tennis sensation pro™

'... a virtual tennis game that gives audio and haptic feedback allowing the visually impaired to compete with fully sighted users'

benefits

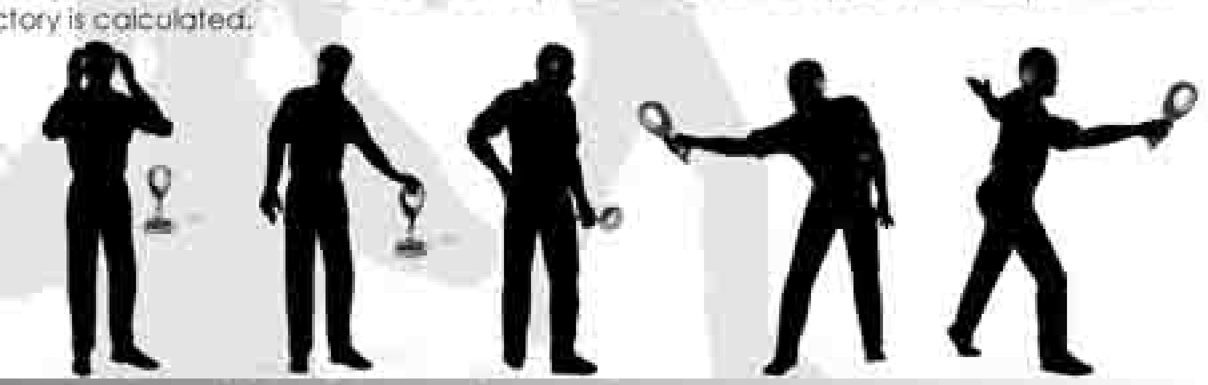
o allows blind users the opportunity to play competitive sport against fully sighted users.
o gives all the aural and tactile feedback of real tennis.
o developed as an inclusive sport rather than a video game
o allows physical parameters such as racquet and court size, ball compression and even gravity and air properties.
o can be played anywhere - the court can adjust to the location
o opportunity to use as rehabilitation aid for children with a visual impairment as well as those with physical or mental disabilities.

features

o auditory representation of real tennis
o accurate feedback of shot quality
o wireless technology allows remote play
o accelerometers used to detect motion
o gesture recognition used to analyze shots
o proper mathematically modeled game dynamics

how it works

1. users can define their individual court and racquet size and the ball compression that they will use.
2. player hears sonified representation of a tennis ball trajectory (different sound parameters represent changes in height, lateral position and distance to player)
3. player makes a stroke as the ball approaches.
4. the system calculates the resulting coefficient of restitution and ball vector depending on stroke and shot quality.
5. audio and haptics (force feedback and vibrotactile) gives the player feedback on the shot quality just as with real tennis.
6. initial ball position and velocity vectors and spin rate are wirelessly transmitted to the opponents racquet where their approaching ball trajectory is calculated.



project development

computer science collaboration

o collaboration allowed product to reach a level of development that would otherwise have been unachievable
o excellent experience working with other discipline

Work was undertaken with the department of computer science from the product inception. PHD students involved in a variety of specialism gave backup, advice and feedback in new areas of development that are only now being seen in the consumer market. This proved invaluable from a project and learning perspective and gave a good comparison to an industrial experience. Ultimately a working prototype was created that proved the concept and provided an invaluable development model for further iterations of the design.

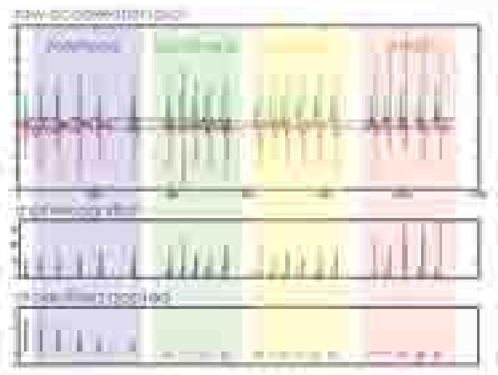
GIST GLASGOW INTERACTIVE SYSTEMS GROUP

Computing Science GLASGOW

gesture recognition

o gesture recognition proved significant advantages over normal integration method
o required lower processing power while the system inherently grades shot quality

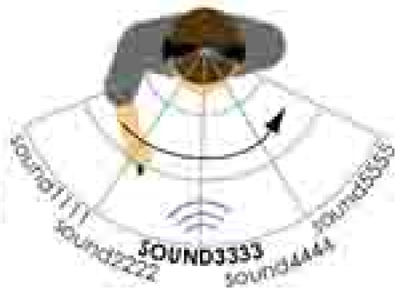
gesture recognition is an interesting approach to motion sensing using simple filters instead of multiple integrations
1. acceleration profiles of desired 'gestures' are stored in the system.
2. when an unseem gesture is performed the system applies a series of filters to the resulting acceleration profile
3. once the desired filter has ben applied the resulting signal will be distinctive and recognizable by the system.



spatial audio

o research and testing into advanced audio and interaction methods.
o huge possibilities with combination of technologies

research was undertaken into the possibilities of using 3d/spatial audio. This is a development of stereo and dolby systems, using filters to create true directional sound. This was an interesting line of investigation that i am sure will filter into main stream products over the coming years.



user testing

o product design engineering combines user centered design with mechanical engineering to create products that and both functional and user friendly
o results in a product that what the end user needs or wants

it was important throughout the project to refer back to the end user to gian feedback and ensure that the project was taking the correct course and the solution was going to be appropriate. mockups and prototypes had to be carefully considered to gain correct feedback. the

design methods

o concurrent design process
o project planning and management required constant consideration throughout to coordinate the fields and contacts

A concurrent design process was undertaken to allow a the multidisciplinary project to be developed within the allocated time period. A sequential process would not have allowed such a cohesive product. Research, development, testing and user trials were all carried out throughout the project which put a strain on project management but produced good results.

details

haptic 'kick'

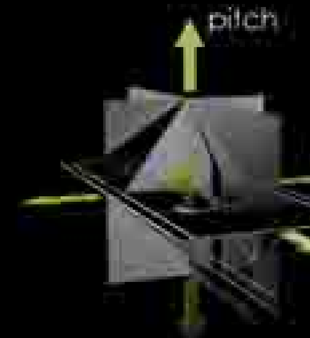
o motor output shaft held within casing causing the motor body to rotate.
o large current pulse supplied by 8000uF electolytic capacitor causes motor to kick.
o using motor as inertial mass reduces overall weight.

virtual parameters

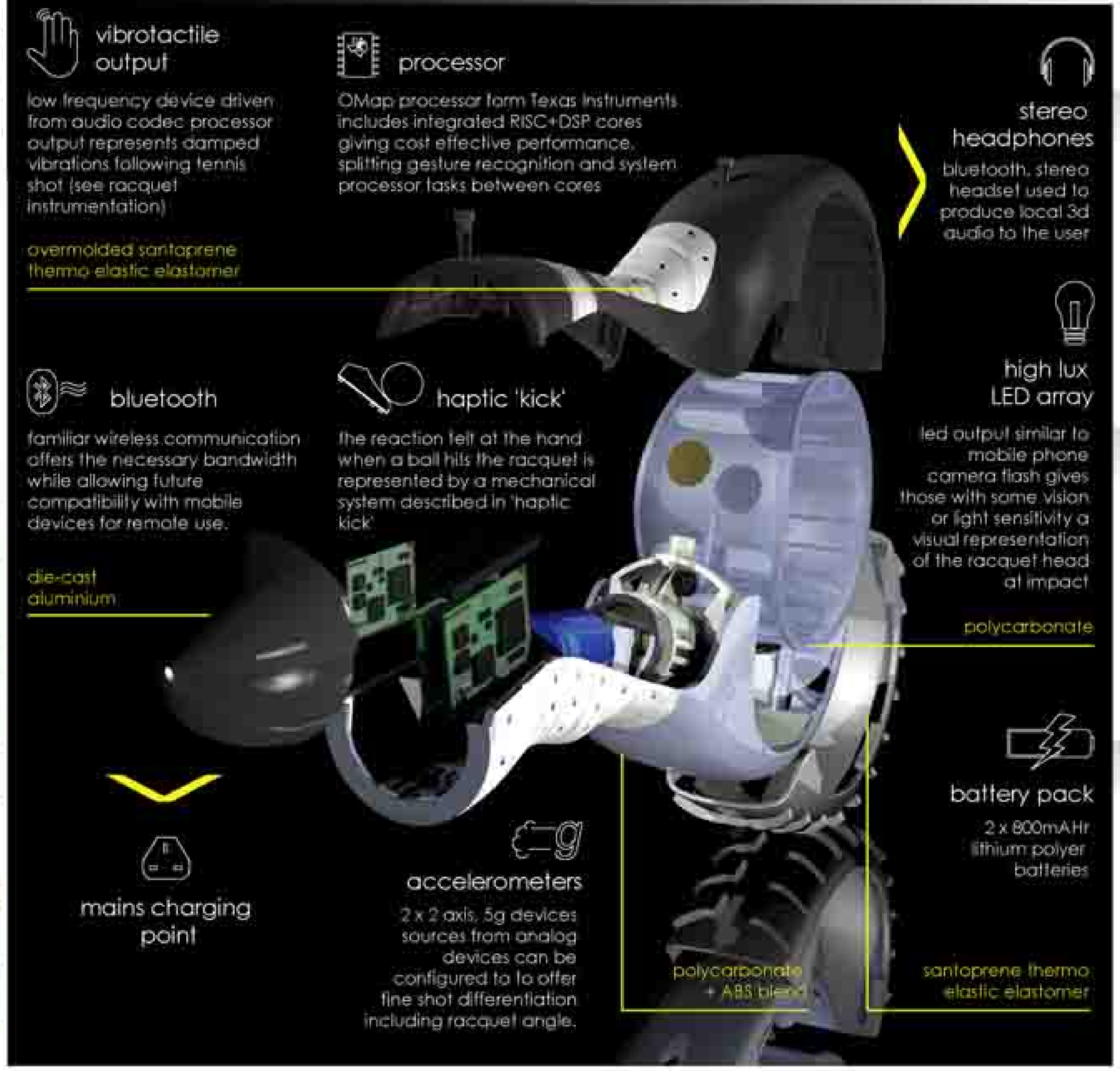
o modelling the game dynamics in Matlab/Simulink allowed the effect of different physical parameters to be analysed.
o this showed that tangible variables could be adjusted to adjust the difficulty of the game.
o this allows each player to find an appropriate level so games are always copetitive

sonification

o the ball is sonified so the player can locate the ball through audio medium
o this gives an alternative to hand eye coordination for the visually impaired



general arrangement



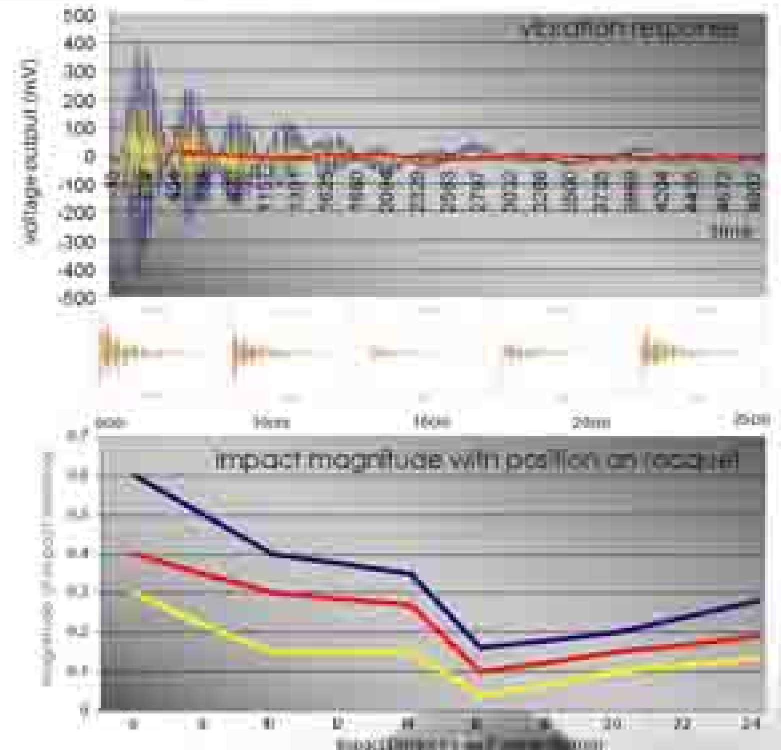
mechanical and electrical engineering

racquet instrumentation

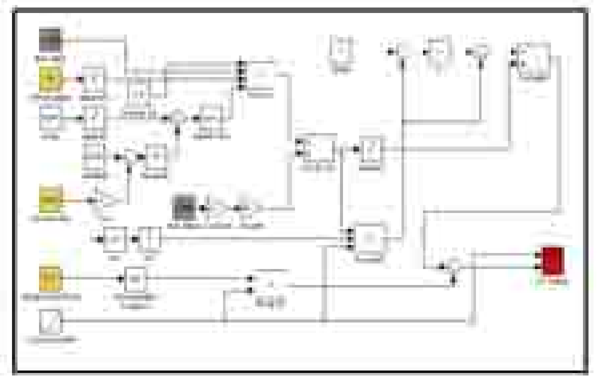
o it was essential that the game was to give realistic haptic feedback.
o to accomplish this a real tennis racquet was instumented with accelerometers and load cells and the balls struck against the racquet face at different locations.
o the results could then be analysed so the vibration response could be modelled mathematically.
o this allowed a mechanical system to be designed to represent the model

the top graph shows a classic composite wave with damping recorded from a off center strike. The bottom graph shows the variation in response magnitude over the length of the racquet head.

$$x = e^{-0.43t} R\sin(16.77t + \phi)\sin 201t$$



system design



o all systems modelled in Simulink before programming to give design flexibility
o simulations allowed problems to be identified early in the design process.

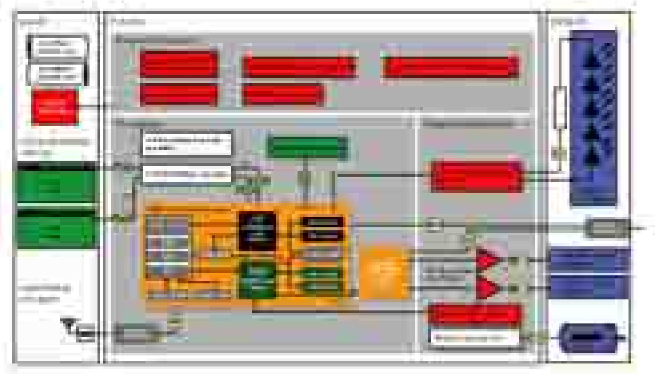
to the left can be seen a development model of the ball flight dynamics. matlab allowed simple parabolic flight to be modelled for programming and future more complexity and realistic elements were developed.

haptic feedback

o mechanical representation of ball strike was designed and tested.
o design criteria was response quality, mass and overall size.

Having tested the response of a real racquet [illegible] necessary to design and build a mechanical [illegible] developed a system using the percussive effect [illegible] a more feasible solution was achieved [illegible] output of a DC motor and applying a [illegible] capacitor. This proved successful [illegible] mass to be added to create significant [illegible]

electronic and electrical design



o the electronic and electrical system was designed to system level to gain a feel for necessary complexity, cost and component specification.

The first prototype was PC based due to the difficulty in programming microprocessors at development stage. this is the area that requires further development to prove the overall concept

allan sinclair_meng > product design engineering > glasgow school of art + university of glasgow

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