as the thrust obtained from the available power source. Result obtained from this study is an optimized centre of gravity of the capsule by placing different set of batteries and rotors at the bottom of the pod. [1]

Jeffrey C. Chin, Justin S. Gray, Scott M. Jones, Jeffrey J. Berton, in their published paper reviewed about the Open-Source Conceptual Sizing Models for the pod of the Hyperloop. They together came to a conclusion that the refined analysis of the pod highlights various multidisciplinary combinations that modify two major characteristics of the initial concept. First, the velocity of the pod and the cross sectional area of the tube are linked together, this forces the size of the tube to become two times the diameter of the original parameters of the tube, which helps the pod to reach a velocity of Mach 0.8. Second, the temperature of the tube at a steady-state is influenced by the ambient thermal interactions independent to the heat generated by the pod compression system. [2]

Mark Sakowski (2016) in his published paper has discussed about the retrospective analysis of values from a recognized oil fueled fuselage such as car, truck on the global transportation and sustainability. This helps in the reduction of GHG reduction. The purpose of the study is to examine the effect of renewable energy currently present which instantly helps in the implementation of the newer and more efficient technologies. In this particular paper author concluded that significant associations were found out with different ideas for the implementation. There was no contact found out with mechanical guide ways, but large capital costs were involved. [3]

N. Kayela, (2014) in this particular published paper discussed about a cross sectional study which was conducted for getting the risk factors as well as the estimated rates, also about some kind of adjusted odd ratios assessed into the subsets. The purpose of this whole study was to determine the risk factors and the outcomes of the shooting shuttle and also for determining the running electromagnetic impulse that disperse a pod to a very high velocity. Author came out with a result that there is an increased risk of spontaneous crash. The speed of the air passing through the gaps tells about the shape of the pod. [4]

Mohammed Imran (2016) in his published paper has discussed about the various elements of Hyperloop transportation system. He also discussed about the two version of Hyperloop transportation system in which one is the commuter only version and another is the commuter plus automobile version. Author came out with a result that the transportation of passengers can be possibly done in a very less time at cheaper rates. Further improvements in this

technology can lead to more reduction in price with greater sustainability. [5]

## III. THEORY AND OPERATION

There are many major improvements that had been done in every mode of transportation so as to make then fast and at the same time efficient, railway is one of them. But every major improvement that has been done so far is always blocked by the challenges like rubbing and air opposition. But these problems can be overcome by making vehicles moving at a very high velocity. Here the idea of Hyperloop comes in which is having a pod with a accommodation of 28 commuters levitating inside the vacuum tube train structure under partial pressure and moving freely against the air pressure because of the presence of electrical driven input fan and axial compressor. The problem of high pressure air which is responsible for slowing down the speed of railways is easily resolved by using this setup in Hyperloop. As the Hyperloop levitates and starts travelling along the tubes above the air bearing, the axial compressor starts rotating, transferring the high pressure air from the front side of the pod to the rear side and the pod moves smoothly.

The levitating pod inside the tube moves easily at a very high velocity of 1000 miles per hour. And also operates at approximately one millibar (100 pa) of pressure. This high velocity transportation system is having some important characteristics that are immunity to weather, collision free, twice the speed of a plane, low power consumption, and energy storage for 24-hour operations.

The Hyperloop concept was first proposed by Elon musk and a group of engineers. The original Hyperloop concept was described as the vacuum- tube train structure. Hyperloop is generally consists of number of transparent tubes sealed together throughout the distance which has to covered by the pod according to the routes made. This vacuum tube train structure will be constructed either above the ground or below the ground so as to avoid any kind of disturbance like change in whether condition, earthquakes, etc.

A pod which is also known as capsule of a Hyperloop will floats freely against the air resistance inside the packed tubes structure which is having a partial vacuum carrying maximum of 28 commuters at a time. This pod will float on a layer of air which is provided to under pressure pneumatic lifting device. This concept is very similar to that which is used to levitate the pucks above an air hockey table. In another design of Hyperloop passive maglev (magnetic levitation) is used in the place of pneumatic lifting device.

The pod will also consists of an electrical driven input fan and axial compressor setup which will used to overcome the issue of the air resistance responsible for the slowing down the speed. As the pod will start moving along the sealed tube structure the axial compressor will start moving and transfers the high pressure air from frontend to the rear end thereby creating vacuum inside the tube which helps the pod to move freely against the air resistance. The tube will also consist of linear induction motor which helps in acceleration and deceleration of the pod to appropriate velocities for each section of tube route.

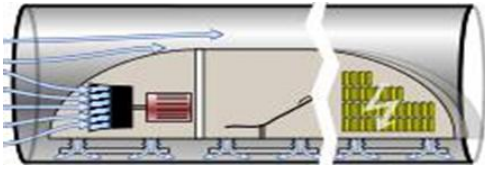


Figure 2 Concept of a hyperloop capsule

#### IV. CONSTRUCTION

##### A. PVC pipe capsule

Plastic pipe is very lightweight, adaptable, solid, and flexible. The various items that are made from plastic and composite materials are used in a various number of applications of standard metal and fired channeling.

Plastic pipe provides critical investment funds as far as both weight and establishment, in any case. Plastic funneling comes in strong divider and creased arrangements, and is accessible in an assortment of basic materials.

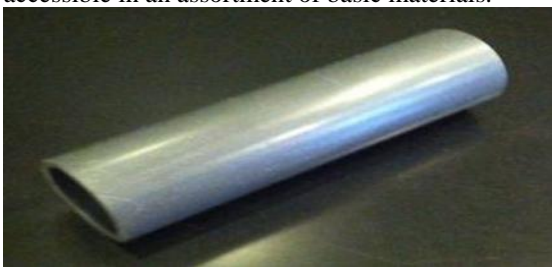


Figure 3 PVC Pipe

##### B. Acrylic Tube

Acrylic tube, also recognized as a plexiglass, is a rugged and a see through plastic product that do the job as an ideal alternative to standard glass. Acrylic rod is ten times rugged than standard glass but half the weight.

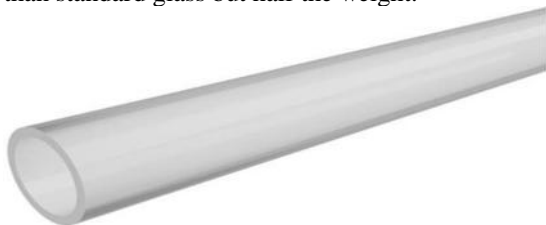


Figure 4 Acrylic Tube

##### C. Vacuum Pump

A vacuum pump generally is a kind of mechanical device that is used for the purpose of removing the gas molecules from a sealed object in order to leave behind a partial vacuum. A vacuum pump was invented by Otto von Guericke in the year 1650.

Generally, the vacuum pumps are combined in chambers and operational procedures into a very broad variation of vacuum systems. Occasionally there are times when one pump will be working on a single application. Generally, partial vacuum will be created by making use of a positive displacement pump that transfers a charge of gas from an inlet port to an outlet port. If there is any kind of mechanical limitations then such type pumps can only attain a low vacuum. If there is a need of creating a vacuum in a system then it usually requires throwing all the molecules of gas out of the system. The Molecules of gas will only be move out of the system if there is a significant pressure difference between two sections. The

section which is having the smaller number of gas molecules will be marked as the low pressure section of the system and the area with more significantly more number of gas molecules will be considered the high pressure section of the system.

A device which is used to induce the pressure difference between two sections of the system is considered a pump. In some system, the pump which is used to create vacuum is considered as a vacuum pump.



Figure 5 Vacuum Pump

##### D. E.D.F. Jet Motor

An electric ducted fan (E.D.F) is a unit generally used in jet planes that are remote controlled because of their high thrust as well as high RPM.

The electric ducted fans are remarkable reproduction carrier and to control such a unit which is having so much thrust and RPM one should have a great foundation as well as experience of handling remote controlled plane with such amount of power. An Electric duct fan unit is very expensive. An electric duct fan unit can easily make a big size remote controlled airplane flying high enough in air because of its tremendous thrust and high RPM.

An electric duct fan is also not very big in size it will be small in size still will be a remarkable unit which will be housing a multi-bladed propeller also known as fan which is capable of turning at a very high RPM (revs/minute) and at the same time is able to generate tremendous amount of thrust. The thrust as well as the RPM of the fan can easily be controlled by a controller.

The operation of EDF unit is very simple, as propeller of the unit starts rotating; air gets sucked into a pipe through one end into the fuselage of the unit, and after that it will be forced out from the back of the unit. With a high RPM and a tremendous amount of thrust, an EDF unit can supply a plenty of push to the RC Plane. EDF units are generally constrained by high RPM brushless motors. An EDF unit generally needs a very big lithium polymer battery pack (Li-Po) with a high breaking point or high discharge which will generate enough current that can be supplied to the unit for acquiring the required amount of thrust and RPM.



Figure 6 E.D.F Jet Motor



# Hyper loop Transportation System

## E. Neodymium Magnets

A neodymium magnet is the most broadly used rare- earth magnet. It is a type of permanent magnet. A neodymium magnet is generally a combination of neodymium, iron and boron and the final structure obtained from this blend is known as tetragonal crystalline structure. Neodymium magnets were developed in the year 1982.

Majority of neodymium magnets are the grounded type of everlasting magnets and also economically available. The neodymium magnets have replaced different kinds of magnets in various applications. According to some researches present day things are required powerful and unchanging magnets, in practical applications we can consider motors used in cordless mechanical assemblies, rigid plate drives and engaging hooks. A neodymium is a metal which is ferromagnetic; it means that it is capable of getting magnetized to become a magnet like iron at its curie temperature. Neodymium magnets are having high remanence value, high coercivity value and energy products, but their Curie temperature are often lower than other types.



Figure 7 Neodymium Magnets

## F. Controller

A radio controller is based on a 2.4 ghz configuration which provides a link between the radio controller and the radio controlled models. The transmitter consists of a minimum 6 channel receiver. The transmitter uses 4 AA NiMh batteries. The controller instead of 4AA batteries can also be used on a 2s lipo battery. One of the important features of this radio controller is its ability to change from mode 1 to mode 2 in a very less response time on just flipping a single switch.



Figure 8 Avionic 6 Channel Controller

## G. Battery - 3S\*2-2200

The RC LiPo 3S batteries are generally used in RC controllers. This battery is having a capacity of 2200mAh. This battery is capable of generating a voltage of 11.1v. RC LiPo Batteries are generally manufactured for Remote Control Models.

This battery is weighs around 168g. This battery comes with a continuous discharge of 30C and a maximum burst rate of

60C. This battery is rechargeable and it should only be charged at or in between the suggested charging ampere range of 0.1A-5A.



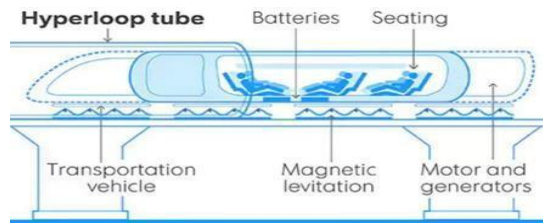
Figure 9 YOWOO RC Lipo 3S 2200mAh

## V. WORKING

Hyperloop is known as the fifth mode of transportation. It might feels like a very futuristic concept but this concept is really on the edge of becoming a reality. This concept was proposed by Elon Musk. In future it might replace transportation and traveling via railways. Hyperloop concept is capable of giving competition to airways also. This concept of transportation is known to be the safest and efficient compare to the other four transportation methods.

Hyperloop is much faster compare to railways with velocity twice to that of airways and at the same time safest compare to existing methods. Hyperloop is also less space consuming as it will be getting constructed above the ground level or below the ground level. This high velocity transportation system is having some important characteristics that are immunity to weather, collision free, twice the speed of a plane, low power consumption, and energy storage for 24-hour operations. This system mainly goes into loops that are why it's called Hyperloop. The concept and design of Hyperloop was made open sourced by Elon Musk so as to encourage interested peoples in further developing it.

When original Hyperloop concept was first proposed by the Musk in 2012 is consists of series of transparent tubes that are sealed together throughout the distance which to be covered according to the route. This vacuum tube train structure will be either above the ground level or below the ground level. The tube will be maintained at a partial vacuum. Then there will be a setup of linear induction motor throughout the sealed tubes for controlling the acceleration and deceleration of the pod. The pod will be capsule like structure can accommodate maximum 28 passengers. A pod will have a setup of inlet fan and axial compressor present at the nose to eliminate the high pressure air building in front of it, slowing it down. The pod will levitate in the tube in the presence of partial vacuum which is very similar to the pucks levitating above a hockey table. As the concept got open sourced, according to another concept passive magnetic levitation is used for some purpose. The pod inside the vacuum tube train structure in the presence of partial levitation will move freely against the air resistance and friction without slowing down and so approaching a velocity of 1000 miles per hour. Hyperloop operates approximately at 100 pa of pressure. Hyperloop is free from any kind of vibration. The tube pillars are made to withstand against any kind of instance tremors.



**Figure 10 Working of Hyperloop Transportation system.**

## VI. FUTURE SCOPE

When concept of Hyperloop was proposed by Elon Musk, the whole idea behind this concept was to find a proper solution for all the problems related to the existing transportation system. Elon Musk called it as the fifth mode of transportation. This concept was made public by the Musk in the year 2012 as he wanted to encourage others also to come up with different ideas and modifications.

Hyperloop is having some very great characteristics like it is immunity to weather it is collision free it's having a velocity twice the velocity of a plane, consumes less power and having ability of storing energy for 24-hour of operations. In future Hyperloop will surely replace at least railways because of its ability to travel much faster than railways slashing the traveling times by half. When this whole idea of Hyperloop came out in the public it was all looking like a futuristic science fiction but then its first route got published in the year 2013 and now this concept is on the edge of becoming reality. The overall market of Hyperloop is most likely to show a quick expansion in coming couple of years. The first ever Hyperloop route was got published by Elon Musk in the year 2013 running from the Los Angeles region to the San Francisco bay area with total of five interstate corridor. Recently, many more Hyperloop projects are getting published by different corporation. A startup company named Arrivo corporation came up with a plan for a magnetic levitated automobile transportation system with a route running from Colorado to Denver international airport and first leg of this is going to be completed by 2021. There are some Hyperloop projects for India going to be started in near future for a proposed route between Chennai and Bengaluru. Hyperloop Transportation Technologies are in approach to sign a Letter of Intent with the Indian Government for this project. The proposed route is going to be 345 km which could be covered in estimated time of just 30 minutes. Hyperloop Transportation Technologies proposed another route for India starting from Amravati till Vijayawada that can be covered in just 6 minutes. These projects are likely to be started with a 6 month feasibility study. Another Hyperloop project which is going to be started in India soon is by Virgin Hyperloop one and the proposed route for this project is Mumbai – Chennai. The Mumbai-Chennai Hyperloop proposed route will create a system of cities and will provide a crucial East-West connection across India. Hyperloop will bring new economic opportunities and industry linkages, and ease the movement of passengers and goods between Mumbai, Bengaluru, and Chennai. Indore-based Dinclix Arrangements' DGW Hyperloop brings a Hyperloop entranceway between Mumbai and Delhi passing through Indore, Kota, and Jaipur. All of these projects are likely to be

started in near future some 5-6 months of feasibility study and are planned to be completed by 2021.

This shows that the future is going to be very bright and its market is most likely to show a very quick expansion with many more corporations coming forward in the market. With a rapid urbanization over the world, the basic requirements for smart and favorable techniques of transportation are also escalating rapidly.

## VII. CONCLUSION

For producing a better economy it generally requires snappy, more affordable, increasingly secure and continuously capable transportation modes. In present time our roads, airplane terminals and sea ports are congested because of rapidly increasing population and we haven't got any type of transport in past 100 years. Hyperloop concept solved all these problems. Hyperloop is the proposed solution for each of the problems that are faced related to the existing transportation system.

Hyperloop is came out as a better option compare to the existing transport systems because it is fast with a velocity twice the velocity of airplanes, journey times get slashed by half with the travelling cost almost similar as airplane travelling cost. Hyperloop is also safer compare to the existing modes of transportation. Hyperloop is having four important advantages that make it a better option in comparison to the existing systems and one of the four key features is that it's quick. It's on-request and direct. Trains usually have a calendar as well as will be having various stoppages. Hyperloop always leaves when you're prepared to go, and units can withdraw up to a few times each moment and can transport commuter and the commuters will be directly dropped to their venue without any stops in between. It is ecologically alluring, with a little natural effect, progressively proficient vitality utilization and it is not having any immediate discharges. It is more affordable and also a very diverse innovation. As we know that High-speed rail and conventional trains with magnetic levitation require more control along the whole length of the track. Therefore, the cost of tracks more and it requires more amount of work to be done. Hyperloop can accomplish better execution for less expense.

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