Augmented Reality Modelling Language Interface for Mobile Healthcare Devices

The ubiquity of personal smart hand-held devices make them a natural fit for real time pervasive computing. There is high penetration of these devices in urban areas. Another interesting trend is the increase in elderly citizens living in urban areas. The provision of accessible healthcare to this ageing population with shifting demographics requires special attention. In 2008, the elderly population (greater than 65) made up 16% of the UK population. This group is projected to rise to 23% by 2033 [14] mainly due to declining birth rates and increased life expectancy.

Geriatric patients are over-represented in terms of their consumption of medical services [5] and there is a drive to fix the poorly coordinated and fragmented healthcare provided to the elderly, and discontinuity between hospital and home care [10]. The recent Personal Care at Home Bill passed in March 2010 highlights Government's efforts to bridge this gap. All of the above are supportive of the need for greater emphasis on technological intervention to address problems with elderly care including inconsistent access to medical records, incomplete diagnostic information, lack of patient engagement, and poor integration of disparate healthcare systems.

Challenges:

1. Observation Bias: In situ monitoring of a patient might not yield clinical results. This is because a relationship exists between the patient's environment and patient's condition. For example, data collected while monitoring a patient within the time constraints and artificial environment of a hospital would vary from data collected over a long period of time, during the patient's daily routine. This variation needs to be quantified and staff would need additional training on how to interpret results.
2. Low-power wireless sensors: For example, Bluetooth communications protocol fail the test when it comes to battery-related issues such as power consumption and length of use before recharging becomes necessary versus ZigBee and international standards like IEEE 805.15.4. However, the soon-to-be-released Bluetooth low energy (Ble) is an attempt to address this challenge.
3. Interoperability: Wireless Body Area Network (WBAN) systems need seamless data transfer across standards such as Bluetooth, ZigBee etc. to promote information exchange, plug and play device interaction. Further, the systems need to be scalable, ensure efficient migration across networks and offer uninterrupted connectivity. One also needs to take into account the fact that most mobile devices do not follow standards for fixed screen sizes, processing power, memory and other hardware constraints [9].
4. System Devices: Device usability is critical for our demographic. It is also crucial that the sensors used in WBAN are small in size, light-weight, easy to use, reconfigurable, and have space reserved on the wireless spectrum for them. In addition, the storage devices need to facilitate remote storage and viewing of patient data as well as access to external processing and analysis tools via the Internet.
5. System and device-level security: Considerable effort would be required to make Body Area Network (BAN) transmission secure and accurate. A patient's data must only be derived from that patient's dedicated BAN and never mixed up with another patient's data even in densely populated urban areas. Furthermore, the data generated should have secure and limited access.
6. Confidentiality and privacy: Users prefer choice with respect to switching these devices on/off [11]. An option for incognito data collection currently does not exist but would be necessary to gain wider social acceptance. For example, a patient might be comfortable with their medical data being monitored anonymously for public health initiatives or encrypted with only their general practitioner able to review this information with a passkey from the patient.
7. Data validation: Pervasive sensing devices are subject to inherent communication and hardware constraints including unreliable wired/wireless network links, interference and data residing on multiple devices. This may result in incomplete datasets being transmitted back to the end user. Data validation helps reduce false alarm generation, degradation in quality of care, and to identify possible weaknesses within the hardware and software design [3][4]. Information fusion and topology control mechanisms resolve many of the problems in this space.

To tackle some of these challenges, I have submitted a doctorate proposal to design and build a system that provides augmented health information to patients and their health providers. Multi-modal interaction with this system must be intuitive and robust including a gestural interface option. Information can then be displayed across multiple surfaces and platforms. Using the dimensions described by Bengisu Tulu et al [3] to define a proposed system (i.e. the purpose, application area, environmental setting, communication infrastructure, delivery option and desired outcome), the aim is for a system that monitors geriatric patients in home/mobile environments using mobile phone 3G and other wireless considerations to transmit medical data to the patient and to health centres in order to augment patient care by providing quick and efficient medical information to the patient and relevant healthcare providers.

Key steps are remote data acquisition, distributed processing (including data normalisation and storage), data transmission and data presentation. The devices to support this include a biomedical sensor, processing server, distribution server, display projector and a web client.

With respect to presentation, the European Standardization Committee has developed a standard for the representation of vital signs information [13]. Although this standard is intended to enable interoperability among different manufacturers' devices within a hospital setting, the data format may be amenable to use in remote monitoring environments. A robust display framework should also make provisions for data presentation on multiple platforms including projector displays, wap (wap wml device), sms (gsm phone), and http (web client). In addition, animated 2-D and 3-D topographic maps can be used [12]. It should also integrate different views of the same medical recording or dataset and the ability to easily switch between these is an important aspect of medical diagnosing.

Multi-modal interaction (including gestural) with this device is a desired feature in order to improve accessibility - a major issue within this demographic. W3C working groups' and Sixth Sense (by Pranav Mistry and Professor Pattie Maes of MIT) developments can contribute to setting the standards required for gestural interaction with respect to mobile healthcare devices.

Finally, as remote monitoring becomes widespread, we anticipate that clinicians and other care providers will be overwhelmed with data. Thus, an important aspect of work is to explore how best to represent this data e.g. sonification and projector displays. Another important challenge is to automatically identify important medical events that should be brought to the physician's attention; helping patients monitor their own conditions.

<u>*Conclusion:*</u> For me, this workshop lays the foundation of what can be done to leverage technology to pass on the benefits of telemedicine [9] to an increasingly ageing population including:
• Gestural interface standards for accessible wireless healthcare
• Biomedical sensor system design for monitoring and displaying physiological signs
• Engineering of interactive sensor-driven applications
• Better accessibility of patient data and doctors' recommendations
• Time saved in travel or reaching the doctors and faster communication with relevant people
• Increase patient engagement which results in greater self-awareness and better disease management.

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