Background and Discussion Starter

Wearable Devices
and
Applications

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Why

This section covers the major motivations asking why.

Wise use of technology

Technology can be used for benefit via wise application. Offering to provide technology for the use of metta.org will allow the wisdom inherent within metta.org to pervade the resulting device design and associated applications.

Guiding motivation

The use of technology can be guided by the dharma. A top down approach to design could consider the structured considerations within the dharma, and then consider how each of these could be applied to everyday life via technology.

Integration of practise via technology

Integrating practise into everyday life

The use of wearable technology could support integration of intensional practise within the context of everyday activity.

Integrating practise within social community

Web based social applications and portals could support inter personal practise.

Financial support for metta.org

The generosity relationship between teacher and pupil continues to evolve in a western context. It may be possible for profit from sales and subscriptions of wearable devices to support teaching organisations such as metta.org

Device Sale

Profit from the sale of the wearable devices would support metta.org. Offering devices for sale on a pre paid basis could reduce any requirement for capital investment related to manufacturing devices.

Service subscription

The offering of services on a subscription basis could generate an ongoing profit stream. Provision of the infrastructure to support long term services no longer requires capital investment, and on demand purchase of low cost cloud based infrastructure allows matching infrastructure expenses to service subscriptions, removing the requirement for capital hardware investments.

Existing Development

Allan has existing use for the wearable devices, primarily to support more contextually aware delivery of technology augmented learning environments. The uptake of wearable devices within school institutions is likely to be slow and face headwinds given that schools have a complete cross section of parents including some who are technologically conservative.

A long term view recognises the potential benefits of body monitoring as part of technology supported teaching, so gaining as much experience delivering and using worn sensors is desirable.

Making the device and supporting application technology available to the niche domain of teacher guided meditation students would provide experience in the application of such wearable technology without requiring significant additional device design, or significant additional platform development.

In short, the existing educational requirement could be offered to metta.org without requiring significant additional design effort, and could provide experience for Allan in the use of technology guided by wisdom of metta.org.

Affective state in personalised education

The motivation for collecting body sense data in an educational context, is to enable algorithms to navigate the tension between boredom and overload. Collecting affective state allows content and intelligent tutoring platforms to deliver customised content delivery and assistance based on a fusion of knowledge models along with direct measurement of student state.

Sociometric Badges

The use of wearable devices to collect and use body sense data to support development of inter personal skills has been seen in a commercial enterprise workplace context via sociometric badges.

In a class setting, collection of the patterns and levels of speech utterances can support students developing certain patterns of spoken social interaction.

Non exclusivity

The development of wearable devices for educational use precludes giving exclusive use of the technology to metta.org.

At this stage the future of device augmented education is unclear, and the organisational structure of the technology even more uncertain. It is not known if the device and platform will be operated, sold or acquired.

It would seem prudent to scope some broad understanding of how and what technology is been gifted to meta.org. Perhaps a restraint of trade could preclude Allan doing any commercial work in the area of teacher supported meditation practise via worn devices. Clarifying what exclusive rights belong to metta.org will protect metta's investment of time, energy and wisdom.

It would be good to explore grey areas. Potential conflict could arise if Allan were to offer a flexible education focused device that could have applications loaded that support wellness such as pause and relaxation. The suggested separation of any activity primarily focussed around meditation, would be exclusively offered only my metta.org

What

This section covers what should be done to achieve the objectives of the why section.

The above why objectives could be worked towards by a progressive development of a series of worn devices making use of a supporting platform.

Initial use of educational hardware device design

The educational use of devices requires Allan to develop a number of prototypes that are capable of supporting a rich collection of sense data, and online analysis and presentation as soon as possible. Delivery of powerful augmented education is constrained without knowledge of the affective state of the student.

Requirement for a flexible platform

In the educational context the use and analysis of the data is likely to change and develop so a flexible platform that allows loading various algorithms on device, along with the provision of unknown online services and web based interface is required.

There is a similar parallel requirement to allow metta.org to discovery an appropriate set of body sensors, and development of appropriate services and applications in the meditative domain.

Phases of hardware device capabilities

Unknown final hardware sensor requirements along with the addition requirement of flexibility in the on device analysis suggests three distinct device phases.

Initial basic device supporting on device apes and online social apps.

An initial device could be delivered very quickly with a greatly reduced set of sensors.

The primary purpose of a proof of concept device would be to enable Zed, Allan and other non end users to develop applications using the provided platform. A major part of the platform would allow creation of applications without the requirement for coding. A simple cloud based visual coding environment would allow on device applications, and web portal social service applications to be created and deployed. Details are in later section.

Success of a proof of concept device would be the ability for Zed or others to create their own on device algorithms, and associated web based social applications.

Note that the web based applications could be browsed on a mobile device, precluding the requirement for any Apple or Android specific downloaded apps.

Sensor rich device for commercial use.

A device would be delivered later with a set of sensors based on the predicted educational requirements, and adjusted and refined for any meditation/ ID specific requirements. It is envisaged that this device would be sold by metta.org.

It is possible that the initial set of applications will not use all sensor data. Later applications could unlock or make use of the full set on hardware sensors.

Future device with unknown additional sensors.

A future device may require additional sensor data. Putting development of additional hardware sensors to one side for future development could limit project creep.

Sensors over and above those likely to be required for the initial educational and meditative device should be able to be discussed, and put to one side for future use.

Creation of metta.org specific apps

It is anticipated that design and creation of all applications for the meditative domain would be the primary responsibility of metta.org.

Allan would provide the online environment that allows for the development of these applications, and would provide example applications for each of the sensing capabilities.

Likewise, the decision on what social features should be offered on the cloud based online applications that use the sensor data would be decided and implemented by metta.org.

Allan will provide a platform that enables creation of the on device algorithm applications, and creation of the cloud based web application interfaces.

The design environment for creating these on device algorithm apps, and the social online applications is based on the programming environment that was developed to teach young students to learn to code. The environment is simple, basic and intuitive.

Ongoing operation

The final form of deliverable could change, but it is anticipated that Allan would provide a complete cloud based server ready to enable application development.

Allan could also to support ongoing operation and delivery of the web based social applications if requested.

Metta.org may choose to continue to host the infrastructure on cloud based servers, or to operate physical in house servers.

Allan would prefer to assist in passing over complete operating Amazon / DigitalOcean.com server for ongoing day to day maintenance, backup, and monitoring by Metta.org

The effort involved in the operation of the servers and infrastructure is not large, the more important factor is the passing over of control and ownership of the servers.

Device manufacture

Allan would deliver a complete set of ready to manufacture materials for the full sensor device. This would include all instructions, files, documents, physical testing tools and devices for an external hardware assembly house to use.

Allan is happy to assist in the administration and management of any orders for outsourced manufacture and assembly of devices. However, providing a nominated outsourced assembler with the complete set of design documents, testing jigs etc enables metta.org to have the confidence that they could produce devices independent of Allan.

A very small scale assembly house capable of accepting small scale orders from a hundred to thousands of device will be selected – most likely SeedStudio in china.

The manufacturing logistics related to paying the cost of components, the assembly fee, shipping, receipt and distribution of final hardware devices to end users is expected to be conducted solely by metta.org

Given that a small number of prototype devices would have already been manufactured and assembled, it is possible that the process is as simple and close as possible to making payment to the assembly house, and receiving a parcel of hundreds or thousands of device some time later.

Allan would only provide a few prototype units. It may be that metta.org would wish to place a very small order for initial familiarisation of the device with metta.org teachers and leaders. Going through a small order may be useful in gaining experience of the steps in the outsource manufacture.

How

This section covers a lot of specific detail related to the device, and how it will achieve what was desired.

Wearable devices

This covers some of the hardware and sensor specifics of the devices identified in three phases.

Pause and Relax (pendant badge or wrist strap)

This initial device would be very limited, and would primarily focus on enabling the end to end experience of creating on device algorithm applications, and web based social interface applications.

The limited use of the device would be to provide a reoccurring or regular reminder to come back to awareness. It may be possible to stretch to conceive a social use, where users receive a vibration during the day, that they answer with a single yes – I am aware tap, or a double -no not aware- tap. The user could then engage socially in trying to achieve targets of awareness that is reported to the members of their social selected group. This is an over-worked example to illustrate on device application creation, and social app creation. The second phase unit with more capabilities would allow more realistic app scenarios.

The device would have a small form factor approximately 35mm * 20mm * 8mm for all electronics, excluding housing could be worn in one of three ways:

- Able to be mounted inside a leather wrist strap tube with an adjustable watch buckle.

- Able to be enclosed in a comfortable wrapper, and hung as a pendant from the around the neck.

- Able to be enclosed in an attractive surround and worn on the chest as a broach or badge, held in place with a magnetic clasp.

A quick design delivery of a prototyping would include the following limited set of features:

- Replaceable rechargeable battery capable of operating from mere 1 to 7 days on a single charge.

- Charge via a usb socket on the device. Associated charging, monitoring, and power regulation.

- Single simple pulsed vibration motor to provide tactile output.

- Simple detection of single and double tap on the device using an xyz 3d accelerometer.

- Wireless bluetooth connectivity to allow uploading on device apps via a provided wireless dongle that plugs into a standard USB port.

- Small application for install on a PC or Mac to allow wireless communication when the device is in range, allowing for uploading apps, transfer of sensor data.

- Processor and firmware capable of running on board applications.

- Support for clock and alarm timers.

As can be seen, the device is extremely feature limited, but is capable of becoming familiar with the process of creating and loading on device applications, and creating cloud based web social apps using the stream of sensor data.

Speech and physiology (additional sensors)

This device has an initial set of hardware features based on the educational requirements, potentially tweaked for the meditation requirements.

It is expected that a comprehensive set of sensor hardware capabilities would be included, even if the apps do not make use of the sensor data until a later date. I.e. preference to over include potentially useful sensors.

The device would likely include the following hardware features:

Small form factor 45mm * 20mm * 9mm able to be mounted in a wrist band, hung as a pendent or worn as a broach badge.

- Replaceable rechargeable battery. Due to the size and weight constraint, heavy sensor use is likely to require daily charging, most likely each night. Charging by a standard usb charging cable.

- Wireless bluetooth connectivity. Device pared to either a provided wireless USB dongle and it's associated installed computer sync application, or connectivity to an Android sync application run on a bluetooth capable Android phone.

Due to the time effort, and expense of the closed Apple ecosystem, an iPhone based bluetooth sync application will not be developed. It is possible that another programmer could be commissioned by metta to create an iPhone sync app. This failure to code a sync application on iOS is a time and cost restriction only. Coding a sync application could be completed by any iOS development organisation without requiring membership to the Apple MiFi program.

The sensors available on a phase 2 device are suggested to include:

- Two microphones. One forward facing to collect ambient room acoustic levels that are not speaker dependent. One upward facing microphone to collect sound level highly correlated to speaker utterances.

The microphones are not capable of recording sound. Instead the microphones collect approximate intensity level at a very slow 50 times a second, for each of 4 frequency bands. This data is useful in detecting patterns of speech, but not analysis of speech content.

- Support for wrist skin resistance measurements as an indicator of stress. The device provide very short cables to connect to either dry electrodes sewn into wrist band, or short cables to snap onto disposable gel Ag adhesive electrodes. Research shows dry electrodes function in the absence of movement, removing the requirement for preparing the skin with alcohol swap and affixing gel electrodes. Dry electrodes would be sewn on the leather band and the short connecting wire to the electronics module would be fully enclosed within the leather tube.

- Bi-directional short range infra-red transmission and detection. When device is worn as a broach the transmitter and detector face forward and provide the ability to detect other facing broach devices within a short 1-2M range. This is useful to detect patterns of interaction between multiple wearers.

- Single and double click input by detecting a finger tap on the device with a 3 axis xyz accelerometer. The accelerometer also provides tilt measurement which can be useful for measuring the engagement of a student leaning forward to slouching back.

- Tactile feedback from single simple vibration motor.

- Heart rate detection from skin facing side of wrist worn device. Note that the same IR transmitter and sensor that faces forward on the broach badge worn unit can be re-purposed to detect heart rate when worn on the wrist. The skin facing optical detector is paired with a red and green led that is shone onto the underside of the wrist. The light level that is reflected varies in intensity as the blood flow through the vein changes with each heartbeat. The comparison between the two colors can also provide information on the varying oxygen concentration of the blood during each heartbeat cycle.

The robust collection of pulse rate is greatly enhanced by a snug fit of the wrist band to lightly press the sensor onto the underside skin. Ambulatory motion introduces noise artefacts in the heartbeat signal, so the heart rate should only be considered reliable when the accelerometer readings indicate a lack of any rapid motion.

- Temperature measurement from the rear of the badge broach facing the chest after going through clothing. When worn on the wrist the underside faces the wrist skin.

- Clock, alarm timers, battery charge status monitoring.

- On board storage, memory and processing capability to run the on device algorithms, and buffer the streamed data as required. Inbuilt firmware operating system to run the downloaded on-device apps.

- On board storage of secure stream crypto key for each session in a preloaded one time pad.

Future device and sensing capabilities

Additional sensors such as ECG are put to one side for future possible consideration.

Apps

There are two main classes of applications. The application that runs on the device, and the rich interactive visual applications that are viewed in a browser.

On device apps

The on device apps are primarily concerned with the rules and collection and fusion of sensor data, along with management of the communication and streaming and security of this data.

Web based portal

The web based portal provides password controlled access to rich interface from a standard web page that can be browsed from any modern web browser on Mac, PC, Android and iPhone / iPad devices.

The web portal is expected to offer opt in social inter-personal experiences.

Design Environment

The design environment would be used by non end users to create the on device and the cloud based apps.

The environment is simple to use, using a rule based visual drag and drop interface. This is inspired by the Scratch visual programming environment that Allan reimplemented to teach coding to 10 year old pupils.

Apps are created and then deployed automatically to the required device. Multiple apps can run simultaneously on a device.

Web based apps are created by dragging very simple building blocks in the visual programming environment, For example dragging a screen block, and then dragging a list block into the screen, and setting the list property to show a certain data could create a page or tab with a historical list of some sensor data. Dragging a chart icon would show a histogram rather than a tabular list, etc.

Primitive drag-able objects for the application include both individual and group primitives.

The social capabilities emerge from the use of simple opt-in groups that share analysed sensor data across the members.

Associated simple interfaces allow device owners to opt in to create group, and or become a member of a group.

A strong opt-in permission model ensures end user confidence that sensor data can only be accessed by an application they explicitly approve.

In a similar way, summarised or analysed data from a user would ever only be able to be shared with a group after explicit joining of a group by the end user, along with explicit opt-in release of very specific stream of data to be shared within the group.

The familiar opt in, app download model used on mobile devices should be familiar to end users.

Just like mobile devices, there is a familiar granting of permission for an app to be allowed to use a specific sensor capability. Likewise each opt-in online app will have the user grant permission to release a set of sensor data for use in the online app, and potentially for sharing with other group members in a shared social app.

Manufacture

Allan would hand assemble the few prototype devices, and send on.

All design documents such as parts lists, PCB files, gerbers, firmware for loading onto the device would be provided. It is expected that the firmware would be provided by the CPU chip manufacturer in the USA for pre-loading into the CPU. This programmed CPU would then be sent to the assembly house, with the firmware device operating system all ready safely loaded into the device. Thus the firmware is not accessible to the assembly house.

The firmware would remain with the USA chip manufacturer, and all account passwords for this firmware provided to metta.org

Small scale outsourcing

A priority will be to select an outsource assembly house that is able to complete small orders. It is anticipated that the smallest order would be 50 units, with likely volume several thousand devices.

Tooling and Testing

Once a prototype development was completed, Allan would also make test jigs for use by the device assembly manufacturer. Any additional manufacture tools, such as device testing, burning a unique device identifier into a device etc would be made and provided to the assembly house.

Finance

At a high level Allan would provide prototypes and all files and a non public test infrastructure deployment to this group etc.

Then all resources would be provided ready to go to an external outsource manufacturer and assembly houses.

The actual purchase, financing of devices, and operation and expense of online server infrastructure, would not require to go through Allan in any way.

Transparent costing

Allan would provide Bill of Material for the devices to support an understanding of the hardware costs. This will be based on quotations from two reputable US based component suppliers, and from quotations from any other source. Printed Circuit Board manufacturers, and assembly house will be based in USD from chinese suppliers. Allan is not familiar with USA assembly house costs.

Price fluctuations

Price fluctuations and availability changes of components should be anticipated, and allowance built on top of the BOM cost quotations.

Exchange rate movements

It is possible that exchange rate movements will vary the device cost, although most chinese assembly manufacturer provide quotation in USD.

Operation

Operation of the infrastructure for the online servers, for secure storage of the sensor data stream will not be undertaken by Allan.

Allan will provide indications of server hosting costs from two USA based organisations, and will deliver a ready to go cloud based server.

Portal requirements

The online infrastructure to support the portal and online apps is based on a modern stack. As much as possible this will be documented, but it may be wise for metta.org to locate an in house resource fluent in deploying and operating cloud based services.

Structuring based on the expectation that Allan will not operate the portal is not so much to avoid Allan providing support, but is to ensure that the platform is capable of operating regardless of Allan's availability of time and remaining breaths.

Legal

Allan is open to suggestions of appropriately legal structure and agreement.

Legal IP protection, and in depth confirmation that unknown other IP has not be infringed has not been conducted by Allan.

It would seem easy and useful to clearly agree on IP ownership, use of software etc at the beginning of the project, rather than at a later date when a relationship may be less active or non operational.

Allan is very comfortable having a focus on termination or relationship separation agreements in advance.

Source code

Allan is expecting to provide complete set of any and all source code for the hardware devices, firmware operating system, app development environment servers, and supporting infrastructure.

Given that Allan would be using this platform for other ventures, this source would be provided on a non exclusive understanding. It may be that a restraint is entered into to allow only metta.org exclusively to directly market the device to meditation domain.

All on device apps and social web apps would be developed on the platform by metta.org, and remain metta.orgs exclusive property.

Use of tools

It is worth noting that a large proportion of all source code on the platform is not manually written by Allan, but is generated by an application Allan coded.

Allan would of course provide a full working copy of the program that generated this source code, and this would include source code for the generator program.

Allan is unsure of the correct legal terms, but a license to use but not distribute the generator, but not own or control the generator would enable Allan to retain freedom to enter into his own endeavours, while providing metta.org with all required software used in producing the source code for the platform.

Security

End user perception of security is likely to emerge as a key concern, especially given the personal nature of data streamed from sensor devices.

It is suggested that visibility of security is intentionally made obvious, perhaps even at the risk of ease of usability. If the whole platform were seen to be a little bit over the top, in terms of granting permissions, and security, this could build end user confidence and peace of mind.

This leaning to favour security over usability is opposite to the simplicity and usability drive that pervades the platform in non security areas.

Avoiding sensitive personal data

The best way to ensure security of end user data is to not collect it. Where possible it should be attempted to avoid user specific information. This may lead to a design on online apps that use pseudo names, and not real names for example.

It is suggested that at every stage, it is questioned if personal information could be avoided.

In a similar way, data should only be streamed of the device with a preference for the most abstract, aggregated form. For example collecting the deviation of heart rate, rather than a complete set of all heart rate readings would be favourable.

Best practise

Standard best practise will be followed on the platform. Details of this can be provided in a separate future document.

Web portal

In addition to best practise implementation of security, it is suggested that users authenticate onto the platform using higher than typical user name and password.

A user could be required to authenticate with two factor authentication, such as a short term TXT code sent to the user. Or the user could be required to prove that they have something, by entering a requested series of 4 digits from a grid of numbers delivered with the device to the end user.

Device sensing and granting permission

An opt-in granting of permission would be required before any user chosen application is installed on their device.

This would be made as simple as possible, so that the user maintains a string sense of control over their sense data.

The end user would select from a list of available apps created and maintained by metta.org on the online cloud portal.

Data communication cryptography

All communication of streaming sense data from the device to the server that stores the data, and delivers the online applications will be cryptographically secured.

In addition, it is suggested that all data streamed is secured by a streaming cypher, with the key being provided from a list of keys on the device.

It is possible to store a long list of unique keys that is ever only used once on the device. A similar system is used to secure transmission of nuclear launch codes to submarines.

This use of a one time pad on the device to secure the streaming data is effective at shifting the time when the secret keys between the server and device are exchanged.

Typical browser security exchanges keys as part of the initial HTPS connection, right at the start of data transfer.

Sharing a large list of keys between the server and the device provides an additional level of security because all data that is sent between the device and the server uses not just the traditional secure HTTPS web protocol. But in addition all data that is sent is encrypted using a shared key and password that was agreed upon and stored on the device when it was manufactured.

I will try to simplify this description of the use of an additional security step over and above the usual HTTPS users are used to using for their online banking.

In short, the use of the one time session key stored on device, allows a one liner sentence honestly stating that the communication between the device and the server uses not only the security used for online banking, but the security used to protect sending launch instructions to nuclear submarines.