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%Source code Produced by David Zhang
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%This code solves when to Launch

% launch into Venus orbit and meet with Venus
% then orbit Venus until the landing date

%rocket speed?

clear all
close all
%Physical constants
G=6.672e-20;  %km^3/(kg*s^2). Universal gravitation constant
%G=6.672e-20;  %km^3/(kg*s^2). Universal gravitation constant
m_sun=1.98e30; % kg. mass of Sun
m_ven=4.867e24;% kg. mass of Venus.
mu_sun=G*m_sun;     %km^3/s^2. Kepler's constant
mu_ven=G*m_ven;
Radius_ven=12104/2; %km. Radius of Venus.
% Rp=108e6; %Perigee of Transfer Oribt
% Ra=146e6; %Apogee of the Transfer Oribt, also the perihelion of Earth
around Sun

Rp=108e6; %Perigee of Transfer Oribt, average Venus distance to Sun
Ra=149.6e6; %Apogee of the Transfer Oribt, average Earth distance to
Sun
TO_eccentricity=(Ra-Rp)/(Ra+Rp);  %eccentricity of the transfer orbit
that spacecraft uses to rendzvous with Venus.
a=(Rp+Ra)/2;

T=sqrt(4*pi^2*a^3/mu_sun);
T_days=T/60/60/24;

tx_angle_max=67; %in degree. maximum El angle measured from Z-axis the
antenna on the lander can go to get out of Venus atmosphere.


TO_travel_days=T_days/2; %Important days. Transfer Orbit (TO) travel
days=146.23 days. The Russians used about 4 months!! So our number is
reasonable

Venus_orbital_const=0.6152;         %%ration of rotation period of
Venus to Earth around the SUn
Earth_orbital_period=365;   %days
Venus_orbital_period=Venus_orbital_const*Earth_orbital_period;
%rotation period of Venus around the SUn
Venus_daily_deg=360/Venus_orbital_period;   %number of degrees that
Venus travels per day
Earth_daily_deg=360/Earth_orbital_period;   %number of degrees that
Earth travels per day

tolerance=2*Venus_daily_deg; %degree. Used in
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future_angle_to_future_date_func. This gives flexibility when we are
looking for the days to reach the approximate desired angle. If to be
exact, it may take a long long time.
%tolerance=3
Venus_TO_deg=TO_travel_days*Venus_daily_deg;  %number of degrees Venus
has travelled during TO period

%Where is Earth relative to Venus?? When in time will they be in these
%positions? Then we have solved when we launch need to launch.


Venus_to_Earth_Launch_day_deg=Venus_TO_deg-180;  %54.4459 degress. this
is the angle between Earth and Venus on the day of Spacecraft launch


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%
%write a program that given
%1. today's Venus and Earth relative position
%2. the known distance between Venus and Earth and
%3. the angle of line 1 and 2. where line 1 is from Sun to Venus. Line
2 is from Sun to earth
%We can determine on which day will Venus and Earth fall into these
%positions


%Venus and Earth relative positions

%ON Jun 30, the distance from Venus to Earth is 1.504AU
%1AU=149,597,871 km

AU=149597871; % km

ven_to_ear_initial=1.504*AU;
ven_to_sun=108e6;    %km. venus to sun distance
ear_to_sun=149.6e6;  %km. earth to sun distance

%from Law of Sine: http://en.wikipedia.org/wiki/Triangle
a=ear_to_sun;
b=ven_to_sun;
c=ven_to_ear_initial;

current_ven_to_ear_angle=acosd((a^2+b^2-c^2)/(2*a*b));  %deg. 120.8676.
This is the angle between Venus and Earth on Jun 30.

[launch_date,
wait_to_launch_days]=future_angle_to_future_date_func(current_ven_to_ea
r_angle, '06/30/2013', Venus_daily_deg, Earth_daily_deg, 360-
Venus_to_Earth_Launch_day_deg, tolerance); %Important days
launch_date
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%
%When the space craft rendezvous with Venus, Earth, spacecraft, and
Venus have
%travelled for TO_travel_days
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%the angle between Venus and Earth would be

Venus_to_Earth_on_rendezvous_day_deg=Venus_TO_deg-
TO_travel_days*Earth_daily_deg;  %the angle between Earth and Venus on
the Rendezvous day.
date_of_rendezvous=future_date_func(launch_date,
floor(TO_travel_days));               %important day
date_of_rendezvous
max_line_of_sight_deg=position_to_angle_func(tx_angle_max);
[land_date,
wait_to_land_days]=future_angle_to_future_date_func(Venus_to_Earth_on_r
endezvous_day_deg, date_of_rendezvous, Venus_daily_deg,
Earth_daily_deg, 360-max_line_of_sight_deg, tolerance); %Important days
land_date
wait_to_land_days; %# of days between rendezvous and land

%Assume the spacecraft position relative to the landsite at the
rendezvous
%point is the same as the day of landing. So the spacecraft roation
%period*an integer=wait_to_land_days.
%let's name the integer as craft_rot_divide

craft_rot_divide=1000;
wait_to_land_sec=wait_to_land_days*24*60*60;
T_craft=wait_to_land_sec/craft_rot_divide;                %rotational
period of spacecraft around Venus
craft_rot_radius=((mu_ven*(T_craft^2)/(4*pi^2)))^(1/3);   %the distance
from spacecraft roation orbit around Venus to the center of Venus
craft_rot_altitude=craft_rot_radius-Radius_ven    %km. The altitude of
the spacecraft relative to Venus. Earth GEO altitude is 6378kM

%Mars Landing craft initial landing speed is 13000 miles/hr =5.8km/sec
%Mars atomsphere is 100 times thinner than earth.
%Earth atomsphere thickness: 96.56km or 60 miles
%Venus atomsphere thickness: 250km

%Assume landing speed is 10km/sec
land_speed=10;
time_to_land=craft_rot_altitude/land_speed; %in seconds
time_to_land_min=time_to_land/60           %about 25 minutes from
15079km altitude.



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%When do we land? This is solved by finding out when the Venus and
Earth in
%in line of sight of each other.
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voyage_days=TO_travel_days+wait_to_land_days

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%Given the input (current angle, current date, Venus_daily_deg,
Earth_daily_deg, needed_angle)
%find output: future date

%Venus and Earth relative positions

%ON Jun 30, the distance from Venus to Earth is 1.504AU
%1AU=149,597,871 km




function [future_date,
days]=future_angle_to_future_date_func(current_angle, current_date,
Venus_daily_deg, Earth_daily_deg, final_angle, tolerance)

%current_angle: the angle between Earth and Venus. If current_angle>=0,
Earth is ahead of Venus
%final_angle: the angle between Earth and Venus. If final_angle>=0,
Earth is ahead of Venus

Earth_init_angle=0;    %let's align Earth on X-axis.
Venus_init_angle=current_angle;
days=0;
Venus_angle=Venus_init_angle;
Earth_angle=Earth_init_angle;

%tolerance=2*Venus_daily_deg; %degree. This gives flexibility when we
are looking for the days. If to be exact, it may take a long long time.


while (~((final_angle-tolerance)<(Venus_angle-Earth_angle) &&
(Venus_angle-Earth_angle)<= final_angle+tolerance))
    days=days+1;
    Venus_angle=Venus_angle+Venus_daily_deg;
    Earth_angle=Earth_angle+Earth_daily_deg;
    if (Venus_angle>=360)
        Venus_angle=Venus_angle-360;
    end
    if (Earth_angle>=360)
        Earth_angle=Earth_angle-360;
    end
end

future_date=future_date_func(current_date, days);
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%date calculator
%adds current date with number of given days to give the future
corresponding date.

function future_date=future_date_func(current_date, days)

R = addtodate(datenum(current_date), days, 'day');
future_date=datestr(R);


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%Given the distance between Venus and Earth
%This code gives the angle (theta) between them

%{

Resources:
http://wiki.answers.com/Q/What_is_the_distance_of_all_planets_from_the_
sun
http://www.windows2universe.org/our_solar_system/planets_orbits_table.h
tml
http://www.windows2universe.org/sun/statistics.html
http://www.fourmilab.ch/cgi-bin/Solar

Venus Diameter: 12104 km
Earth Diameter: 12753 km
Sun Diameter: 1.4 million km
Average Venus to Sun Distance: 108 million km
Center to Center from V to S:

Average Earth to Sun Distance: 149.6 million km
Center to Center from E to S:

%}
function theta=position_to_angle_func(tx_angle_max)

dia_sun=1.4e6;   %km
dia_ear=12753;   %km
dia_ven=12104;   %km
ven_to_sun=108e6;    %venus to sun distance
ear_to_sun=149.6e6;  %earth to sun distance

Rv=(dia_sun/2)+ven_to_sun;    % distance from center of Sun to the
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landing site: Sun_to_Venus Distance+Venus Radius
Re=ear_to_sun;  % distance from center of Sun to center of Earth
%Rv=108;    % distance from center of Sun to the landing site: radius
of Sun+Sun_to_Venus Distance+Venus Diameter
%Re=150;  % distance from center of Sun to center of Earth: radius of
sun+sun to Earth+Earth Radius

%tx_angle_max=67; %in degree. maximum El angle measured from Z-axis the
antenna on the lander can go to get out of Venus atmosphere.

%solve for angle formed between Rv and Re=theta
%Re=hypotenuse
%A=side of the right angle facing theta
%B+Rv=the other side
%A^2=Re^2-(Rv+B)^2
%A_solution 1=[-b+sqrt(b^2-4*a*c)]/2*a
%A_solution 2=[-b-sqrt(b^2-4*a*c)]/2*a

station_ang=90-tx_angle_max;   %the angle between A and the line from
earth station to the lander.
a=1+(tand(station_ang))^2;
b=2*Rv*tand(station_ang);
c=Rv^2-Re^2;

A_1=[-b+sqrt(b^2-4*a*c)]/(2*a);
A_2=[-b-sqrt(b^2-4*a*c)]/(2*a);

if A_1>=0;
    A=A_1;
elseif A_2>=0
    A=A_2;
end
A

theta=asind(A/Re);  %in degree. angle formed between Rv and Re
beta=2*theta+90;    %in degree. line of sight. the range that Earth
station can see the the antenna on the lander

%The max distance between Venus and Earth when the probe is at 67
degree
%will be
max_dis_between_Earth_Venus=A/sind(tx_angle_max)
```