HCI Design Report

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1 Prototypes and Discussion

We first present our incremental prototypes, followed by a short discussion of why they were discarded or how they were honed to lead to the final design. We informally tested the prototypes in paper or slide show form. Paper prototype material is included as an appendix to the report. The tests were informal in the sense that we did not qualitatively measure variable, but instead observed the users, took note of their behaviour and discussed their overall experience of the prototype. We also hosted an online survey to gauge public opinion of different input types to lead us towards a final design.

1.1 Prototype 1: Touch Screen Input with Extended Interface

The first design involved the idea of a standard touch screen input, with the screen positioned in the usual place in a car, that is in on the dash between the driver and passengers seat. The design featured an expansive interface with multiple menus and options. The interface was first drawn on paper (see appendix paper prototype 1) to try out, and then mocked up on keynote as shown (more screenshots/sketches of deeper menu options are shown in the Appendix):

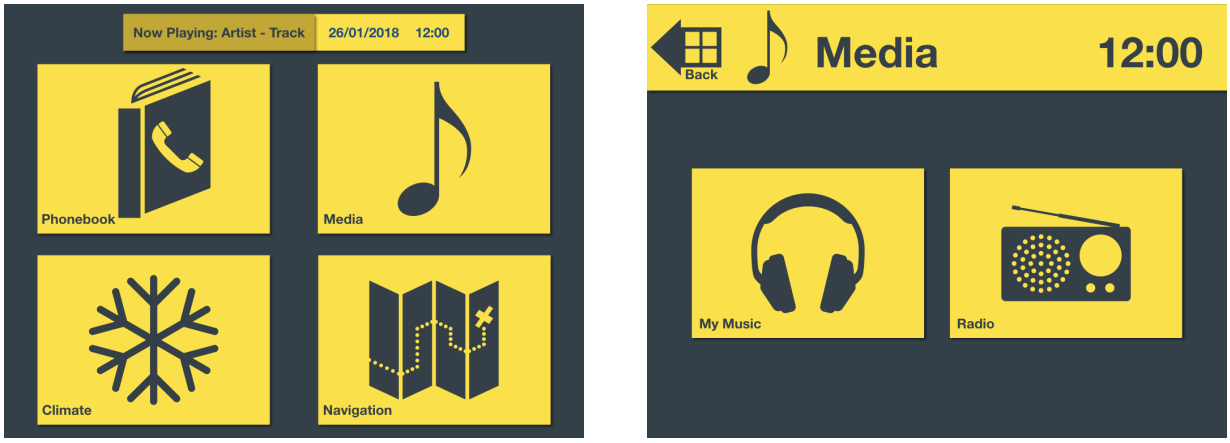


Figure 1: Figures showing design of extended interface.

In an informal evaluation, with users interacting with the mock up slide show while pretending to drive (watching dash cam or hazard perception videos, but without actively taking the hazard perception tests), the general impressions were:

- The interface was too complicated to be intuitive and user friendly in the context of driving a car.
- There was too much text on the screen. Users had to divert attention to reading menu options and it wasn't obvious what to do without reading.
- It took users longer than they would have liked to find the option they were looking for amongst the deep menu layers.
- It would be very difficult to split attention between driving tasks and the screen.
- The vast array of possible selections on the screen meant that you had to focus your eyes on the screen to find what you wanted.

The key idea taken forward to the next design was simplicity. We also reflected that a touch screen input generally requires the users visual attention for a couple of seconds to select an option, and as such we considered alternative input types to avoid the driver taking their eyes off the road.

1.2 Prototype 2: Simple Interface + Multi-touch Input

The main focus of this design was to severely reduce the visual complexity of the interface, with big button like options as shown, with shading to indicate one has been selected, and minimal text. The hope was that a minimal interface would be less distracting for the driver and easier to navigate through.

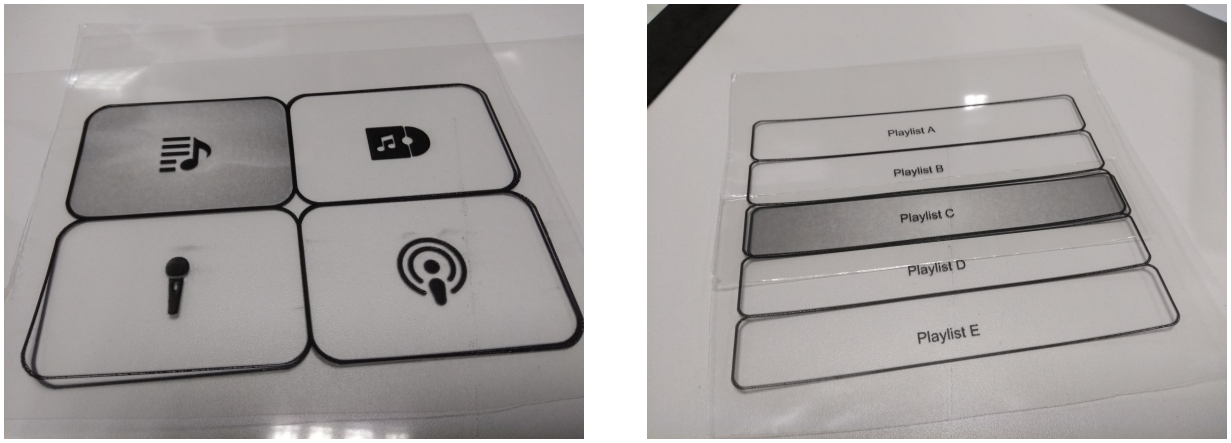


Figure 2: Figures showing design of minimal interface.

We also considered an input method that didn't require as much visual attention as a standard touch screen. The idea was to have a touchpad (not a screen) positioned to the drivers side (e.g. left hand side for UK vehicles). The pad supported touch gestures and multi touch input: for example to select a playlist you could 'write' the name of the playlist on the pad. We assumed people would be able to write without looking at their hand and thought this design might allow for complex input while keeping visual attention on the road. To select the third item in a menu you could touch with three fingers.

We prototyped this interface with paper, and positioned a touch screen phone to the users side to simulate the touchpad input. We ran Google's Handwriting app on the phone and asked users to write strings such as playlist names or addresses without looking down towards their hand, i.e. while focusing on POV driving videos.

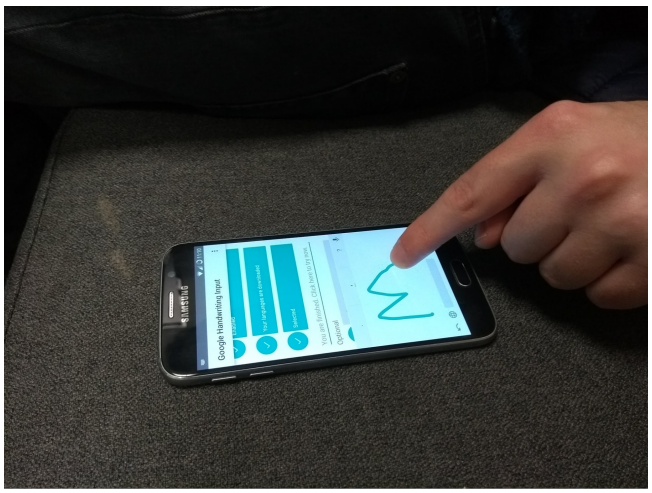


Figure 3: Experiment of touch gesture input.

The general impressions were:

- A touch pad was just one extra thing to divide your attention between.
- The success rate of text input via the handwriting functionality wasn't satisfactory and resulted in frustration.
- It was no easier or less distracting to use the touchpad over a standard touch screen.
- The simple menus were preferred to the complicated ones of the last design and users intuitively knew what to select.
- The concern was raised that a user might not know what the icons meant without text, but we felt that the menus were so easy to traverse that guess selecting to find out what each was on the first use was better than cluttering the interface with text.

In addition to user reactions, the survey (see appendix survey) reflected that by and large people didn't find the touchpad functionality desirable. The key ideas taken forwards to the next design were: simple interface works, but touchpad input isn't ideal. We turned our attention to alternative input methods and interfaces that would work with new input types.

1.3 Prototype 3: Wheel Scroll-Through Menus

The idea behind this prototype is that all of the navigation through the interface is driven by a simple wheel that supports 3 methods of interactions - scrolling up, scrolling down, and clicking the wheel. To support this method of interaction all of the infotainment systems menus consist of lists which scroll vertically, with the central icon being the currently selected element.

A single click allows the user to select this central menu element and a double click allows the user to move back to the previous menu. The primary advantage of this method of interaction is that users are capable of rapid navigation through long menus. Additionally the interaction being done exclusively through the scroll wheel cuts down on the user?s cognitive load as there are only a limited number of actions available at any given moment in time - this is in stark contrast to the multitude of options available in the extended interface.

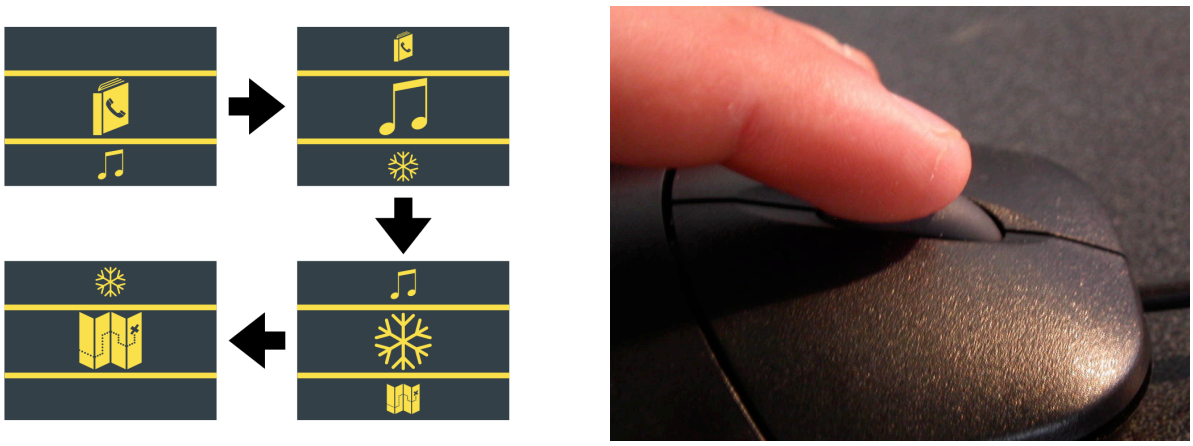


Figure 4: Figures illustrating scroll wheel navigation.

- Users found the simplified method of interaction for this interface much better than the multi-touch input. However concerns were raised with regards to accidental scrolling whilst driving.
- One fundamental issue with this approach that we quickly identified was out decision to limit the scrolling menu to three items on screen at a time. Although this seems less distracting whilst driving it could ultimately have the opposite effect as users could find themselves constantly scrolling through the menus in order to find information that could simply be displayed on screen.
- The vertical scrolling approach also led to a large amount of wasted space on the screen.
- An area where this approach did seem to excel was handling long lists of menu items. Users stated that the scroll wheel would be especially useful when browsing these long lists, examples of which include a list of music playlists or a contacts phonebook.

1.4 Prototype 4: Minimal Interface on HUD with D-Pad Input

Taking forward concerns from previous feedback, this design presents the same minimal interface as prototype 2 on a transparent HUD display in front of the driver as shown ref image. The idea is that the driver doesn?t need to change their line of sight while driving to see the interface. The interface will only appear when the driver starts to interact with it, otherwise it will be completely transparent, or perhaps display speed or other typical dashboard displays.

The interface that is displayed on the HUD does not provide access to the full infotainment system, it is a reduced interface to be used when the car is travelling at speed (for example, above 20mph) where fatality is likely in the event of a crash. It only provides a restricted set of functions and doesn?t really cope with text entry at all: when the car is at speed, text entry is delegated to vocal input. Drivers are encouraged not to text while driving anyway, so we didn?t see this as a major design flaw. A new method of input was also trialed in this prototype, specifically directional buttons similar to that on a video game controller were suggested to traverse the options. There would be an additional central button that could be pressed once to select, twice to go back or held to return home.

We demonstrated this design by printing it onto transparent sheets and laying them over dashboard cam footage as shown in the image. We didn?t have directional buttons at hand, but arrow keys on a computer keyboard worked as a simulation. We asked users to try to

Figure 5: Figures showing design and trial of HUD.

find and play a playlist using the prototype. General responses to the design indicated that:

- Users appreciated the minimal and transparent design and didn?t find it as distracting as previous designs
- Users found the black interface difficult to make out against the background when it was also dark, which was almost always the case due to the background being road.
- A concern was raised with regards to how the interface might perform in bright conditions, e.g. when the sun is streaming through the windscreen.
- Users like the arrow keys as input for the main 4-panel menus, but found them fiddly for scrolling down lists like the playlist list (e.g. having to press the button many times to get to the bottom of the list wasn?t efficient).

2 Final Design

The final design combines elements of prototypes 3 and 4 and is illustrated fully in the appendix. The minimal interface was chosen to be displayed on a transparent HUD as depicted previously, and will be controlled by 4 buttons on the steering wheel that each correspond to one of the 4 panels in the display as shown. When the display shows a list, the method of input changes to a scroll wheel/touchpad also located on the wheel (ideally at the centre of the directional buttons). The wheel/touch pad will double up as a button that can be pressed once to select, twice to go back or held to go home. The crux of the design is simple four panel menus that are memorable and very easy to traverse: menu diving is minimised.

In the version we build we will either change the colour of the interface from black, or have the interface be black with white outlines as is common to maximise contrast and ensure the interface is visible behind a wide range of backgrounds and in various light levels. We?ll focus on the media functionality in our build, with the acceptance criteria being that a user can, from the home menu, find and play a list of songs by searching by artist, album or playlist. An interface map is as in the appendix, where selected an option from the list at the bottom of any of the paths results in the list of tracks / podcast being played.

A short video of the process of selecting to play a playlist from the home screen **can be seen in include video link**. Note that the idea in the video was changed slightly prior to filming. Instead of having directional buttons to select an option in the 4-panel menus we made the options correspond directly to the buttons so that the user doesn?t need to be aware of which option is currently selected in order to navigate to a new option, as would be the case with using standard directional buttons to select an option out of four.

3 Appendix

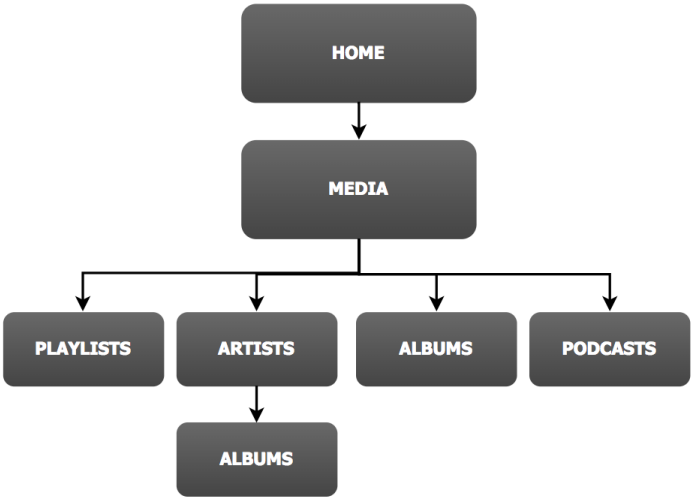
3.1 Final Design Material

Here are some images of the design in its current form. Some changes are still to be made, for example changing the colours to increase contrast.

3.1.1 Traversing through the menus to select a playlist

Figure 6: Once a playlist has been selected it will immediately play.

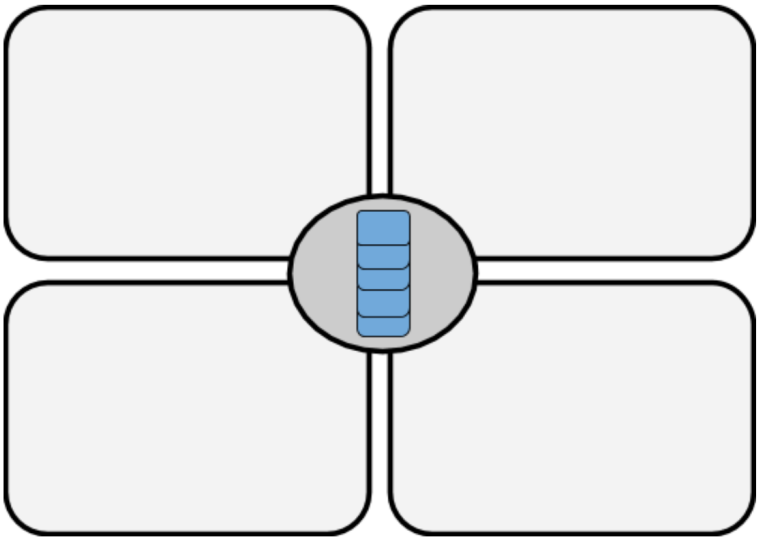
3.1.2 Interface Map: All media options



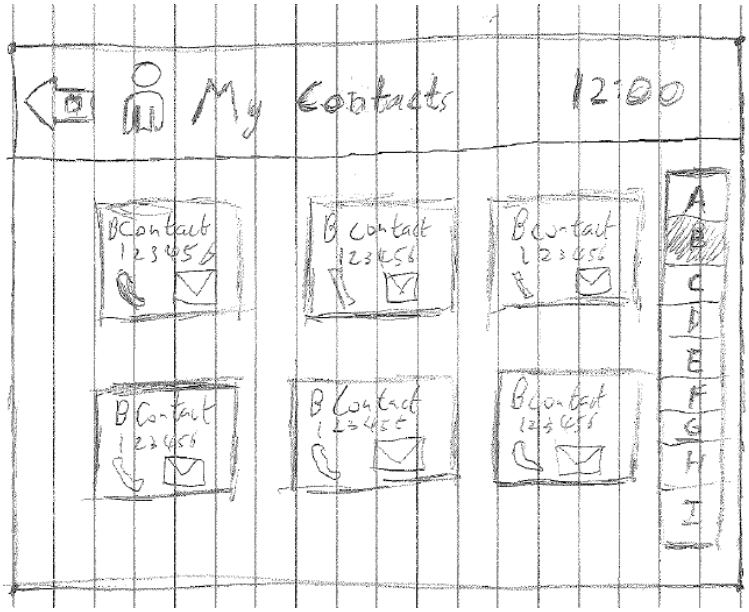
The bottom of each path is always a list. Selecting an option on one of these lists initiates audio playback of the chosen article.

3.1.3 Input Method Sketch

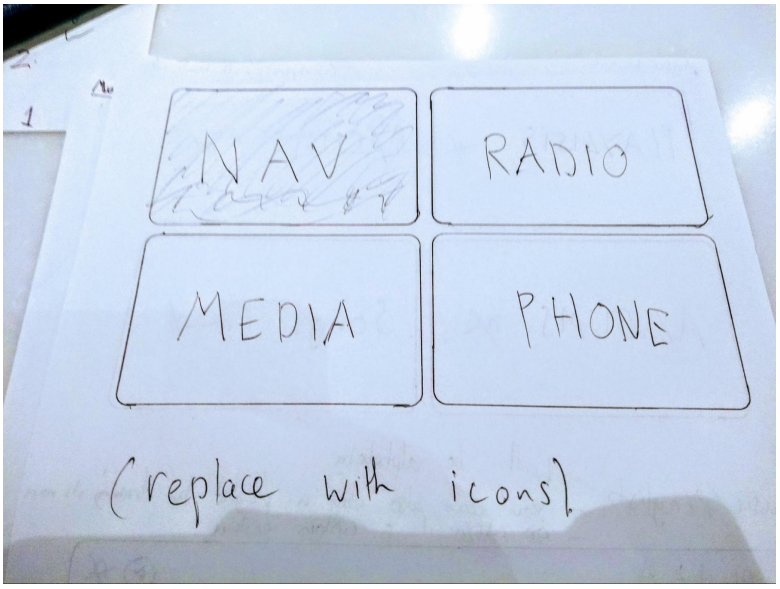
The four larger buttons correspond to options in the four panel menus. When you get to a list, the central scroller is used to scroll through the list and select options. This could be either a touch scroller or a wheel, and can be simulated by mouse wheel input or similar when we build the software. It is pressed, doubled-pressed or held to select option, go back and go home respectively. In a car this would be positioned on the steering wheel to allow easy access while driving. However if this proved impractical it could be easily located on the central dash. The idea is the user doesn?t need to look at this to use it. In real life this would small enough to use with one thumb.



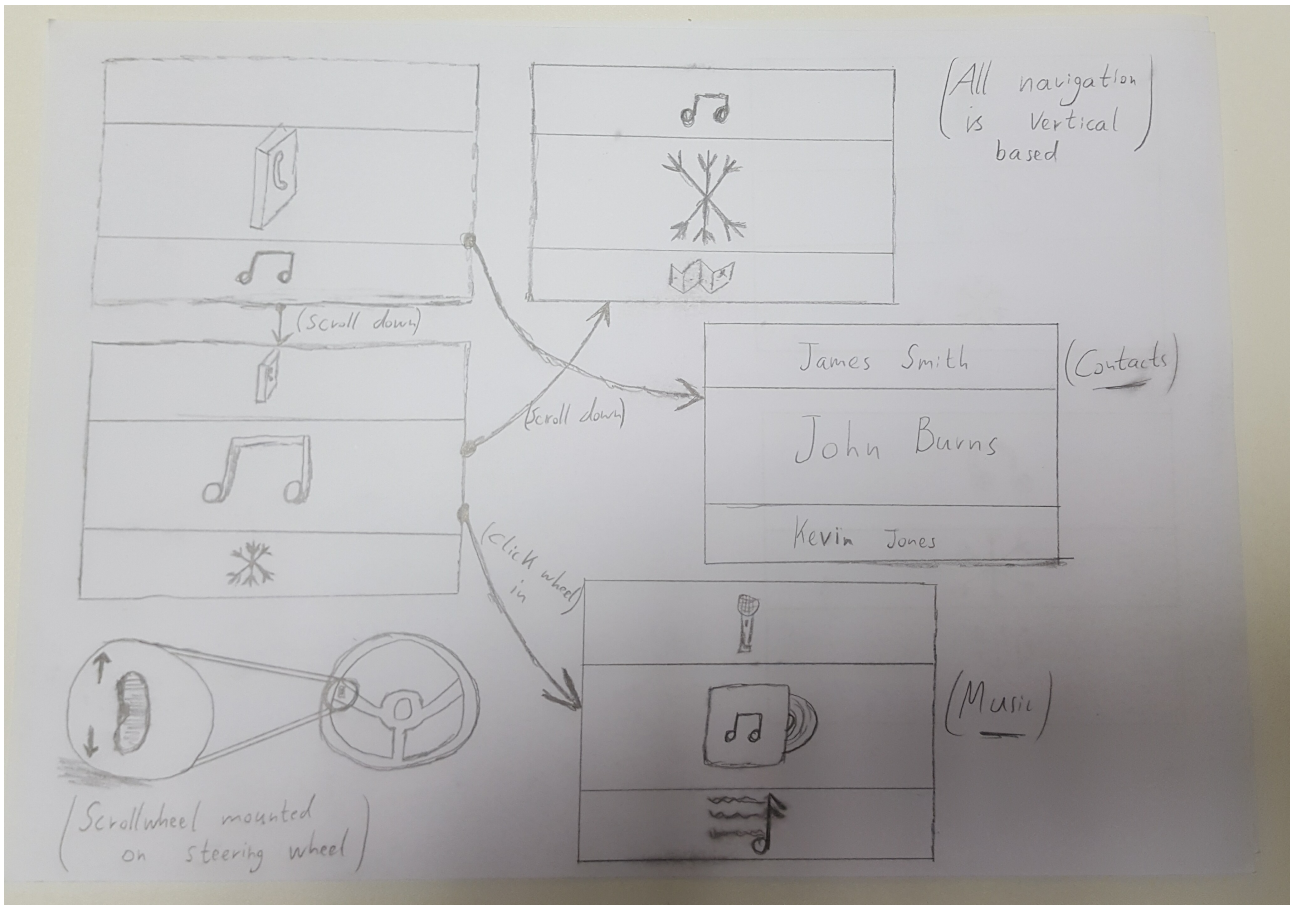
3.2 Paper Prototype 1



3.3 Paper Prototype 2



3.4 Paper Prototype 3



3.5 Survey Responses

- The survey queried 11 people.
- The average rating for their current infotainment systems was 74%
- 45% of people had a touch-screen interface in their car.
- 91% had physical controls in their vehicle.
- 73% of people were against the idea of gesture controls.

3.6 Consulted Resources

Current Infotainment Systems

- Review of what?s currently out there: https://www.autotrader.com/best-cars/luxury-car-infotainment-systems-a-comparison-267107
- Most and least distracting infotainment systems out there: https://www.consumerreports.org/car-safety/most-and-least-distracting-infotainment-systems/
- Best in car entertainment systems: http://www.autoexpress.co.uk/car-tech/93634/infotainment-test-best-in-car-entertainment-systems-reviewed

Technologies

- For drawing input: https://www.google.com/inputtools/services/features/handwriting.html
- Cool videos on touch gesture control: https://www.youtube.com/watch?v=XVbuk3jizGM

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- Best in car entertainment systems: http://www.autoexpress.co.uk/car-tech/93634/infotainment-test-best-in-car-entertainment-systems-reviewed

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- Cool videos on touch gesture control:
  - https://www.youtube.com/watch?v=XVbuk3jizGM

General Research

- General Distraction Surveys:
  - https://www.usatoday.com/story/money/cars/2017/10/05/aaa-distracted-driving-infotainment-study/734677001/
  - http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.323.7242&rep=rep1&type=pdf
  - https://www.extremetech.com/extreme/257083-infotainment-systems-increase-distraction-aaa-study-finds
  - https://phys.org/news/2017-10-vehicle-infotainment-distractions-wheel.html

- Research suggesting multi touch gesture input is less distracting that standard touch the buttons interfaces:
  - https://www.researchgate.net/publication/300484427_In-Car_Touch_Screen_Interaction

- http://people.cs.aau.dk/~dubois/papers/p1139-bach.pdf

- Head Up Displays and distraction

  - https://www.cars.com/articles/2013/11/are-head-up-displays-the-answer-to-driver-distraction/
  - http://www.businessinsider.com/every-car-should-have-a-head-up-display-2013-6
  - https://www.ft.com/content/e32fcc04-643b-11e4-bac8-00144feabdc0
  - https://www.nytimes.com/2015/09/11/automobiles/as-head-up-displays-become-common-distraction-becomes-an-issue.html

- Information regarding car fatalities
  - https://www.washingtonpost.com/local/trafficandcommuting/why-more-than-1-million-americans-have-died-in-car-crashes-since-1990/2016/02/24/818e4a24-db0f-11e5-925f-1d10062cc82d_story.html?utm_term=.ea11e4434f9c