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作品名稱　**How to spill your coffee**

得獎獎項　**三等獎**

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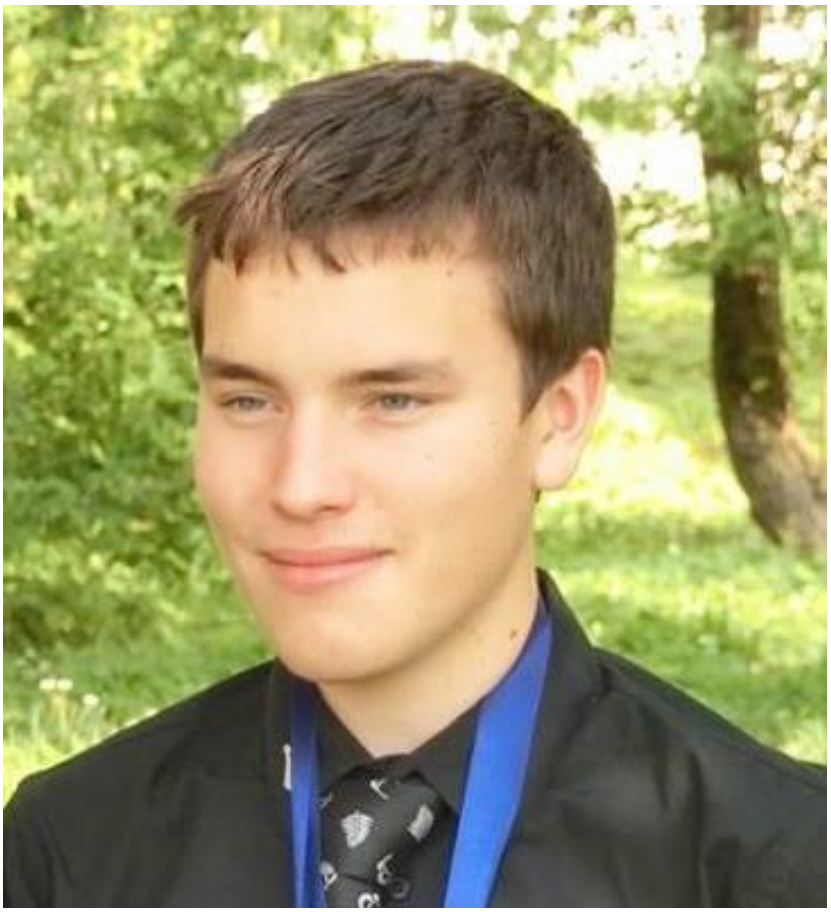

Abstract

We all do it – walk along with a cup in hand, and carelessly spill it. While it's usually more annoying than anything else, it happens to affect almost all of us, and little is done to minimise the likelihood of it occurring. So my aim was to explain the physics behind why we spill drinks when we walk, and to investigate how we can minimise the likelihood of this occurring.

I broke this investigation into two distinct parts, explaining the system of the cup, and explaining the effect of walking.

From initial observations, it was clear that the cup was a resonating system. Like any resonating system, the cup has a natural frequency. When the cup is oscillated – moved back and forth – at near this frequency, the size of the liquid oscillations is very large. This is because the acceleration is in phase with the motion of the liquid, so in each cycle maximum energy is input into the system. In my investigation I experimentally measured this natural frequency, and created a mathematical model to explain this frequency. It was also found that as the size of liquid oscillations in the cup increases, so does distortion of the fluid surface, possibly enabling spilling.

To systematically analyse the effect of walking, I had subjects walk on a treadmill, so walking surface and speed were controlled. However, I also needed an accurate way of measuring the motion of a carried cup. Firstly, I tried to use video analysis; however I found this far too imprecise for measuring small changes in velocity of a cup. In the end I used a smartphone to record the acceleration of a carried cup, as acceleration is what causes the movement of liquid in a cup. This allowed surprisingly accurate measurements to be made, and allowed both the size and frequency of the acceleration to be recorded.

In order to relate the system of the cup and the oscillation provided whilst walking I conducted a qualitative experiment into the effect of stride frequency on the likelihood of spilling. When stride frequency was very close to the natural frequency of the cup, spilling occurred almost instantly, while it did not occur if stride frequency was much higher or lower.

In the end, my research showed that to minimise the likelihood of spilling your drink walk slowly, use a narrow cup, focus on walking smoothly, and fill the cup well below the rim. Despite this, some people happen to be much smoother cup carriers than others, likely due to their individual biomechanics. And, if you really don’t want to spill your drink, you can always use a lid.

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Body motions are connected by joins and will greatly reduce the motions amplitude to keep the coffee safe. Author uses call phone to detect the hand hold coffee cup motion and its velocity acceleration. This is a good application. The surface wave of coffee in the cup is also am important faction to keep the coffee safe.