Assignment 2

Team

Student 1

Student 2

Part 1

A report is based on the video on the Beresheet spacecraft crash-landing.

Time	Situation
25:04	The sub state was changed from **ORIENTATION** to **BRAKING.**
25:13	A **point of no return** has been reached.
33:03	An Inertial Measurement Unit (**IMU2**) gyroscope failed
33:17	A command has been issued to try turning **UMI2** on.
33:24	If this will cause a problem with second?
33:31	**Consultation** is required.
33:33	**Loss** of communications with the control network
33:37	End of **consultation**
33:47	The command to not turn on UMI2 has been issued.
34:05	The command to not turn on UMI2 has been issued. (a second time)
34:23	The **telemetry** was obtained again. Increasing **vertical** and **horizontal velocity**.
34:54	**Vertical Velocity** is marked in red.
35:41	A command has been issued to **reset**.
35:46	What to do?
36:01	A woman got up to talk to one of the engineers.
36:40	The **main engine** has returned to work. • Altitude: 678 • Velocity horizontal: 948 • Velocity vertical 130 (red)
36:42	Altitude: 415
36:43	Altitude: 283
36:44	• Altitude: 149 • Velocity horizontal: 947 • Velocity vertical 134 (red)
36:46	Finish

As we can see, two faults occurred after a point of no return. The faults are unrelated. According to the conversations and actions conducted by the ground control crew, the ground control crew was not prepared to handle a fault in UMI2. Due to a sudden loss of communications with the control network, the ground control crew was unable to reset the individual component to solve this problem. By the time communications were restored, the spacecraft's main engine had already been inactive for an extended period. The engine was brought back online following a system-wide reset; however, the spacecraft had already lost too much altitude to slow its descent sufficiently. You can also notice that after turning on the engine, the horizontal and vertical speeds increased. Only when the spacecraft is upside down can this happen. The final telemetry reading indicated that at an altitude of 149 m the spacecraft was still traveling horizontal 947m/s and vertical 134 m/s, resulting in a total loss on impact with the lunar surface.

Part 2

Link to the GitHub repository.

- How to run
  The minimum Golang version you need is 1.13. Write the following command in the console after entering the project folder: *make run*.
- The structure of the simulation
  - Moon
    Contains the Moon class and a function to calculate the acceleration rate with which the Moon acts on another object.
  - Bereshit
    Contains the Beresheet class and the spacecraft landing function.
  - Simulator
    It contains the Simulator class, which runs a simulation function once every 1 second, and it outputs PID data to the console and to a CSV file.

The main goal of this simulator is trying to make landing process successfully which will do it fully automatically using all sensors available in the spacecraft.

We have here few parameters we count on:

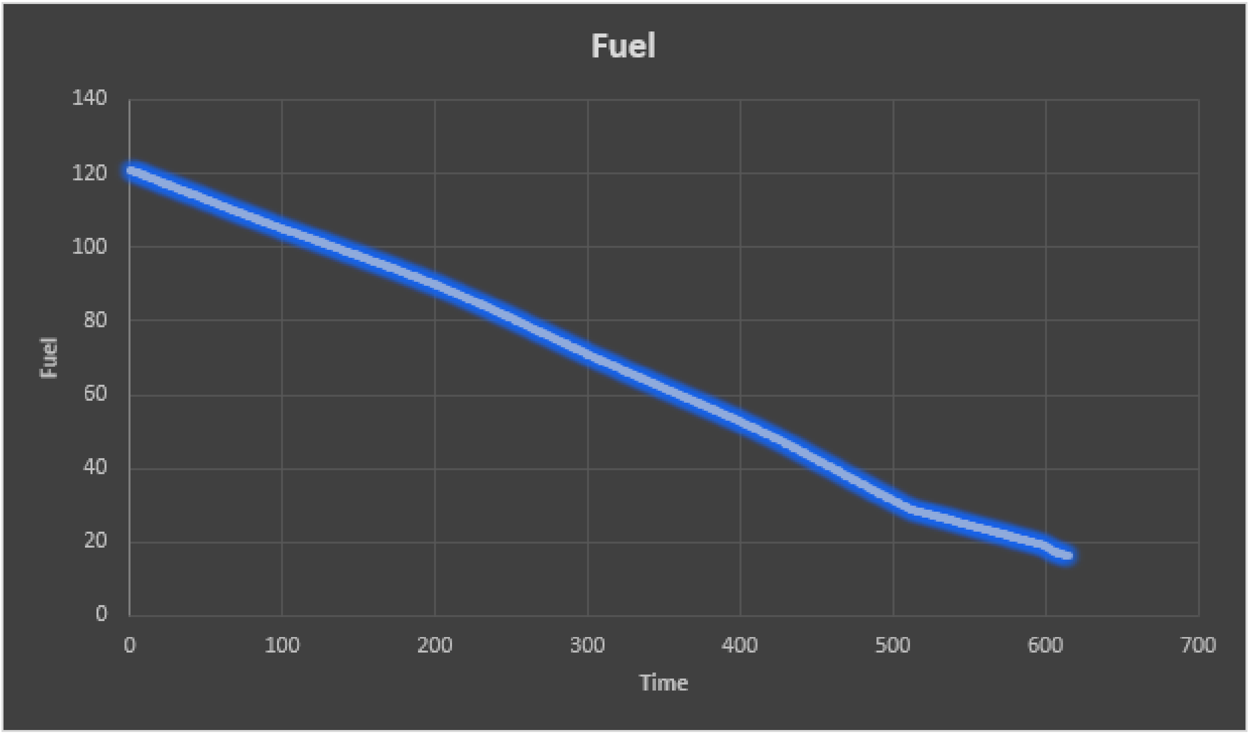
- Vertical Speed, Horizontal Speed, Distance, Angle-rotation, Altitude, Acceleration Rate, Weight, Fuel.

All these parameters and few more will calculate every frame; it can be either 1 per second or even more iterations per second.

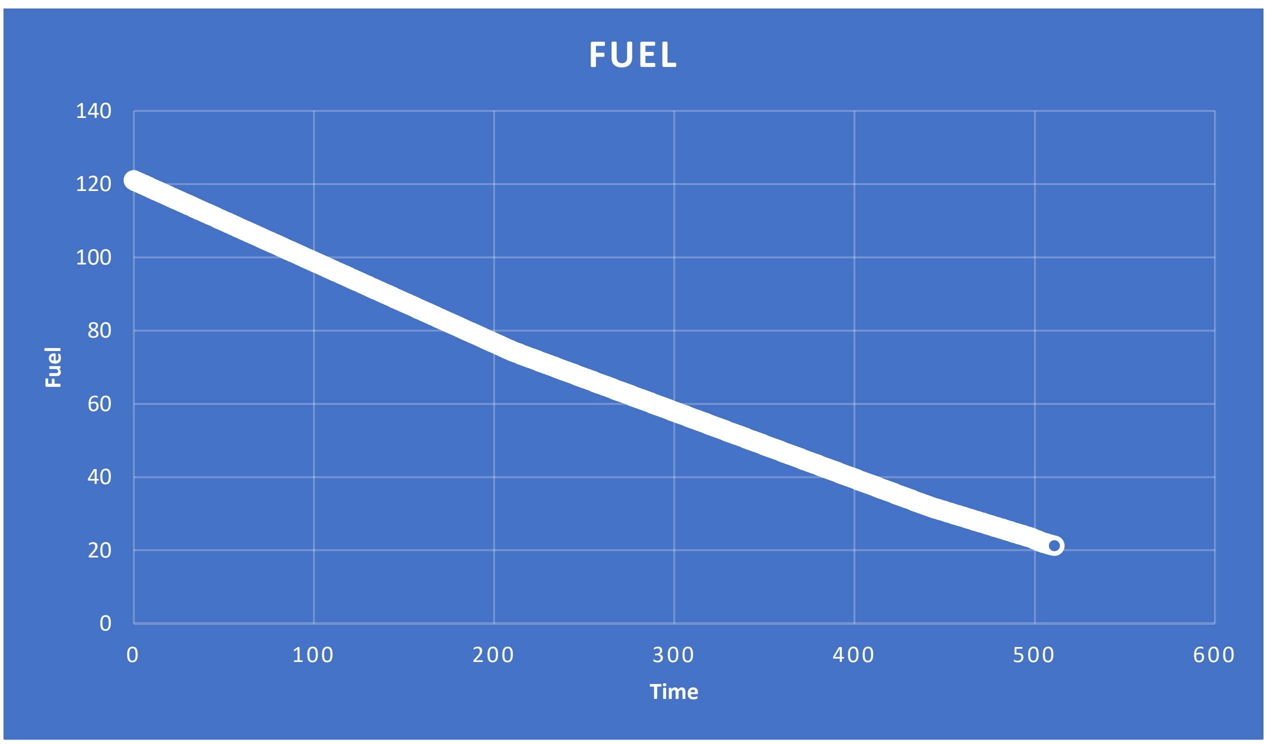
There is no graphics in this simulation, so the only way to see what happened is debug mode on which prints details every frame.

A comparison of the two algorithms is shown in the charts.

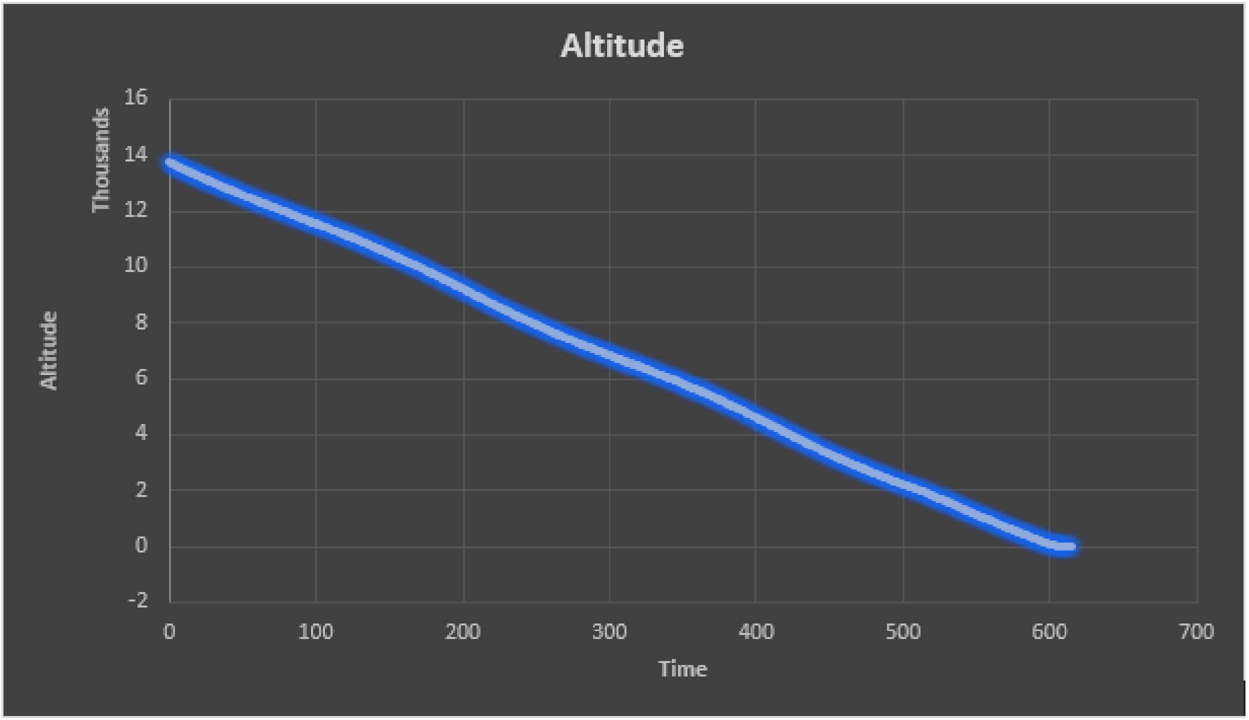
- **Fuel**
  - *The algorithm of Boaz*



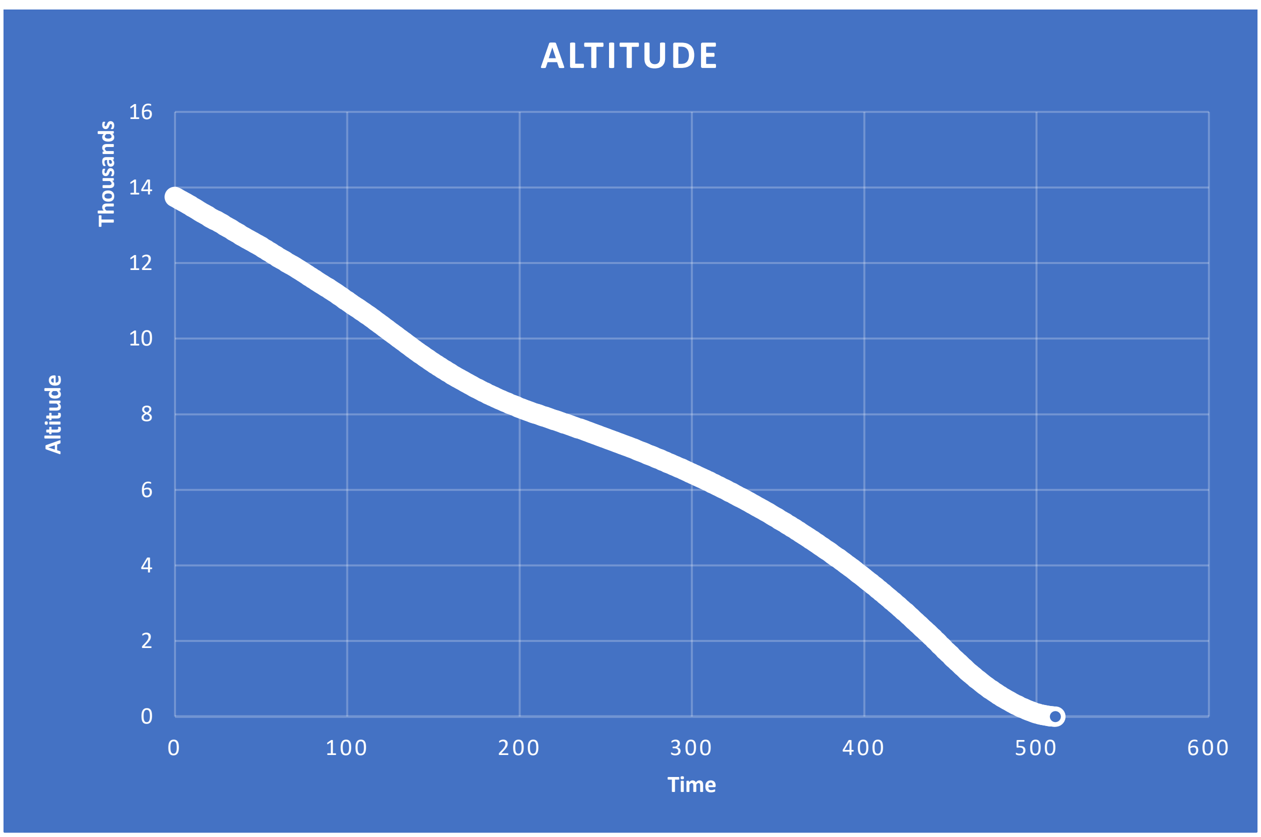
  - *Our algorithm*



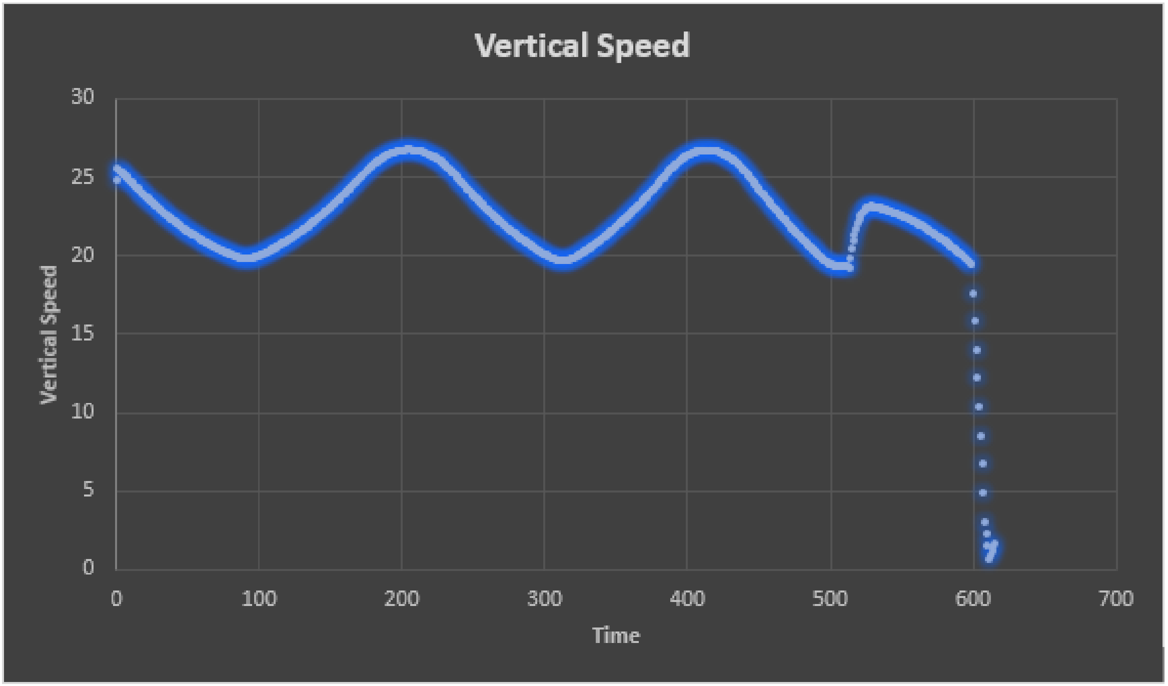
- **Altitude**
  - *The algorithm of Boaz*



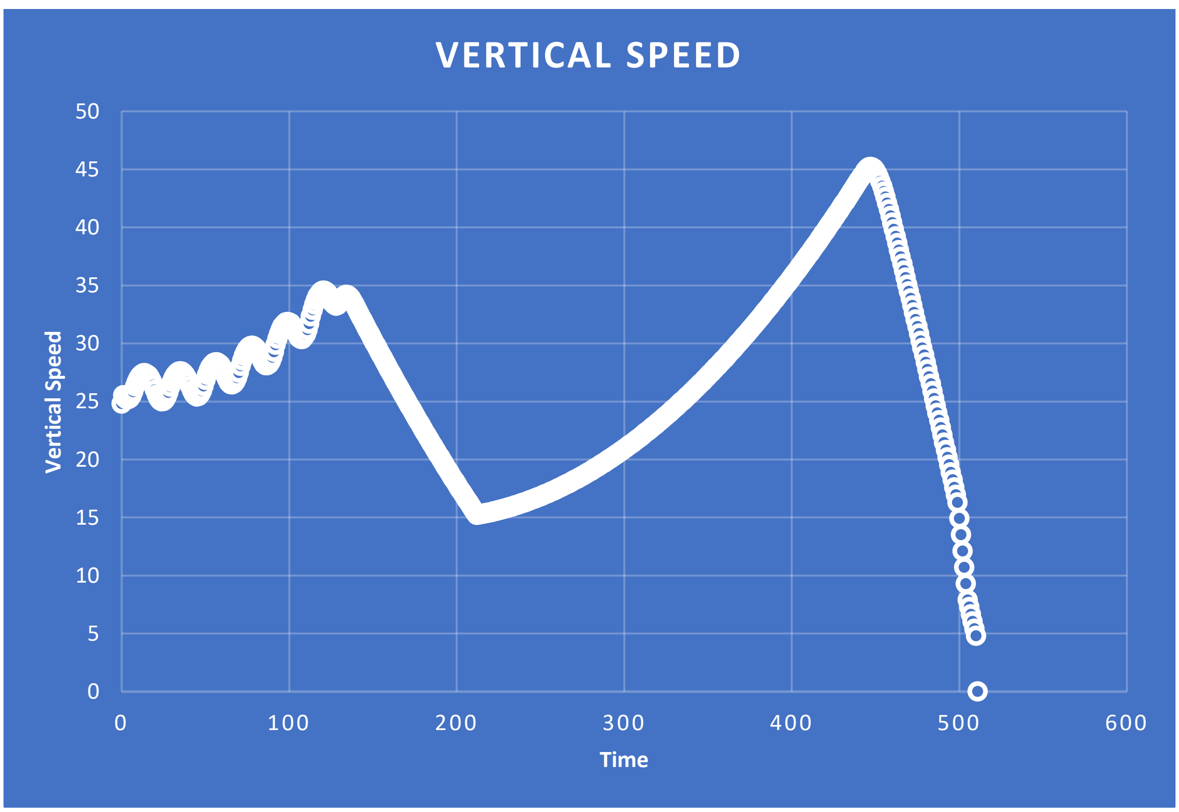
  - *Our algorithm*



- **Vertical Speed**
  - *The algorithm of Boaz*

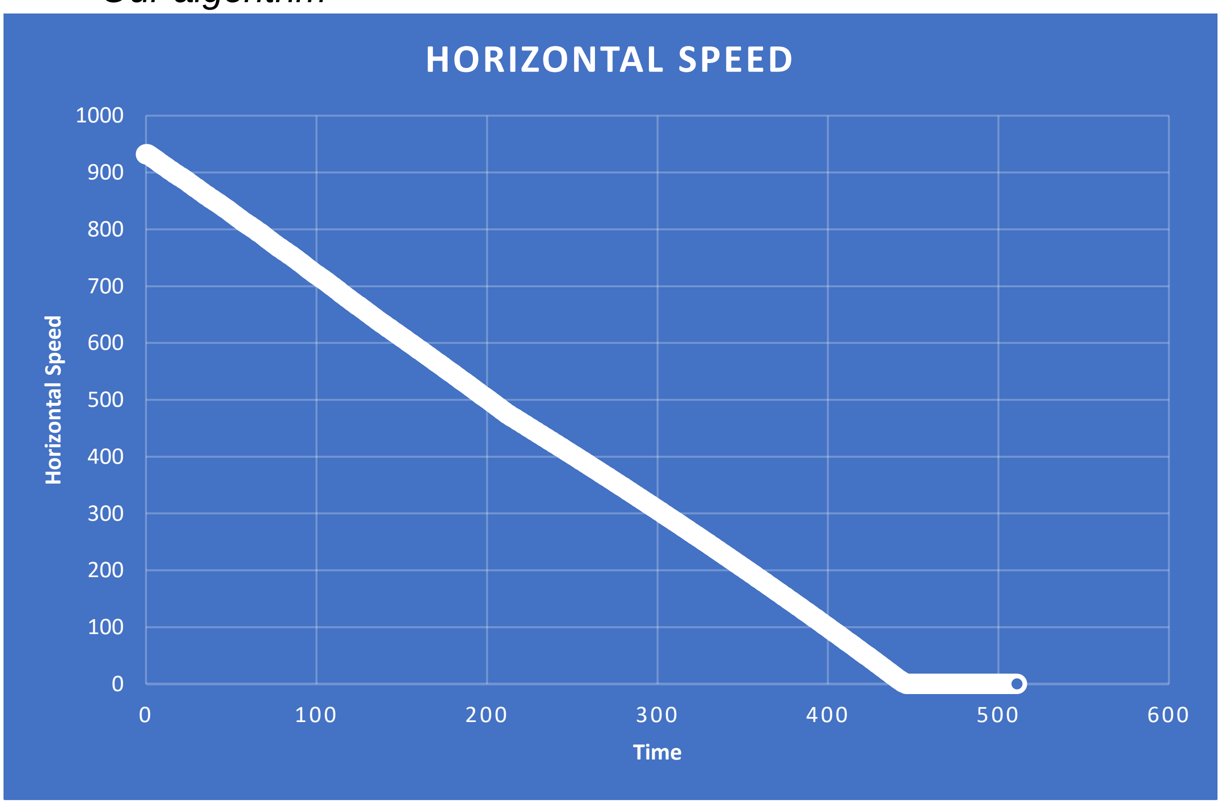


  - *Our algorithm*

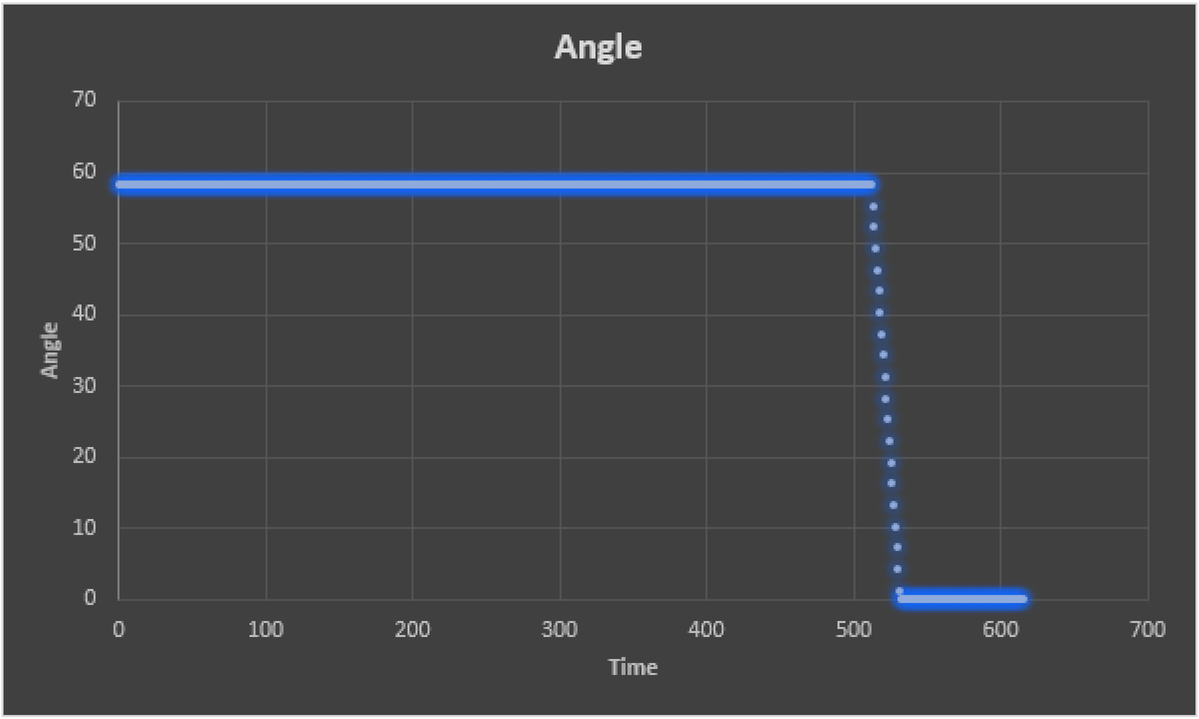


- **Horizontal Speed**
  - *The algorithm of Boaz*

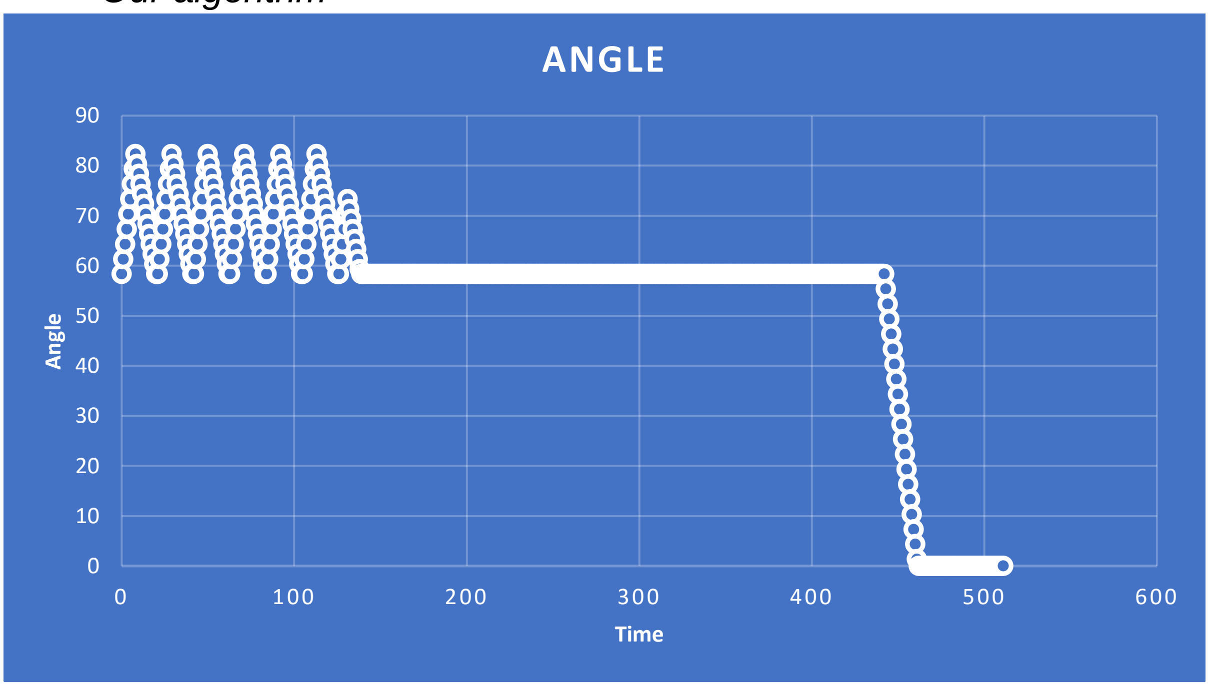
  - *Our algorithm*



- **Angle**
  - *The algorithm of Boaz*



  - *Our algorithm*



As a result, we save 4.868 liters of fuel and our Bereshit lands 100 seconds earlier. We also land 62 kilometers closer to our destination.