Super Mario Galaxy 2 - Camera effects on speed
By Joselle

All distances and speeds cited refer to Mario, not Luigi or Yoshi.

When you're on a planet with normal (flat) gravity, the camera is almost always either:

- Close to, and only slightly above your character
- Far away, and higher above your character
- Somewhere in between

When the camera is *farther/higher*, aerial movement going north and south is slower.

- "North" means away from the camera, and "south" means toward the camera.

- For example, a running double jump covers 953 distance units on the top of the Starship (close camera), and only 926 distance units at the start of Clockwork Ruins star 1 (distant camera). Since Mario's running speed is very nearly 13 distance units per frame, the difference in this example is about 2 frames' worth of running.

- The jumps reach the same height and take the same amount of frames, but cover less distance.

- Diagonal movement is also affected, but not as much. It would make sense that the more north/south facing your angle is, the more you are affected, but this has not been extensively tested.

- This effect was observed with Mario in jumps, double jumps, and long jumps. Other kinds of jumps have not been tested. Luigi and Yoshi have not been tested either. More testing would be useful to confirm how broadly the effect applies.

What part of the camera affects north/south speed: distance, or height?

- This is unknown. If one could find a place in the game with a close, high camera or a far, low camera, perhaps we could find out which one it is.

Other effects that are much, much smaller and may or may not be related to the camera:

- Aerial movement going east and west is very, very slightly slower. The effect is far less than the north/south effect.

    - In the Starship case, a double jump covers 959.891 distance units. The smallest distances observed were in Puzzle Plank's pipe room and near the start of Upside Dizzy (a 2D level),

where a double jump covers 959.875 distance units. So if there is any effect on east/west movement, it is over 1000 times smaller than the north/south effect. ((959.891-959.875)*1000 < 953-926)

- Ground speed MIGHT be very, very slightly slower, regardless of facing direction. Or it might not be different at all.

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    - In the Starship case, change in position is 13.000009 per frame, and in the Clockwork Ruins case, change in position is 12.999664 per frame. However, measuring speed directly (instead of position) suggested that both of these instances had 12.999995-12.999996 speed, so the exact difference (if any) is unknown.

        - Differences on the order of 0.000001 may very well be due to floating-point imprecision, rather than something more subtle about the game's mechanics.

    - Assuming a range of 12.999664 to 13.000009, it would take about 30,000 frames (over 8 minutes) of running for these speeds to make even 1 frame of difference in your time.

East/west movement vs. north/south movement

- East/west aerial movement is faster than north/south aerial movement, as can be seen from the numbers above. So a jump to the east or west will travel slightly farther than a jump to the north or south.

- Ground speed is sometimes very, very slightly different between east/west and north/south movement, but the relationship here is unclear. Sometimes ground speed is the same, sometimes ground speed going east/west is faster, and sometimes ground speed going north/south is faster. If there's a difference, it's on the same order of magnitude as the camera's effect on ground speed (which is very small).

Implications

- If you're having trouble getting enough distance on a north/south shortcut jump, consider turning the camera so that it becomes an east/west jump (or at least a diagonal jump). In general, the longer you're in the air, the more the camera change will make a difference.

    - For example, try using this on the second long jump in the Fluffy Bluff star 1 shortcut. Normally this is a north long jump, but if you turn the camera 90 degrees before you jump, you can avoid going straight north for most of the long jump's duration. This can increase your distance by about 5%; that doesn't sound like a lot, but it's noticeable because the jump lasts a while.

        - For more details on cloud long jumps and this Fluffy Bluff shortcut, see the document on the Cloud suit's extended long jumps.

    - Of course, many places in the game don't allow you to turn the camera, so you can't use this trick everywhere.

- There is pretty much no place in the game where you can control how far away and high the camera is. However, when TASing or emulator testing, it's good to keep the camera effects in mind when seeing what kinds of jumps are possible.

    - If you can just barely long jump over a 1000-distance-unit gap in one area, then maybe you won't be able to long jump over a 1000-distance-unit gap in a different area that has a more distant camera. Especially if the camera forces you to jump north or south.

Data

- All data is for Mario.

- Spreadsheet of distance data: https://docs.google.com/spreadsheet/ccc?key=0At6ZPjx3B1RqdDNydXhVYlNqRVhCZ3lDcmE5VDlkS1E&usp=sharing

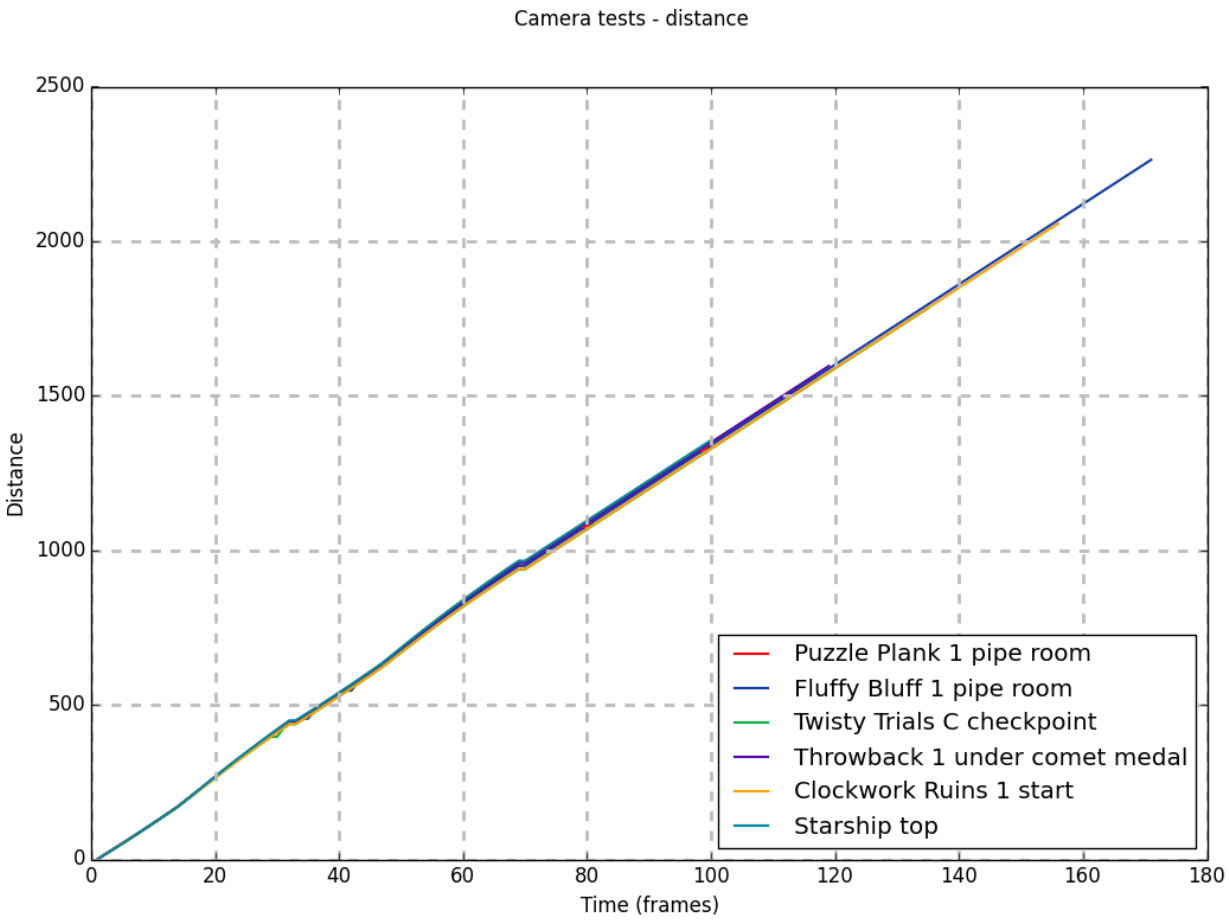
    - "Speed" data was derived from distance with the formula: speed(t) = distance(t+1) - distance(t). This CAN pose issues if Mario's movement turns out not to be perfectly straight when holding the exact same stick direction, due to camera movement or something. However, I occasionally checked the distance values against the actual speed values in the game's memory, and things seemed to check out save for very minute differences. For example, see the "Speed" data in the spreadsheet.

- Graphs

    - The graphs were generated by saving the above data as a CSV file, and then using a Python script that uses Matplotlib to draw graphs.

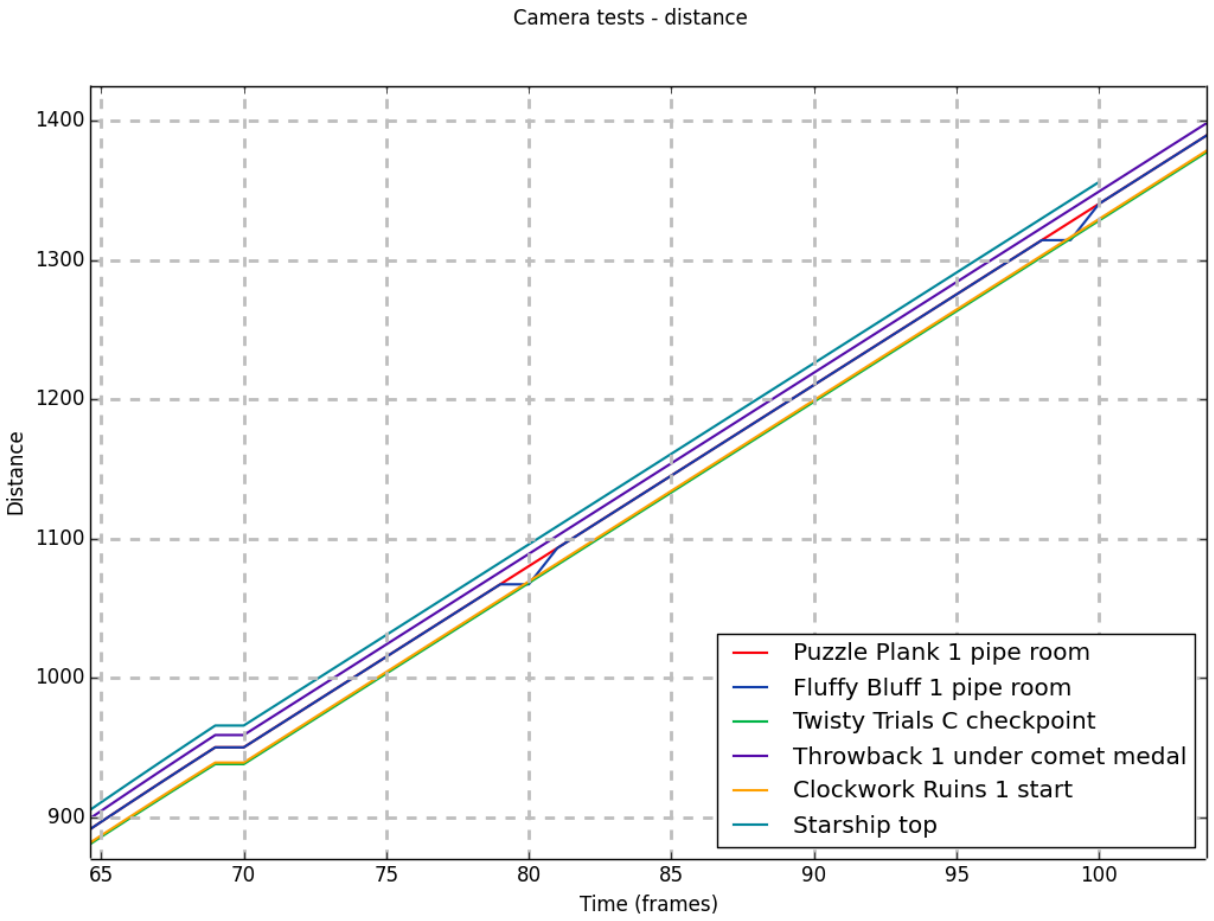
    - "Distance" is the horizontal (X and Z coordinate) distance from the starting point.
    - "Speed" is the horizontal (X and Z coordinate) speed.

Distance during a double jump going straight north, at full running speed, with both jumps as short as possible, in places with varying camera distances. The results are all fairly close, but they are slightly different.

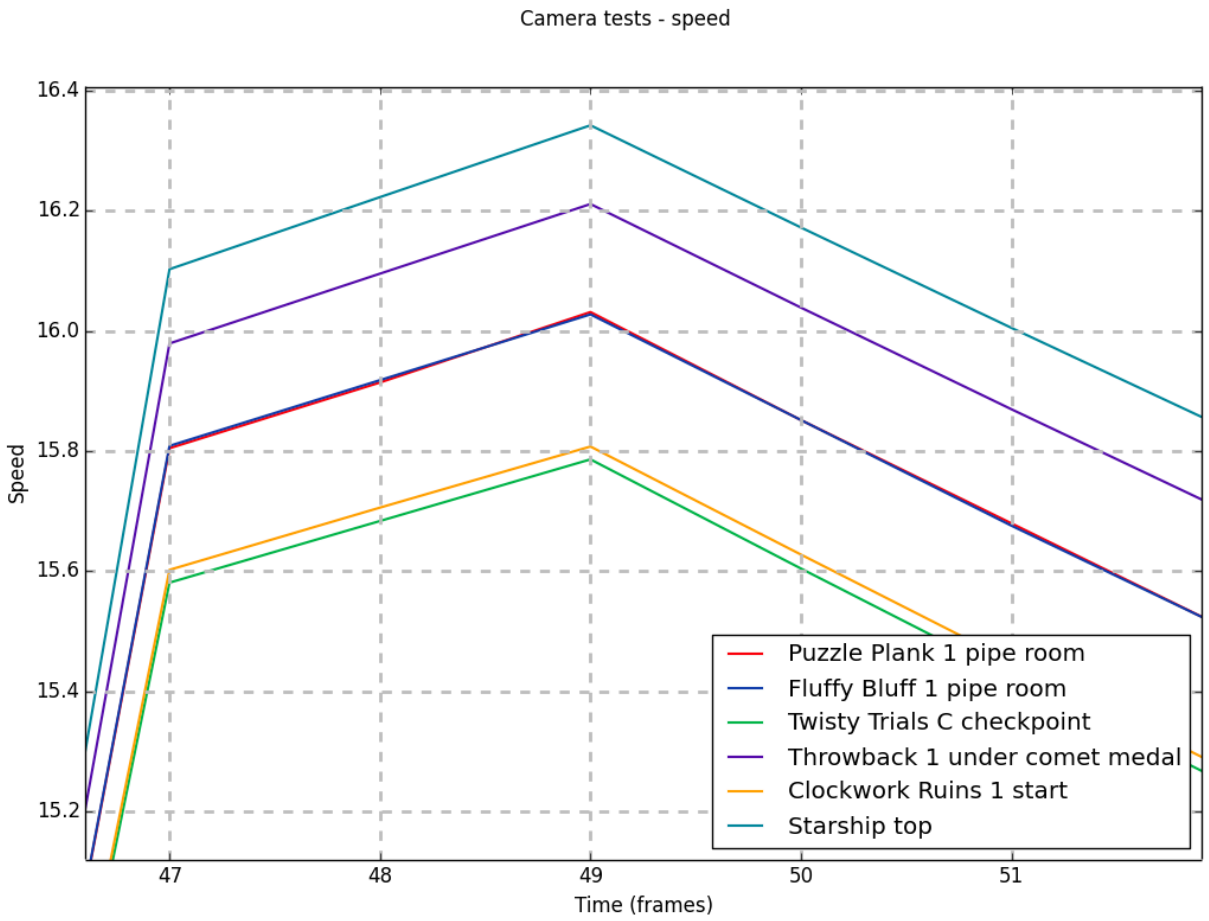


The part around frame 70 is where the double jump ends. The rest is just running forward. “Starship top” gets the highest distance, followed by “Throwback 1 under comet medal”, then practically a tie between the Puzzle Plan and Fluffy Bluff 1 pipe rooms, then “Clockwork Ruins 1 start”, then “Twisty Trials C checkpoint” (i.e. the checkpoint flag in the Comet star). This seems to go in order from closest camera to farthest camera. The range here is around 25-30 distance units, which equals 2 frames of running for Mario (who has 13 running speed).

The “Fluffy Bluff 1 pipe room” line dips down a couple of times because for some reason, the position memory value I used sometimes failed to get updated for one frame - and this only happens in certain areas, like that pipe room.



It’s way easier to see the “ranking” if you look at this part of the speed graph. This is just after the second jump of the double jump has reached its maximum height.

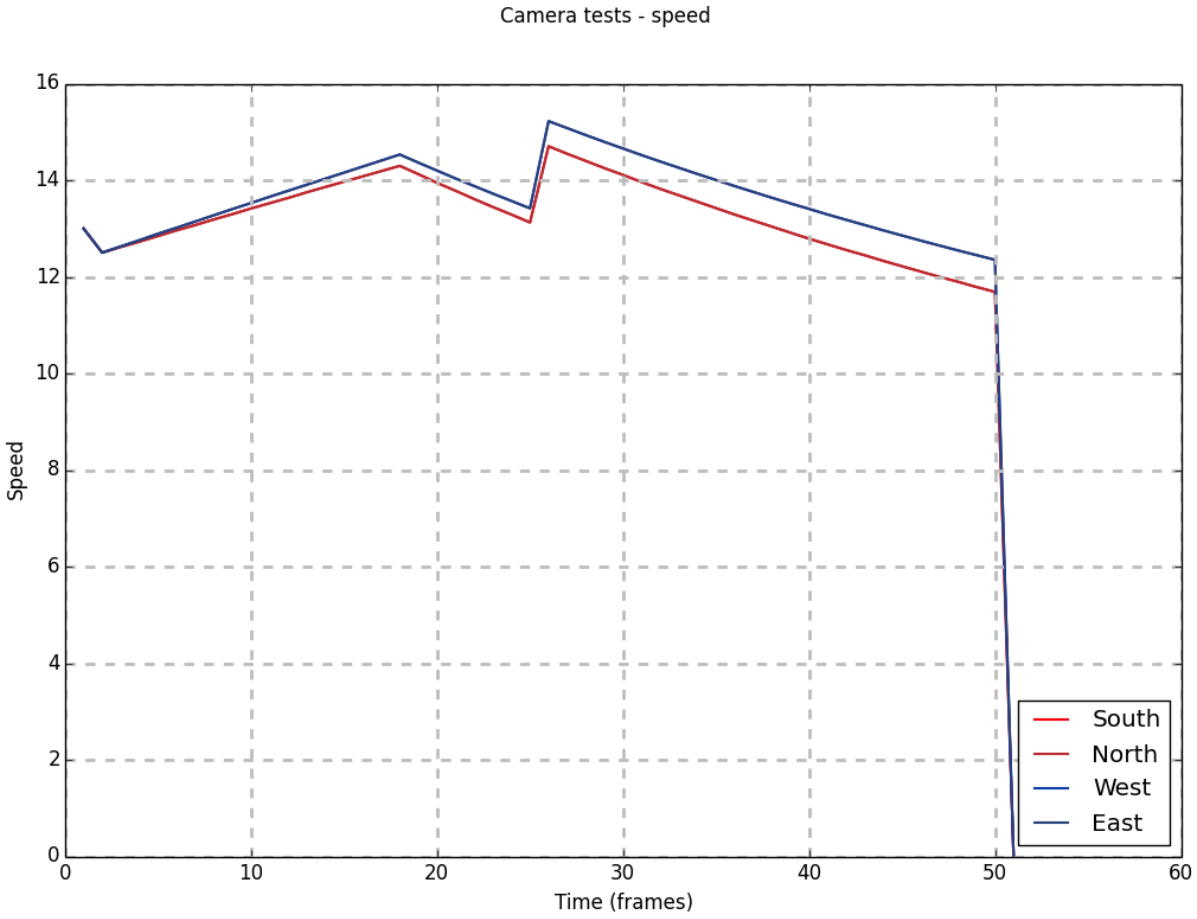


Speed during a single jump, holding A the whole time. This is horizontal speed only (no up/down component), and on flat ground. The one-frame spike around halfway is at the peak of the jump.

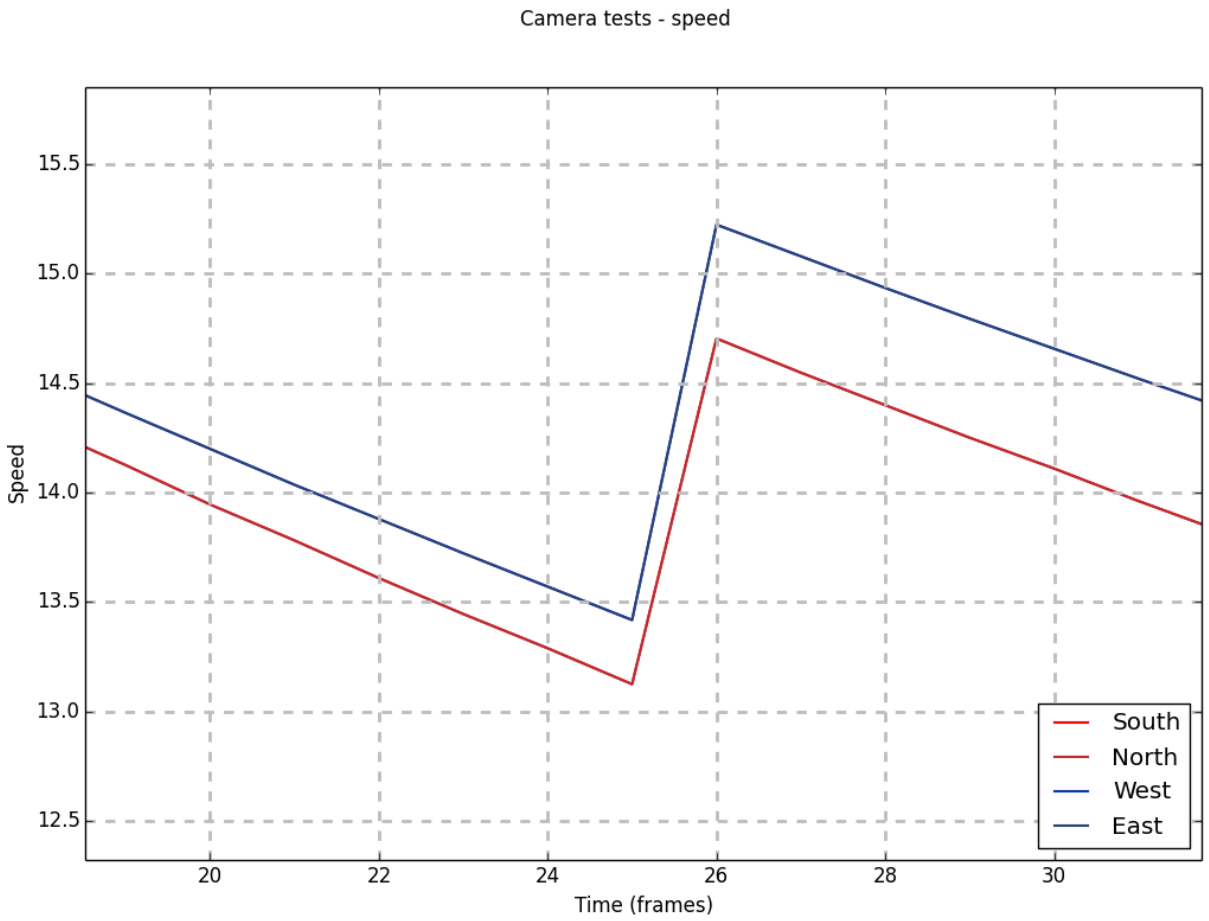
Only two lines are visible here; that's because the north and south lines are practically the same, and the east and west lines are practically the same. The graph shows that the jump gets more speed when going east/west instead of north/south.

It seems that the speed increase rate, rather than the speed decrease rate, is the main difference between north/south vs. east/west.

These tests were done in Puzzle Plank 1's pipe room.

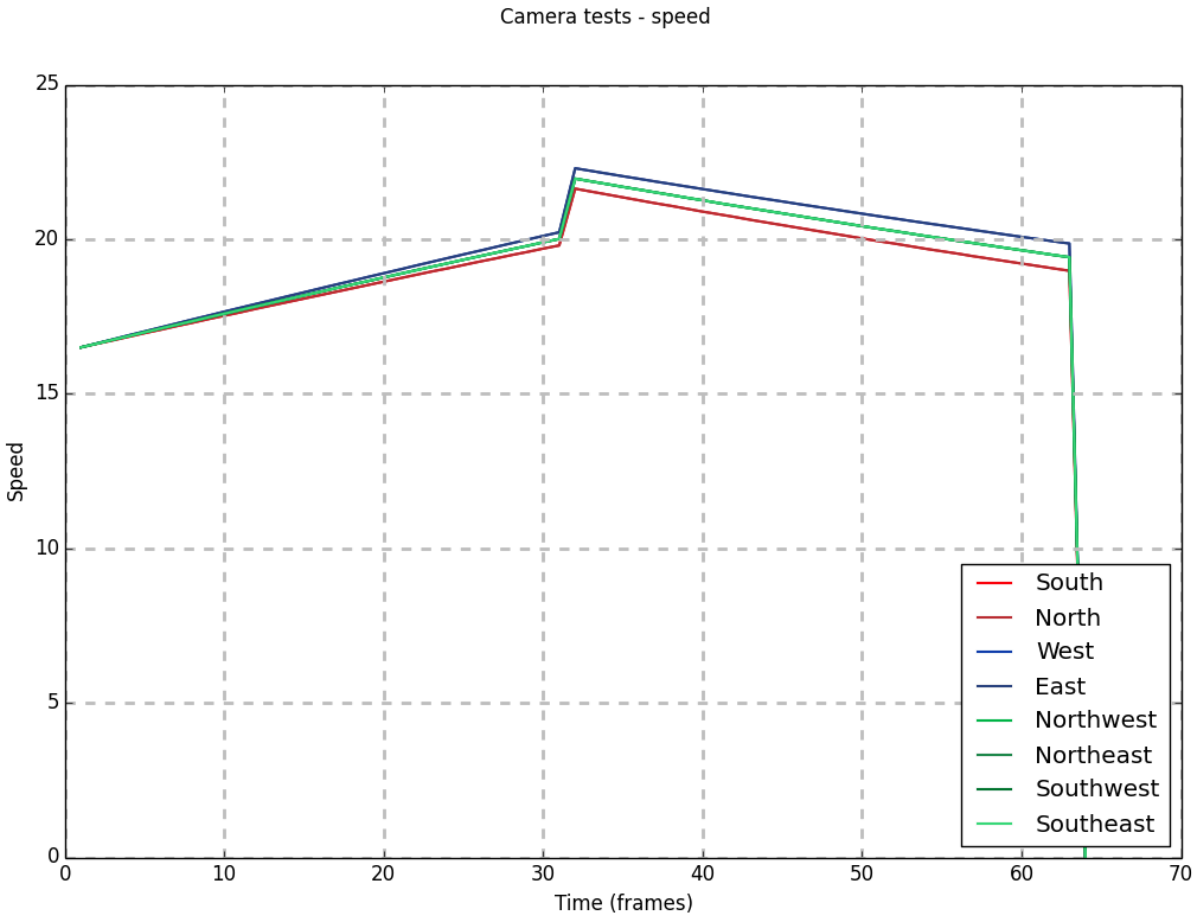


A close-up on the jump's peak. It's worth noting that the speed increase amount during this one frame is quite different between north/south and east/west.

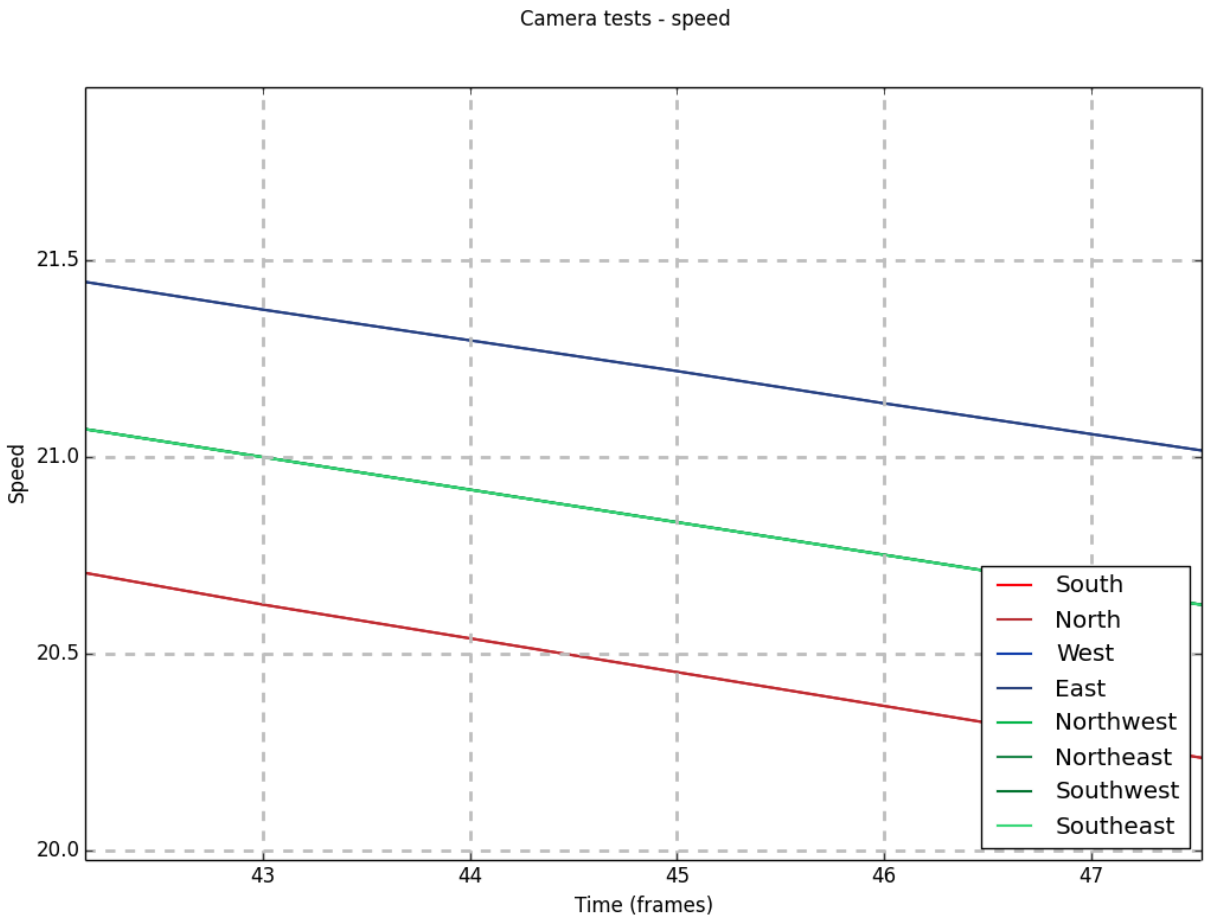


Speed during a long jump done on flat ground. Exhibit B in showing that east/west air movement is faster than north/south. But this time, we also have diagonal directions, and those land somewhere in between.

These tests were done in Puzzle Plank 1's pipe room.



Again, there are three groups of lines that overlap almost perfectly with each other: east/west, then northwest/northeast/southwest/southeast, then north/south.



Speed during a long jump that falls for a while. Exhibit C in showing that east/west air movement is faster than north/south. The directions in the graph's legend only indicate the initial direction Mario is facing. During the tests, the camera moved around. I tried to keep holding the stick in the direction that Mario was facing to the best of my ability.

As a result of the changing camera and my control stick imprecision, the curves are not as smooth as in some of the previous graphs, but you can still see a clear distinction between three groups of lines: east/west, southwest/southeast, and sorth.

These tests were done from near the top of the tower where Fluffy Bluff's secret star is (hence why there were no north-jumping tests here). Cloud suit was not used during these tests.