Part IB Group Project Design Briefs 2018

Anthropometrics Today
Client: Ina Pruegel, Fitzwilliam Museum
In the 1880s students in Cambridge had their head measured to test for correlations between head size and degree class (https://goo.gl/Tbfoww). To celebrate the 200th anniversary of the Cambridge Philosophical Society, a major public exhibition will reconstruct this experience. You will use computer vision to measure visitors' profiles, matching against archive records of thousands of ex-students to identify a (possibly famous) historical twin, and then render a simulation of a new "handwritten" record card that can be accessed online to compare your future grades to theirs.

Audible Appliances
Client: Nicholas Hellawell
Many home appliances would be perfectly usable by visually impaired users, except for interaction via a display screen. An example is the exercise bicycle owned by your client. Your task is to create a simple accessory that can be attached to the bicycle display screen, using a Raspberry Pi camera to find and decode relevant parts of the display, and read necessary information out loud during an exercise session. In principle, this functionality could provide a customisable screen reader that might be attached to any kind of device to add screen reader functionality.

Augmented Reality Furnishing
Client: Jack Haughton, Argon Design
It's often difficult to follow furniture assembly instructions, but augmented reality could make it easy. The Holokit is an exciting low cost phone accessory with development tools providing the capabilities of Microsoft's Hololens, but so cheaply that a furniture company could include one in every pack. The goal here is to provide an AR overlay that shows customers how to orient parts relative to each other, apply tools, and any other advice right where it is needed. Your client will provide a furniture kit, and a phone if you need it.

Autonomous highway system
Client: Jan Kis, IMC
Highway congestion is a never ending problem. One way to increase the throughput of the highway is to group vehicles into platoons to shorten the distance between two consecutive cars. Further advantages of vehicle platooning are decreased fuel consumption and emissions and increased safety and comfort. Design an automated platooning system in which multiple vehicles autonomously follow the leader. Safety is of paramount importance, each vehicle should do its best to avoid collisions. The goal is to develop a platoon simulation which can be backtested with 3 Lego Mindstorms vehicles.

Citizen Speed Safety
Client: Ian Hales, Boeing
Many small communities are endangered by drivers ignoring speed limits and driving at high speed through populated areas. Some "speed trap" apps are available for mobile phones, but these are inaccurate. It would be possible to increase accuracy by using two phone cameras, one pointed along the road, and the other across it. Computer vision processing is needed to extract speed data from two time-stamped videos, and construct a calibrated 2D model of the road, vehicle speed, and licence plate number, which can be forwarded to local enforcement agencies together with verified witness testimony.

Energy Budget
Client: Yuichi Abe, Informetis
Shops don't take your money without asking, so why should your home appliances use scarce electricity resources without consulting you? Current "smart meters" are pretty useless, because house occupants have to guess where the power is going. Local company Informetis has an Internet of Things device that sends a WiFi stream of power consumption from any appliance. Your task is to make an app that will aggregate and visualise this data to help households budget for a future where energy costs 10 times what it does today. When energy is rationed, what will work best? Neighbourhood contests, household policies, online games or financial incentives? Your system design needs to address motivation, not just monitoring.

Every Car in Cambridge
Client: Ian Lewis, Smart Cambridge
Earlier this year, for a period of one week, we deployed around Cambridge 90 Automatic Number Plate Recognition cameras. This has provided anonymized timestamped journey segment data for about 4,000,000 vehicle movements between pairs of cameras. Your task is to provide a tool that supports flexible end-user analysis and visualisation of this data. For the same time period we also have car park occupancy information as well as major road journey time information derived from the real-time position of buses and it may be of interest to relate the ANPR data to these sources.

From PDF to Practice
Client: Biko Agozino, JP Morgan
Many hospitals and trusts in the UK produce their own local guidance, regarding what medicines should be given to patients before and after operations (perioperative medication). Policy is buried in PDF documents and academic papers, which combine descriptions of drug properties with factors that might result in different advice to different patients. Your task is to create a system that can automatically extract and compare a wide range of such advice, presenting it in a form such that clinicians can draw on both best practice and individual factors when advising a specific patient.

Mixed-reality PDF editor
Client: Carlo Minciacchi, Leapian
PDF documents lead a double life, on screen and as hard copies. But when people modify hard copies (such as the proofreading marks that copy editors use, or annotations by students on their lecture notes), the digital versions stay the same. If you have a photo of an annotated document, it should be possible to match this against the PDF image, extract the annotations as an image diff, and apply them to the PDF. The simplest approach is just to overlay the annotation ink as a bitmap, but ideally, proofreading marks should be interpreted as edit operations on the original document, potentially including OCR of any clearly handwritten text. Your client can provide some specialist assistance in PDF processing.

Opposing Views
Client: Edward Ashton, Frontier
Many people increasingly exist in an ideological bubble, getting all their news from a handful of sources that they trust and shunning everything else. This leads to polarised, insular viewpoints, stifling debate and increasing divisiveness. Your task is to make a web browser plugin which encourages users to read about a story from multiple angles. When reading an article, it can suggest an alternative, opposing source for the same topic. It needs to be able to categorise stories so that it can recognise the same topic in different publications, categorise sources so that it can find an interesting alternative stance (ideally not just how left- or right-leaning it is, but also things like the background of the author, the size and age of the publication, the tone of the articles), and also present this to the user in a way which will circumvent their defensive instincts and encourage an open mind.

Pigment Analysis
Client: Camille Polkownik, Hamilton Kerr Institute
Painting conservators at the Hamilton Kerr Institute often identify pigment substances in paint by analysing microscope images. They need a tool that enhances their expert judgment, using computer vision algorithms from the OpenCV library to automate mundane classification tasks. This interactive tool should provide a structured and flexible decision process that optimises search for the most likely substance, by allowing the conservator to quickly eliminate unlikely possibilities, and to focus on those properties that seem most ambiguous or problematic for any particular sample.

Predictive aircraft maintenance
Client: Adam Durant, Satavia
Local company Satavia helps airlines and aircraft engine manufacturers to schedule maintenance based on the amount of exposure the components have had to air pollution, dust, ice, volcanic ash and other environmental factors. They have large data sets which could be used to train predictive models that might be added to the Microsoft Cortana Intelligence Solution Template Playbook (assistance from Microsoft Research will be available) for predictive maintenance in aerospace. You will need to deliver a data ingestion architecture for a range of global data, and also demonstrate an aircraft maintenance scheduling application based on machine learning that applies the results.

Real-time AI research
Client: Javier Gonzalez Hernandez, Amazon
Machine Learning researchers often try multiple configurations of machine learning algorithms using libraries such as GPyOpt. The convergence resulting from different configurations is unknown in advance, but could be visualised in real time, while multiple alternatives run concurrently in the cloud. Your task is to create a control panel with architecture support that will allow researchers to monitor large numbers of simultaneous Python experiments, interactively shutting some down, or tweaking parameters via the user interface, in response to what they see.

Sustainable Gaming
Client: Tim Wilkinson, UNEP World Conservation Monitoring Centre
Minecraft is practically a training simulator for environmental destruction - open cast and strip mines, deforestation, large scale industrial development and more. Your task is to use an open source game engine such as Godot to prototype a new kind of game in which players (re)build a natural world rather than destroying it. Rewards and metrics can be related to biodiversity, species conservation, and re-wilding. Sustainable social dynamics and economies might also be an important factor. The challenge is to keep it exciting, but with thrills that don't come from killing and maiming.

The Adaptive Web
Client: Conor Farrington, Department of Public Health
Most websites are designed on the basis that "one size fits all" - for any kind of user or context of use. Your task is to create a tool that allows users to author their own policies for customised appearance and behaviour, for example dark-mode viewing, text subsets, or controls suited to elderly users or those with disabilities. It should also be possible to apply data from one user-selected site (e.g. a weather forecast) to customise the appearance of another. The configuration process should be easily accessible to a wide range of users - so rather than vendor-specific browser plug-ins, a more universal solution might be a configurable online translation service that substitutes alternative CSS and JavaScript through recipes that can be shared with others. Such a powerful tool would also require security provision to guard against misuse.

VR AI Ping Pong Trainer
Client: Matthew Johnson, Frontier
AI and VR are the most exciting areas in computer science today, and this is a chance to bring them together. We would like you to create a VR application displaying a simple view of a Table Tennis table, bats, and ball, and an environment to administer a game of Ping-Pong. However, we would like the opponent to be an AI which you are attempting to coach. It may be useful to have the option to run fast automatic training also to refine your bots, but the ultimate aim is to provide some human training, and to be able to play them directly in VR. It may also be interesting to pitch two independently trained bots against each other, and see how they behave. Rather than arcade games using different function buttons, ping pong can be controlled wholly from position, rotation and motion of a bat, suggesting that all user interaction might be implemented using a Wiimote controller.

Virtual World Generator
Client: Andy Fawkes, Bohemia Interactive Simulations
It is possible to make accurate 3D scans of indoor scenes using depth cameras such as Google Tango or expensive LIDAR scanners. Although the overall geometry is accurate, individual objects cannot be distinguished. Your task is to use a simple SLAM algorithm to recover overall room dimensions, but populate a navigable virtual world in OpenGL using standard 3D library models of furniture and other objects that have been recognised as belonging to relevant categories using pre-trained deep neural net models such as NeuralTalk Model Zoo.

Way to the Clinic
Client: Stefanie Reichelt, Addenbrookes Hospital
One of the group project coordinators recently attended an outpatient audiology clinic at Addenbrooke's hospital, cycling from the William Gates Building. His navigation tools totally let him down – after entering the Addenbrooke's site, half his route was by bike, while the other half was a maze of indoor corridors. Your task is to build an outdoor/indoor navigation app that helps Cambridge locals get to their hospital appointments, using APIs to the University Map, and adapting the open source OpenRoomMap for specialised hospital data.

Wearable house control
Client: William Bakker, IMC
In recent years, smart IOT hardware has become mainstream and affordable. Common household devices include smart lights, sound systems, curtains or thermostats. In principle, a smart hub allows home-owners to control all of these. However, logging in to websites and control apps is more of a pain than just using light switches. Your goal is to provide integrated control from a wearable device (Android smart watch provided), that can be used to customises all functions in a room according to the combination of people present. At the least, the system should switch on the lights if one person is there, but it should also be programmable (or learn preferences and priorities) for music, privacy, temperature etc.