Preface

‘Aging’ is a process of becoming older; in humans aging refers to multidimensional changes in various aspects of life like physical, psychological, biological and social changes gradually over time. Demographics reveal that population aging is widespread across the world and the number of elderly is growing at very fast rate. In fact according to United Nations ‘World Population Aging’ report (2013) the number of elderly individuals aged 60 years or over were approx. 202 million in 1950 and accelerated to 841 million in 2013 and it is expected to get triple by 2050. Aging associated diseases are mainly related to complications arising from senescence and is different from the aging process itself. These aging-associated diseases as stated in open literature, include cardiovascular disease, cancer, type-2 diabetes, Parkinson’s disease, arthritis, cataracts, osteoporosis, hypertension, loss of hearing, etc. The probability of occurrence of all or some of them increases rapidly with aging and in case of cancer increases exponentially. It is estimated that up to 90% of the death developed worldwide is age-related origins (De Grey, 2007). However, it should be noted that even without any serious disease, age clearly affects the mobility of the person, so, the world’s efforts to prevent and effectively treat the acute diseases in general must include the elderly population and take into account their special needs and concerns.

Recently, various researchers have directed their interest towards utilization of the advancement of technologies and ICT to assist and improve the lives of the elderly individuals in their daily routine, such as walking, communicating, eating, sleeping and self-awareness etc. The term ‘Aging Assistive Technology’ was then introduced by researchers in the field and it basically describes the different types of medical or non-medical equipments as well as the procedures and the general practices that need to be implemented to assist the seniors with disabilities or serious diseases (Deines-Jones, 2007).

Generally, the definition of assistive medical device is any equipment to assist the agility of people and designed specifically to help them to cope with their limitations and or disabilities. The design and advancement of these devices depend largely on state of the technologies and the ability of the designers to implement them on a cost effective way for various applications to mitigate difficulties faced by the elderly population. It is worth noting that a large problem arises due to the lack of ‘know how’ of elderly individuals hence there is always a need to educate and train the elderly on the use of the devices in hand and their potential benefits to them (Hoffmann & McKenna, 2004). If there is no sufficient training and familiarity with the devices then ‘mismatches’ between the capabilities of the devices and how effectively being utilized can lead to frustration and mistrust and total discard of the devices in hand all together. Applications of aging assistive advanced technologies like ICT technologies, tissue engineering, stem cell advanced etc. can not only make life easier for elderly population who need help carrying out their daily activities but also improve their quality of life, safety and keep the feeling of self-reliance in them (Charness, 2003). It worth noting that most medical devices designed to assist elderly at home, work or outdoor activities, leisure, shopping etc and generally for daily living activities.
THE CHALLENGES

It is well documented that the advancement of information technology, CAD, material science, bio-manufacturing, and tissue engineering combined with stem cells have encouraged designing cost effective and innovative devices of high efficiency and durability to assist the elderly with and without diseases (Krishan et al. 2010; Morsi et al., 2010; Morsi, 2011). Nevertheless researchers in this field still need to deal with the challenges that exist in the new era. Such challenges can be divided into four categories (Mollenkopf & Fozard, 2003):

1. The challenge of establishing confidence of elderly people to use information technology and train them on the usability of new devices.
2. The challenge of establishing good data base and management practices of elderly people for a given geographical environment worldwide.
3. The challenge of implementing new research findings and convert them into a useful product to advance current technology of aging assist devices.
4. The challenge of establishing a mechanism of technology transfer between the research establishments, institutions and the manufacturing industries

Although, there is sufficient ongoing research to effectively address these challenges, still there is a problem of understanding exact needs of senior citizens and how to educate them to use information technology to help them carry out their daily activities by themselves and achieve semi or total independence. The book aims to introduce the new development in IC technologies, stem cells and bio-manufacturing techniques associated with assistive technologies for the elderly to encourage independent living, improve quality of life, easy health monitoring, increase social contact, social support, social participation and mitigate challenges faced by them in using these assistive technologies/devices.

ORGANIZATION OF THE BOOK

The book is organized into three sections consisting of total sixteen chapters, section-1 ‘Mitigating Challenges in Elderly Population’ consisting of chapters 1 to 5, section-2 ‘Optimizing ICT Technologies for Aging Society’ consisting of chapters 6 to 10 and ‘Elderly Healthcare’ consisting of chapters 11 to 16. A brief description of each of the chapters follows:

Chapter 1 describes benefits of computer applications, and problems faced by the elderly people using them. In the chapter, authors discuss and provide recommendation to mitigate challenges faced by application developers to make the computer applications more friendly (easy to use) for the elderly users considering their age-related impairments, cognitive challenges, generational differences in computer use, and the hardware constraints posed by mobile devices.

Chapter 2 describes elderly health conditions and their driving behaviours, existing vehicle systems with safety mechanisms, and need for optimizing existing vehicle system to provide safer and more enjoyable driving experience for the elderly drivers. Author states that driving-related injuries associated with the elderly drivers are on the rise which can be mitigated by designing smart technical system in vehicles targeted to the elderly drivers.
Chapter 3 presents advanced robotics and ICT fields as an effective solution to address specific societal problems to support ageing and independent life. In the chapter, authors underline the barriers of the state of the art and share their experiences gained at RoboTown Living Lab of Scuola Superiore Sant’Anna, Italy to overcome these barriers. They also highlight the trend of development from stand-alone solutions to cloud computing architecture and emphasize on robust, low cost, customizable, flexible, optimized solution.

Chapter 4 describes use of wearable robots to assist the elderly in rehabilitation and get them back to their normal life and enhance the independent living. In the chapter, authors have proposed an optimized, user friendly, simple to use and easy to control hand exercising exoskeleton called ‘Exorn’ to assist the elderly in rehabilitation/tele-rehabilitation and physical exercises recovery process.

Chapter 5 defines cognitive fitness, explores advanced cognitive assessment techniques, explains cognitive rehabilitation of the elder population, and provides recommendations to improve existing cognitive tools. The chapter, also summarizes/revises the latest years of research on cognitive tests and interventions, and incorporates the added value of the latest developments in computerized and virtual-reality based assessment and training tools, to respectively measure and improve cognitive status in elder population.

Chapter 6 explains importance of wearable assistive devices to support the elderly people. It also summarizes and reviews the current state of wearable assistive devices, formalizes the current design practice with respect to user needs, and presents design considerations such as wearability and usability, in order to assist in the future development of wearable assistive devices for the aging population.

Chapter 7 introduces design procedure of Ambient Assisted and Monitored Living (AAML) systems, and their main challenges such as user’s needs centrality, data visualization, data privacy, and dependability. AAML has several advantages, for subjects/individuals improving quality of life by independent living and enhancement of social, working and physical activities; for their families, reassuring them about their beloved’s safety; for the caregivers, enabling them to provide prompt interventions.

Chapter 8 proposes a proximity-based social communication tool for the elderly with six main features which are proximity, proactivity, less content more contact, visual map-based interface, gamification of support, and personal assistant. The tool can help improving social life of the elderly by increasing social contact, social support, social participation and communication, and thus can promote better quality of life.

Chapter 9 presents a versatile wired and wireless distributed e-home healthcare system by exploiting the benefits of body sensor network and information communication technology. The dedicated system model methodically integrates some of the comprehensive functions such as pervasive health monitoring, remote healthcare data access, point-of-care signal interpretation and diagnosis, disease-driven uplink update and synchronization (UUS) scheme and emergency management to design a complete and independent e-home healthcare system.

Chapter 10 demonstrates technical feasibility and medical effectiveness of personalized services and care programs for Parkinson’s disease, based on the combination of mHealth applications, cooperative ICTs, cloud technologies and wearable integrated devices, which empower patients to manage their health and disease in cooperation with their formal and informal caregivers, and with professional medical staff across different care settings, such as hospital and home.

Chapter 11 reviews evolving paradigm of stem cell therapy and tissue engineering approaches for clinical application and explores its implications. Authors of the chapter state that, incidence of cardiovascular disease (CVD) in adults are increasing worldwide with impaired repair mechanisms, leading to tissue and organ failure. Recently, stem cell therapy and tissue engineering have captured the attention.
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of clinicians, scientists, and patients as alternative treatment options. The overall clinical experience of these suggests that they can be safely used in the right clinical setting, but, large outcome trials will have to be conducted to assess their efficacy.

Chapter 12 describes necessity of Ventrilcular Assist Devices (VADs) for the elderly population. VADs are considered to be the part and parcel to those people who have cardiac complications or heart failure especially the aged patients. In the chapter, authors provide analysis of different kinds of VADs available today with their working principle, advantages and disadvantages. Authors recommend that there is need to develop a ‘next generation’ VAD with advanced features to overcome limitations imposed by existing VADs.

Chapter 13 introduces a novel non-invasive technique for monitoring of human heart functioning through speech analysis. In the chapter, authors state that formant frequencies of speech reflect physiological features of the human body, and a correlation exists between electrocardiogram cycle and acoustical cardiogram cycle obtained from formant frequency analysis of speech signal. Various heart parameters like RR-cycle duration, heart beat rate, systole cycle etc. can be determined from acoustical RR-cycle which can be used for monitoring of human heart functioning.

Chapter 14 presents client-server architecture based pervasive, online, easy to use, automated classification system based on Artificial Neural Network using Feed Forward Back-propagation Algorithm for Parkinson’s disease diagnosis by analyzing gait of a person. Authors have trained, tested and validated the system by a gait dataset consisting data of Parkinson’s disease patients and healthy persons, and evaluated the system based on several measuring parameters like sensitivity, specificity, and classification accuracy.

Chapter 15 presents computer aided diagnosis system for breast cancer detection using mammograms. In the chapter, authors present a method to convert mammogram image to digital image, and apply several techniques on it like detecting cell, filling gaps, dilating gaps, removing border, smoothing the objects, finding structures & extracting large objects, and finally determining granulometry of tissues without explicitly segmenting. Digital mammograms processed with this method appear more familiar to radiologists and naturally close to the original mammograms compared to existing multiscale enhancement approaches.

Chapter 16 presents cancer disease detection system which incorporates quantum computing (Shor’s algorithm) with hierarchical clustering algorithm for implementation. In the chapter, authors state that presently the detection procedure is very time consuming and not accurate, in this respect there is a need of more accurate, fast and efficient method through computing technologies. Adaptation of Shor’s algorithm helps to increase accuracy, and hierarchical clustering technique helps to detect the stages of cancer.

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