**Catalogue of Actions to be Detected & Camera Evaluation**

*When creating the final data set, it is important that we perform future actions with varying levels of speed, with both left and right arms/hands and against different backgrounds in order to ensure we are provided with the best data possible for the selected actions.*

**Definite:**

*These are a select few actions that we will be focusing on and using as a basis to create our data set around. Our project’s current goal is to detect these actions following actions from newly uploaded footage.*

1. (R/L) – Door – (Open/Close)
2. (R/L) – Wiping – [like the motion of scrubbing a surface]
3. (R/L) – Handshake
4. (R/L) – Writing
5. (R/L) – Turning – (Horizontal/Vertical) – [Like a tap or valve]
6. (R/L) – Object – (PickUp/PutDown/Pull/Push)
7. (R/L) – Cutlery – (Knife[cut]/Fork[stab]/Spoon[scoop])
8. **???**

**Probable:**

*These are other actions which we currently believe have unique enough features that should allow us to set up rules to detect them.*

(R/L) - Swinging arms – [such as while walking]

(R/L) – Mouse – (Moving/Clicking)

(R/L) - Waving

(R/L) - Switch flick - (on/off)

(R/L) – Pointing – [potentially too similar to ‘Switch flick’ category]

Washing Hands – [as in rubbing together motion]

Typing

(R/L) - Furniture - (PullOut/PushIn) - [Potentially absorbed into the *‘Object’* category]

(R/L) - Packing a Bag (PuttIn/TakeOut) – [Potentially absorbed into the ‘*Object*’ category]

**Questionable:**

*These are actions that we currently believe may be too difficult to set up rules to detect.*

Interactions with specific everyday items (phone, wallet, money, headphones, deodorant, other stationary, etc) – *potentially too hard to differentiate from one another or from some of the other pre-established categories. However, some of them may be possible, we can potentially experiment if the earlier categories prove successful*.

Eating/Drinking – *We potentially lose too much data to accurately detect these types of ‘above camera’ actions at all due to restrictions with this method of recording discussed in more depth in the camera evaluation section below.*

Eyewear (putting on/taking off) – *Another ‘above camera’ that is now in doubt unless we perform object detection.*

Squeezing – *When holding an object it might be too hard to detect that it is being specifically squeezed and not just held normally.*

Pressing Buttons – *might not be intricate enough to differentiate from some of the other actions like flicking a switch or pointing.*

Appling makeup (or other facial actions) – *Another ‘above camera’ that is now in doubt unless we perform object detection.*

Combing (or other hair actions) – *Another ‘above camera’ that is now in doubt unless we perform object detection.*

Stretching/Exercise *– although some specific/unique ones may be distinguishable enough to detect.*

Cooking actions (chopping, slicing, grating, peeling, stirring, etc) – *may be too difficult to differentiate from other actions (the cutlery related ones for example, though there may be some crossover there), we may be able to have a look into it later if time allows.*

Blowing nose – *tissue or handkerchief may obstruct camera, also it is another ‘above camera’ action that we are unsure if will be caught on footage.*

Dressing *- perhaps putting shoes on is one aspect that might be possible, but since the chest strap needs to be on for the camera, we’re not going to get footage of people putting their clothes on.*

*The possibility of using mirrors to help us capture movements that were too difficult to catch from the first person perspective was discussed as a possible option. Although we did have to consider that in a real life scenario, patients would not be performing all of their daily activities in front of mirrors so it may not be practical to devote a large portion of time to exploring this option. At the very least, we should wait until we have succeeded with the “Definite Category” before exploring this method in depth.*

**Ignore:**

*Actions that we’d prefer not to detect on purpose.*

* Random Scratching/fidgeting
* Other people’s movements
* Movements caused by stability of camera/speed or sudden rotation of the user

**Camera Evaluation:**

The [Kaiser Baas x90](https://www.jbhifi.com.au/cameras/video-cameras/kaiser-baas/kaiser-baas-x90-action-camera/984438/) is the chosen action camera for our project that we have now acquired and performed initial testing with. It uses a micro SD card for storage and records with a 170º field of view allowing for the majority of actions performed in front of the wearer’s torso to be detected.

We performed an initial test of the camera, capturing footage found at the YouTube links bellow. These initial tests were conducted by following a plan to perform a variety of actions in the same order each time. The primary difference between the following 4 tests is the positioning of the camera with the chest mount due to a mixture of attempting to find the best position on the torso and dealing with camera angling issues (discussed below).

In the *‘Normal’* video the chest mount was worn in its default setup with the camera plate resting near the bottom of the sternum on the wearer. However it is also important to keep in mind that when dealing with the chest mount, the positioning is subjective depending on the wearer’s body type and gender.

* [x90 chest mount (Normal)](https://www.youtube.com/watch?v=vdvz4TughNk)

In the *‘High’* video we positioned the camera around the bottom of the neck near the top of the sternum. Initially this was to try and compensate for the angling issues but in the end turned out to provide us with what believe is the best footage from this test session despite being a bit angled downwards which we can fix in the future (discussed below).

* [x90 chest mount (High)](https://www.youtube.com/watch?v=k08XKh_1aqo)

In the *‘Stuck on’* videos we positioned the chest mount in the *‘Normal’* position but instead of the attachment piece, used a supplied adhesive piece to simply stick the camera to the plastic mount to circumvent the camera angle issues that were preventing flat, 90º recording. At the time of the test records, we believed this positioning was the best one although, upon reviewing the footage, have since determined that in order to get the widest field of view possible the *‘High’* positioning was preferred. The *‘High’* positioning was also against a flatter, more solid part of the body meaning that the camera angle would be the most consistent with different body types and genders.

* [x90 chest mount (Stuck on)](https://www.youtube.com/watch?v=jc73DVkO35s)
* [x90 chest mount (Stuck on) #2](https://www.youtube.com/watch?v=VNwryscJBII)

We also performed some basic boundary and distance/depth tests that give an idea of the limits of the camera, although we would like to re-do these in the correct position/set-up, and in more detail to provide us with better data to help inform our filming for final data set.

* [x90 chest mount (Stuck on) - Boundary Test](https://www.youtube.com/watch?v=F34jB1zRcDg)
* [x90 chest mount (Stuck on) - Distance Test](https://www.youtube.com/watch?v=bIphWpf16RI)

Upon completing the initial testing session, reviewing the acquired footage and some discussion, we have come to some conclusions on the capabilities of this camera and our applied methods thus far.

We are securing the camera to the user with a [Kaiser Baas Chest Mount](https://www.jbhifi.com.au/cameras/camera-accessories/kaiser-baas/kaiser-baas-chest-mount-for-x80-action-camera-and-gopro/554341/). The chest mount is an elastic harness that is reasonably comfortable to wear, although it can be a bit awkward to put on initially if the wearer does not know what to do. The camera is put inside its supplied case and clips in to a plastic plate located at the front of the chest mount. However, the default supplied piece used to attach the camera’s outer case to the chest mount is not naturally capable of being angled at a flat 90º due to a puzzling design choice that restricts the rotation of the case. This can be solved via makeshift methods, however can be permanently solved by acquiring an extended attachment piece such as the one found in [this pack here](https://www.jbhifi.com.au/cameras/camera-accessories/gopro/gopro-grab-bag-of-mounts-2016-edition/316223/).

At the time of the recording, we were unaware of several camera features such as the microphone and the date/time stamp that was being printed onto the video. For future recordings the microphone will be off and the stamp will not appear on the screen. Although you won’t hear audio on the current YouTube uploads because I manually muted the sound (which took a while, so this is good to find out before we did our final data sets).

As for problems that are actually related to the camera itself, while it has great 170º horizontal field of view, the vertical field of view is still limited. The problem with the vertical field of view is that actions performed outside of the camera’s direct line of sight are not captured. This mostly encompasses actions that are performed either very high up or low down. Actions that are performed so close to the body that they are underneath the camera or behind the camera are also clearly not captured. It is apparent from the test footage, that unless you are performing tasks that require your arms to be stretched out in front of your body, you are not capturing the majority of your upper arm and shoulder movements. This can pose a big problem because it gives us less visual information to work off when trying to differentiate the actions being performed.

Some of the problems identified here could be alleviated with the use of a [Head Mount](https://www.jbhifi.com.au/cameras/camera-accessories/kaiser-baas/kaiser-baas-head-strap-mount-for-x80-action-camera-and-gopro/554340/). If our x90 camera was head mounted, then it would rotate in unison with the wearers’ neck/head. It means that more actions would get recorded because you are likely to be looking at the action you are performing. When capturing footage from a chest mount, unless you tilt your chest in the direction of the action you are performing (which is unnatural and outside the scope of our project) then you won’t be able to capture those particular actions. However, at this stage of the project we have decided to go against the idea of a head mount due to comfort and practical concerns for end users/patients.

The only way to get a wider vertical angle with the chest mount would be to rotate the camera on the side so that it is recording in portrait, but then you would lose far too much horizontal data and would miss far too many actions so this is not an alternative worth considering provided the trade-off.

To summarise this, essentially the real limitations are less to do with the camera itself, and more to do with how we are utilising it. We maintain that this was the best option for the project when considering all the factors and the scope. While there are several alternatives, none of them are particularly viable.

A 360º Camera, while it can be chest mounted (surprisingly), is far more expensive (around $400 range as a minimum) and would produce a video too large to be easily processed since it is essentially multiple frames being stitched together to create a larger rectangular image. We’re not sure how it would be feasible to put this type of footage through machine learning. It is also worth noting that even though it is 360º since its chest mounted, it will be too close to the body that most of the new angles of footage we could capture wouldn’t be all that usable anyway.

You could alternatively try using a chest mount that suspends the camera away from the body and looks towards the body to capture the footage from an outside perspective. However, this also clashes with the comfort and practical concerns for the scope of our project. Having patients wear cameras on supports held out in front of them would obstruct them even more from completing their daily activities and would not provide therapists with useful results and thus, defeating the purpose of the entire project.

Google Glass was also briefly considered as a potential alternative. While it would probably provide us the best first person data set physically possible, and is not that intrusive or uncomfortable to wear, it is unfortunately no longer being supported or sold by google as of January 2015. What was released to the public was only a prototype however, so it is very possible that google will return to the market with a new product in the foreseeable future. But the google glass prototype retailed for around $1500 USD upon release so it is probably out of the question when it comes to affordable alternatives when it is compared to the x90 on a head mount which is 15 times cheaper with most likely comparable results. Once again the trade-off would most likely not be worth it.