INNOVATION CENTRE DENMARK • MUNICH
THE TRADE COUNCIL • EKSPORTRÅDET

DANISH ASSISTIVE SOUND

REPORT ON SOUND AND HEALTH IN DACH

December 2014

Innovation Project Report
In collaboration with Danish Sound

TABLE OF CONTENTS

1. INTRODUCTION

The Innovation Centre Denmark, Munich, is pleased to submit its findings regarding Sound and Health as part of the Innovation Project Assistive Sound Technology in the DACH region and for the Innovation Network Danish Sound. The report describes the result of the research process based on the previously defined criteria.

The executive summary in section two highlights the overall findings of the Innovation Project. In section three, a background of the German MedTech industry and especially the sector concerning Ambient Assistive Living (AAL). The latter will be elaborated in section four. Section five provides an overview of the relevant clusters, networks and research alliances. This opens an evaluation of the possibility of collaborations in section six. Sections seven and eight focuses on research and projects within Health and Sound, AAL and monitoring, including an outline of the most notable projects and companies responsible for the realisation. In conclusion the report gives recommendations for further actions.

2. EXECUTIVE SUMMARY

Medical technology is one of the largest and most important segments in the German healthcare industry. This sector is characterised by a strong capacity for innovation and the long-term orientation of many small and medium sized family businesses. These two factors for success have transformed Germany's medical technology into a globally recognised industry.

The combination of sound and health, however remain a niche market, characterized by a high degree of research and project collaborations. These seek to narrow in and establish new competences, products and markets within the cross-segment of sound and health. Lower Saxony has proven to be the lead federal state within this segment displaying a high density of research institutions, networks and enterprises. Most of the actors of relevance are members are the Auditory Valley Cluster located in Oldenburg (see figure 2).

In regards to sound, the majority of businesses are concentrated in the segments of devices for impaired hearing (Phonak, Siemens, Kind), sound output electronics (Bose, Sennheiser) or noise cancelling technologies (Aixfoam, OrgDelta, Graner + Partner). Within the application of sound in healthcare technologies Germany has a longstanding tradition within ultrasound; a competitive though fairly saturated market around Siemens Healthcare, GE Healtcare, Esaote). Sound, health and diagnostics are tightly connected in this industry.

In the scope of this report especially the research groups, institutes and alliances of Max-Plank-Institutes and Fraunhofer are of importance. Innovative and highly technological combinatory research projects aim at combining sound- and health technologies in order to create new assistive technologies, monitoring solutions and diagnostic devices. A range of the identified institutes are located in Lower Saxony.

In other industries however, the cross-segment of sound and health represents a minor part of more pervasive business areas which are centred on assistive technologies. The most outstanding of these is AAL. This sector is due to its relation to demographic change highly funded by the federal government and due to its cross industry nature, likely to spawn evermore innovative solutions combining sound and health.

The report at hand seeks to provide an overall view of sound and health by highlighting AAL thematically and the Auditory Valley geographically. This is done on background of the factors outlined through the report.

3. BACKGROUND

The demands on medical treatment and care are rising steadily, not least due to the demographic change in our society. Previous findings on the demographic change can be found in the Innovation Project "The German Megatrends" from 2013. This is why the corresponding fields of research and development – public and private – in Germany are making an increased effort to find new, effective and practicable approaches for enabling people to lead as healthy a life as possible in old age. By doing this, several industries are combined aiming at the development of new technologies which can be applied in our daily lives.

The Program "Human-computer interaction in demographic change" of the Federal Ministry of Education and Research (BMBF) addresses these new technologies in an interdisciplinary research and action approach. The publication was made on March 7th 2013 on the basis of the research program "ICT 2020 - Research for Innovation" in the frame of the federal High-Tech Strategy 2020 and aiming at the implementation of the research agenda of the Federal Government for demographic change under the title "Age has a future".

The human-computer interaction (short: "MTI" *Mensch Technik Interaktion*) refers to a heightening of life quality through the design of technology. The term characterizes the change in the use of technology from simple device operations towards "attentive" and assistive technologies. Technique is thus increasingly transgressing from being a passive instrument to become an active partner or companion of the user. The human-technology interaction draws on various technological disciplines, which combined and merged result in a new quality of technology use.

The six focus areas of the federal research agenda are:

1. Principal issues in a society of longer lives
2. Benefitting from skills and experience of the elderly in economy and society
3. Growing old in good health
4. Social inclusion: Staying mobile and in touch
5. Living safely and independently
6. Good nursing care to boost the quality of life

Even though AAL directly addresses issues concerning demographic change and the ageing in society, the technological outcome can be expected to influence a range of other industries. Furthermore, due to previous hallmarks within assistive technologies like hearing devices and voice controlling technologies the combination of sound and health have proven to be a successful matchup which also in the future will display considerable advances. There is arguably innovative potential in merging industries; assistive living, ambient technologies and diagnostics all emerge from the interdisciplinary of segments.

4. MedTech in Germany: Sound and Health

Global demand for innovative medical technology solutions continues to grow as we live longer, healthier lives. "Medical devices made in Germany" make a significant contribution to enhancing patient healthcare and quality of life around the world. Medical technologies developed in Germany benefit from a world-class research and business environment, with the sector's predominantly small and medium-sized companies enjoying an international reputation as innovators and market leaders. Figure 1 shows the density of MedTech enterprises in Germany. As of 2014 the German medical technology sector has been visible and connected on the web based platform MedizinTechnologie.

Diagnostics through sound technologies are focusing on ultra sound or the recording of minute pivotal changes in physiologically generated sounds (in example respiration, blood flow and heart beat). Preventive technologies on the other hand are focused on providing solutions to well-known diagnosed pathologies. These solutions might very well be from the sound-technology segment of assistive technologies. An example of this is found in ambient living. We now understand that noise pollution especially in the cities is a problem that needs to be faced. This calls for solutions that can minimize noise, create contra-sound, and transform waves.

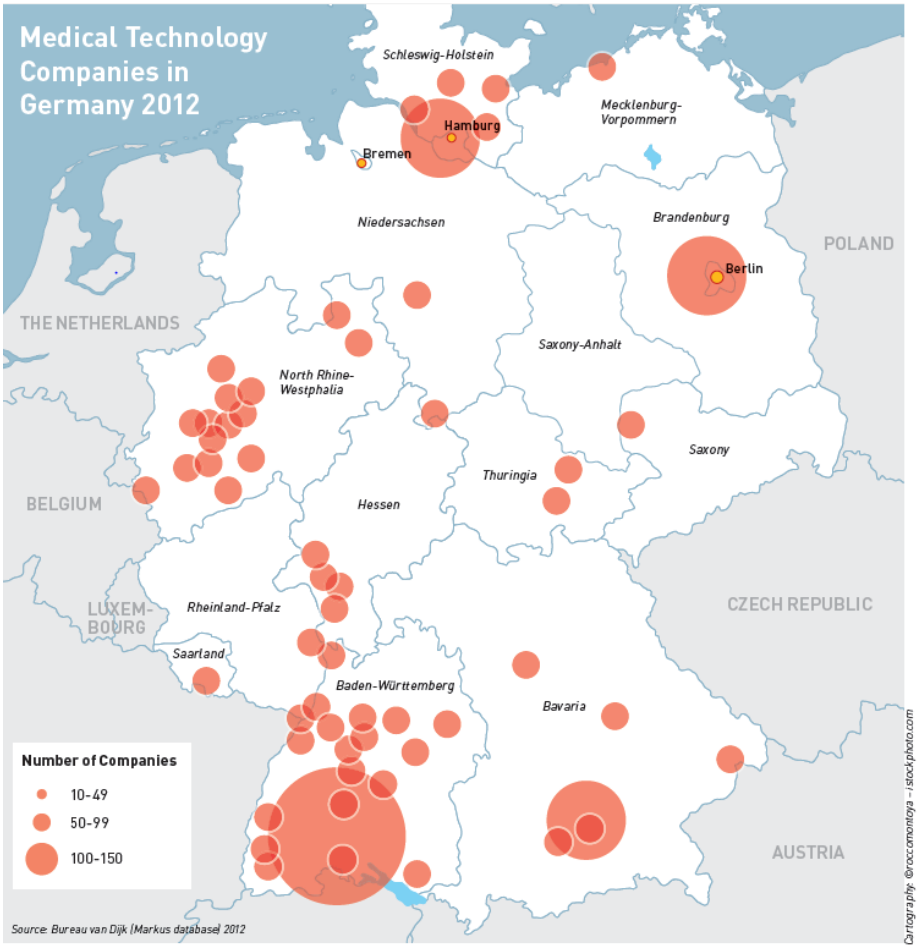

Figure 1: Density-map of MedTech enterprises in Germany.

5. Clusters, Networks and Research Alliances

The following is a collection of networks and cluster of relevance when looking at assistive technologies, diagnostics and sound. Oldenburg, Bremen and Hannover constitute a geographical triangle that demonstrates a high density of research, enterprises and clusters working within these or directly related themes. Most of them are members of the Auditory Valley, which on a German scale, constitute the most important part within the scope of this paper.

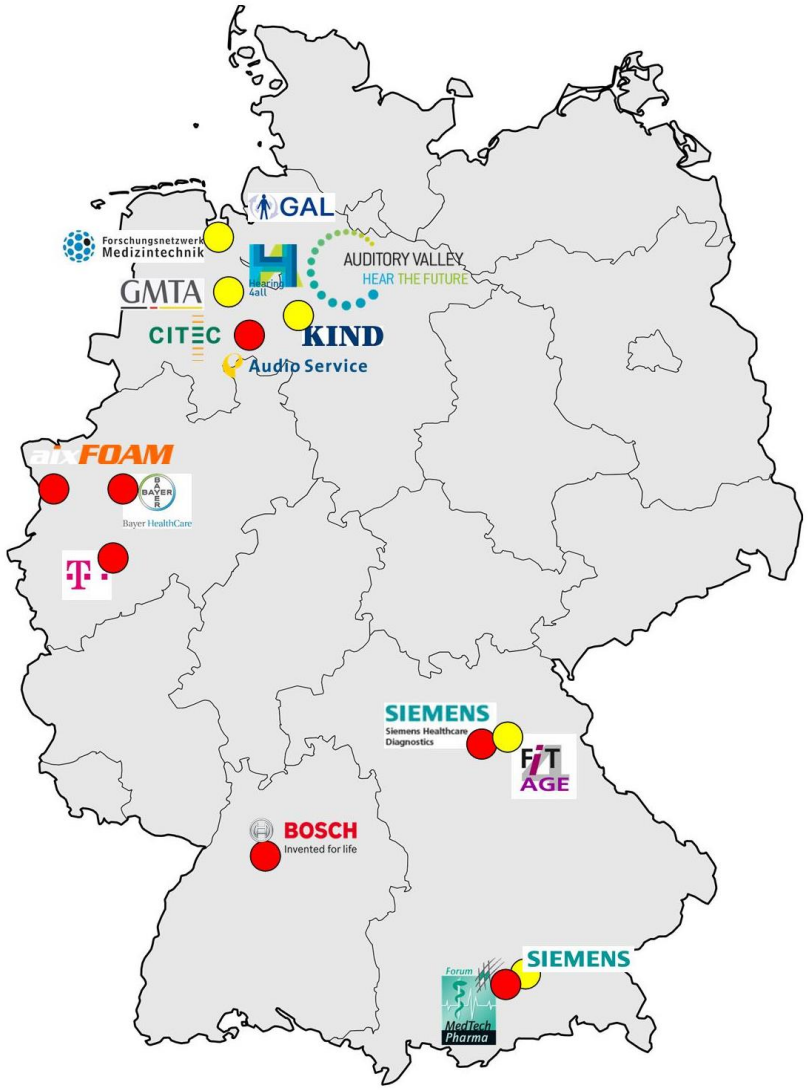

Figure 2: This figure highligst the auditory valley in Lower Saxony. Additionally the location of some of the major players is marked.

Note that the German medical technology companies which are mapped on Figure 1 are not as present in the federal state of Niedersachsen as in the rest of Germany, especially the south-western region, which also proves the highest purchase power. Most of the major enterprises and the patent registries per anno are to be found in this region too.

Auditory Valley - Oldenburg

The Auditory Valley has taken it upon itself to make it easier for people suffering from a minor or moderate hearing impairment to be able to get hearing aids as well. Another important subject is raising people's awareness of the potential danger in certain hearing situations, and ways to prevent it. In the Forum for Partners & Friends, we work with several institutes and corporate groups to make our goal "Hearing for all" a reality. Forum members receive newsletters and professional information on a regular basis, and have the opportunity to attend conferences, cultural events and exhibitions about hearing.

Hearing4all - Oldenburg

Hearing4all is part of the Auditory Valley. The aim of the interdisciplinary cluster of excellence is to support hearing for all. This aim is of great importance, given that 18 percent of the German population – in particular, more than 50 percent of those above 65 years of age - has a hearing impairment requiring treatment. With better individual hearing diagnostics, individualised hearing aids have become possible. Using such individual support facilitates communication for the hearing impaired in an essential way – be it at work, in traffic and at home. To reach this aim, innovative concepts for hearing aid and hearing implant processing will be developed, helping not only the severely hearing impaired, but everybody by putting an individualised "hearing aid" into every smartphone, TV set, and stereo.

Altersgerechte Lebenswelten - Oldenburg

The GAL research Network located in Lower Saxony is about the Design of Environments for the Ageing. The aim of the Lower Saxony research network is to develop information and communication technology for the production and maintenance of quality of life, health and self-determination in the second half of life by means of:

1. Identification of new methods of information and communication technology for senior-friendly lifestyles, develop and evaluate (content objectives) and
2. Enabling of the relevant research institutions in Lower Saxony in the position of being able to participate in the lead larger national or international research project on this topic

The research network GAL is supported by the following organizations: OFFIS - Institute for computer science (Oldenburg), Technical University of Braunschweig, Hannover Medical School, Carl von Ossietzky University of Oldenburg, Center HörTech (Oldenburg), Fraunhofer Institute for Digital Media Technology, Department of Hearing, speech and Audio Technology (Oldenburg), Center aging and Society at the University of Vechta, University of Osnabrück, Research Group Geriatrics at the Charité (Berlin), University of Jena, Klinikum Oldenburg, St. Boniface Hospital Lingen.

Fit 4 Age - Erlangen
The aim of the research network is to find technical solutions that maintain the aging people in apartment and house, at work and in communications with the environment and transport an active and affordable life, even though the average age of the population continues to and same time, the number of able-bodied, younger people decreases. Big players (BMW), pharmacies, voice-solutions are together in this network

Forschungsnetzwerk Medizintechnik - Oldenburg
The aim of the research network is to combine this expertise and synergy to call inter-university research projects in cooperation with the business community to life. The network medical technology has promoted the cooperation between universities, clinics, and medical technology companies and supported. Because the concentration of interdisciplinary skills, a mutual exchange of knowledge and the sharing of resources make it possible to explore complex technologies and successfully develop new products.

Forum MedTech Pharma - Munich
Forum MedTech Pharma is a charitable non-profit making association - incorporated society. The network is forming a unique platform for business contacts and knowledge exchange. They successfully facilitate innovation and co-operation in the medical sector.

More than 600 members are involved in the Forum MedTech Pharma, i. e. companies, research institutes, clinics, health insurances, regional authorities as well as other actors in the field - from 15 countries out of Europe, America and Asia. Their topics cover an extensive agenda on the latest trends in medical technology and pharma: biomaterials, diagnostics, clinical trials, minimal invasive medicine, health telematics and health care system.

German Medical Technology Alliance - Berlin
As a trade association, BVMed promotes and represents the combined interests of the medical technology industry and trade companies. The association offers its members a platform for a constructive dialog and exchange of views in various working groups. Through public relations work and by participation in the development of laws, guidelines and standards, BVMed represents the concerns of its member companies to policy makers and the public in general.

BVMed represents more than 230 industry and trade companies. Among the members of the association are 20 of the largest medical device manufacturers worldwide in the consumer goods sector. Its scope comprises the entire sector of medical dressings, technical aids such as ostomy and incontinence products or bandages, plastic disposable items such as syringes, catheters and cannulae as well as the implants sector of intraocular lenses, hip, knee, shoulder and spinal implants, heart valves and defi brillators and even artifi cial hearts. Homecare services and

biotechnology procedures, such as tissue engineering, are further fields of activity of its members.

German Medical Technology Alliance (GMTA) - Oldenburg
Besides coordinating partners from medicine, science and industry GMTA offers medical device companies assistance with research controlling, in the preparation of business plans, market and risk analyzes as well as certification and licensing procedures of medical devices. The cost and time of registration procedure is always connected in particular for the many small and medium-sized companies in the industry with a financial risk.

The Medical Valley - European Metropolitan Region Nuremberg (EMN)
The Medical Valley is one of the most economically powerful and scientifically active medical engineering clusters in the world. Renowned partners from industry, research, healthcare and politics have come together to form an interdisciplinary network. Medical engineering products and services are currently being developed in over 40 projects. These products and services are aimed at making prevention, diagnosis, treatment and rehabilitation in connection with a variety of illnesses more efficient and more effective.

Medical Valley provides ideal conditions for intensive education and research. 18 institutes of higher education with 90,000 students, 9,000 graduates and 1,500 doctorate students form the region's broad scientific-cultural foundation.

All stakeholders are ideally networked in the Medical Valley EMN. The year 2010 showed just how outstanding the structures are: the German Ministry of Education and Research (BMBF) chose the Medical Valley EMN as a national Leading Edge Cluster upon its application as a "Center of Excellence for Medical Engineering"

Activities in the cluster and communication among the stakeholders is coordinated by the Medical Valley EMN Association, which also supports its members with numerous services.

6. Cross Border Collaboration

The German Healthcare Partnership (GHP) is a joint initiative of the Federation of German Industries (BDI) and the Federal Ministry for Economic Development and Cooperation (BMZ) within the framework of develoPPP.[1] The overall goal of this strategic partnership is to improve access to quality assured healthcare services in developing countries and emerging markets adopting a holistic approach. By combining the specific strengths and resources of private companies with those of public organisations in development cooperation, GHP allows for valuable synergies in the development of customised solutions offered from one hand. Currently, about 20 internationally leading providers of healthcare products and services are active members of GHP, covering a wide range of German expertise in healthcare Ð from consultants for efficient healthcare solutions, architects and engineers specialised in health facilities, suppliers of state-of-the-art medical equipment to hospital management and medical education.

The next section present the identified research groups, institutes and alliances which are at the scientific forefront in the field of Sound and Health research. Some of the institutes are selected due their belonging to the Auditory Valley, even though they might focus merely on either sound or health.

[1] develoPPP.de was set up by the German Federal Ministry for Economic Cooperation and Development (BMZ) to foster the involvement of the private sector at the point where business opportunities and development policy initiatives intersect.

7. Important Research Institutes Health & Sound in Germany

During the last years, music has increasingly been used as a tool for the investigation of human cognition and its underlying brain mechanisms. Music is one of the oldest, and most basic socio-cognitive domains of the human species. It is assumed that human musical abilities played a key phylogenetic role for the evolution of language, and that music making behaviour covered important evolutionary functions such as communication, cooperation, social cohesion and group coordination. Likewise, it has been shown that, ontogenetically, infants' first steps into language are considerably based on prosodic information, and musical communication in early childhood (such as maternal music) may play a major role for emotional, cognitive, and social development of children. (MP)

Max Planck Research Group *"Neurocognition of Music"* Leipzig

Research at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig revolves is working with human cognitive abilities and cerebral processes, with a focus on the neural basis of brain functions like language, emotions and human social behaviour, music and action. The groups look into the perception, planning, and generation of these, and analyses the interaction and common functional bases of their production and perception. Other research focuses on plastic changes in the human brain and the influence these have on various cognitive abilities, and on the neuronal and hormonal basis of modern diseases like high blood pressure and obesity.

Project of relevance: Otto Hahn Group: Neural Bases of Internal Speech

The group investigates how the brain lets us interpret subtle changes in voice tone by means of modern neuroscientific methods such as structural and functional magnetic resonance imaging (fMRI), magneto- and electroencephalography (MEG/EEG) and transcranial magnetic stimulation (TMS). Hereby the group tries to discern if sex plays a role, which factors determine individual differences in our sensitivity for the meaning of voice tone and if musicians, actors or singers have an advantage in comprehension. The objective of the group is to enrich the research of the past decades which traditionally studied language comprehension manly as a combination of word meanings, and also want to focus on the social function of speech.

Institute of Communication acoustics, Ruhr-University-Bochum

The institute of Communication Acoustics at the Ruhr University in Bochum has its main research activities divided into Speech and Audio Signal Processing, Auditory Acoustics, Engineering Models of Auditory Perception, and Cognitive Signal Processing. They focus on themes like Noise Power Estimation, Source Localization and Separation, Robust Speech Recognition and Auditory Virtual Environments. The basis for the research is the perception that auditory communication and processing of acoustic signals occupies a dominant position in

information science and technology; mobile communications, broadcasting services, hearing aids, and sound reinforcement systems being well known examples of its application areas. Furthermore, acoustic signal processing for man-machine communication is of great importance, e.g. in automatic speech recognition, dictation, and speech dialog systems, and for access control. Current research aims at making several modes of human-machine interaction (auditive, visual, and tactile) concurrently available and integrated into novel applications. The Institute is equipped with a high speed computer network, workstations and real-time signal processing systems. Furthermore, we possess equipment and rooms for acoustic measurement.

Project of relevance: Auditory Virtual Environment

The aim of an Auditory Virtual Environment (AVE) is to create situations in which humans have auditory perceptions that do not correspond to their real environment but to a virtual one (Blauert 1997). The main goal is a highly plausible or even natural reproduction. The listener should have a spatial impression of the virtual room and perceive his own movement inside the environment and also the movements of the sound sources. An AVE may be combined with other modalities, such as the visual and haptic modality. This technology might help the visually impaired.

ITAP (Institut für Technische und Angewandte Fysik) - Oldenburg

ITAP was founded in 1990 by the scientific staff of the acoustic group at the University of Oldenburg to comply with the increased inquiries in the global working field of acoustics. In the year 1995 itap turns to a Limited Company (LTD.) in connection with a cooperation contract to University of Oldenburg. Our company carries the name ITAP - Institut für technische und angewandte Physik GmbH and is a SME with a scientific and engineering staff of currently 9 employees. ITAP offers: Solutions on technical and scientific problems by contract research, development and consultancy Support of special acoustic measurement problems Standardized services, e.g. noise emission expertise

Services and Products:

- Noise emmission control
- Vibration emmission control
- Room and building acoustics
- Machinery acoustics
- Measurement and simulation technique
- Sound Emission from wind energy turbines
- Underwater acoustics/hydroacoustics

Fraunhofer IDMT (*Project Group Hearing, Speech and Audio Technology*) - Oldenburg

The project group Hearing, Speech and Audio Technology is part of the Fraunhofer Institute for Digital Media Technology in Oldenburg. The working group develops audio signal processing technologies for voice control in man-machine interaction as well as event detection in acoustic monitoring applications. In addition to development of robust detection systems, the group also works on methods for optimized signal acquisition. The main application area is assistive technologies, which provide assistance and safety in everyday life particularly for the elderly and persons with impaired health (Ambient Assisted Living). Furthermore the group develops voice control in assistive systems as intelligent speech input systems are increasingly used as a user interface for controlling technical systems. The working group develops speech recognition systems, which function robustly even in conditions with background noise and with a large distance between the microphone and speaker, the so-called far field. In the area of acoustics monitoring the group works on methods for pattern recognition that are also used in acoustic monitoring applications. In care homes or home care, potentially dangerous situations such as breaking glass, frequent coughing, falls or calls for help are acoustically recognized and an emergency call then initiated. Other applications include status monitoring of installations, machines, buildings or public spaces.

Competencies:

- Computer-based detection and assignment of noises as well as analysis of complex acoustic scenes
- Voice activity detection and speaker recognition
- Robust speech recognition systems with far-field functionality
- Continuous signal analysis with open microphone
- Signal acquisition and signal processing for speech and event recognition in assistive systems

Projects of relevance

HörTech - Oldenburg

The company's aim is to support research and science, particularly when it comes to gaining new methods and knowledge. These goals are realized by developing and running a centre of competence for hearing aid system technology, which fosters precompetitive cooperation among companies and institutions from the private economy as well as universities and research institutes in projects developing hearing aid system technology or associated products. Within all projects, our participating institutions are guaranteed the necessary confidence they need in order to unfold personal expertise and knowledge. Furthermore, the company develops and commercializes products which have been conceived in our projects or on the basis of project or research results.

Project of relevance: Hearing@Home Project

Hearing@home is a research project which aims to integrate solutions for the hearing impaired into consumer electronics, thus lowering the entry barrier to

hearing aids and helping the affected remain part of the communication society. Integrated in a set-top-box Hearing-at-Home offers noise reduction, individual dynamic compression and lip reading assistance with the help of SYNFACE. This type of support surpasses that provided by hearing aids.

Partners: Offis GmbH (Germany), HörTech gGmbH (Germany), Royal Institute of Technology University (Sweden), Viataal (Foundation for hearing impaired people, The Netherlands), Telefonica (Spain), ProSyst (Germany)

Project of relevance: Designing Age-Appropriate Living Environments Project (DALE)

The aim of the Research Alliance of Lower Saxony of designing age-appropriate living environments - Information and communications technology for obtaining and maintaining quality of life, health and self-determination in the second half of life - (DALE) is: to identify, develop and evaluate (setting objectives with regards to content) new methods of information and communication technology, as well as to enable the relevant research institutions of Lower Saxony to take the lead in greater national and international research projects associated with this topic (strategic research objectives).

Partners: OFFIS, Technical University of Braunschweig, Hannover Medical School, University of Oldenburg, Competence Center HörTech, the Oldenburg Fraunhofer Department of Hearing, Speech and Audio Technology (FhG-AHSA), Center of Aging and Society University of Vechta (ZAG), University of Osnabrück, Charité Berlin and University of Potsdam.

Fraunhofer AAL (Allianz)[2] - Erlangen

The Fraunhofer Alliance Ambient Assistive Living is headquartered in Erlangen. The 13 Fraunhofer Institutes in this alliance are working together with AAL and "Personal Health" solutions. Here, a holistic approach is pursued, which integrates various technologies, applications and user groups, involving flanking activities in the field of research coordination, business model development and standardization. "Personal Health" systems contain in particular portable and miniaturized medical devices specifically for diagnostic and therapy concomitant use in domestic or mobile environment (remote monitoring) are designed. But "Personal Health" also characterizes the transition to people-centred, individualized forms of medical prevention, diagnosis, treatment and care.

Fields of interest:

- Assistance and information systems
- Personal Health Systems
- User acceptance / Accessibility

[2] Fraunhofer consists of Clusters within industries (both institutes and corporations), Alliances within segments (Fraunhofer institutes working related to Automotive, AAL, etc), Institutes (specific fields), and Groups (within fields).

- Vital and environment sensors
- Localization / navigation

Fraunhofer Assistance systems, *IT applications* – Erlangen

Intelligent assistance systems offer support in healthcare, diagnosis, therapy and patient care. Technologies, products and services come together to form comprehensive system solutions that enable people to lead independent lives within the comfort of their own "four walls" regardless of illness and aging. This institute is primarily working with assistive systems for the ageing. They develop technologies based on sensorics and IT-interfaces. They are less concerned with sound then with medical technology as such.

Fraunhofer IBMT – St. Ingbert

Fraunhofer Institute for Biomedical Engineering is with more than 40 members of staff in two departments and eight working groups the largest ultrasound research unit in Europe. The competences of the working groups are based on more than 20 years of experience, and allow the development of all system components from materials with specially adapted properties, to application-specific ultrasound transducers, electronic system components and software development procedures, right up to sensor production and process development. Services range from consulting and feasibility studies to laboratory prototypes and prototype development, right up to certified product development, licensing and evaluation, and are used by industry with a turnover share of approx. 70 %. They develop both medical and technical ultrasound.

Project of relevance: Phased array ultrasound research platform

Diagnostic imaging quality of ultrasound systems is defined by the beamforming characteristics of the ultrasonic device. Modern ultrafast ultrasound plane wave imaging, dynamic focusing, steering, amplitude weighting, pulse coding and controlling the size of the aperture of an array probe are the techniques which are used to form the acoustic beam. Especially for research and development it is needed to have complete control possibilities over the parameters that determine the geometry, the direction, the number and the acoustical properties of the sound beams.

Fraunhofer, *Innovative Assistance* - Oldenburg

Fraunhofer Innovative Assistance is a fairly new transfer centre that extends the Oldenburg »Project Group Hearing, Speech and Audio Technology" at the Fraunhofer Institute for Digital Media Technology IDMT. Since the beginning of 2013 it has been working in cooperation with the Jade University Wilhelmshaven, Oldenburg, Elsfleth, social institutions, and regional business research in the new field instead of assistive technologies. Scientists are involved in the development of

user-oriented assistance systems, with the involvement of users playing an important role

Institut für Angewandte Medienforschung – Bremen

The AudioCluster Bremen is an initiative of Martin Koplin (M2C Institute for Applied Media Research), Georg Sichma (audio and Art) and Prof. Dr. Helmut Eirund (University of Bremen) in cooperation with its partners from science, business, education and the arts. This association of Bremen's leading entrepreneurs, researchers and artists from the topic Audio has set a goal to develop innovative projects between art, education, science and industry and to bring new products to market. Currently, the following priorities are in focus:

- Sounddesign
- Audio Tool Development
- Audio Distribution
- Think tank "Music Village"
- Educational media for children and adults

Deutsches HörZentrum – Hannover

Founded in 2003 the German Hörzentrum Hannover (DHZ) and the ENT clinic of the MHH offers a complete service; the comprehensive audio logical differential diagnosis, on the advice of a possible hearing, if necessary surgery through to lifelong medical, technical and pedagogical follow-up and care of patients. Internationally known is the Department of Otolaryngology and the DHZ for the world's largest cochlear implant program. By 2013, more than 7,000 adults and children could be implanted. 500 new patients supplied with a CI per year.

Hochschule für Musik, Theater und Medien – Hannover

Clinical research programs at *Hochschule für Musik, Theater und Musik* aim at a better understanding of the two central challenges in Musicians' Medicine: Focal dystonia in musicians and pain syndromes in musicians. A number of projects are conducted to investigate the ethology and pathophysiology of these disorders and improve diagnostic tools and therapeutic options. Further clinical studies are carried out to illuminate the applicability of music-supported training of motor functions in the rehabilitation of patients after stroke. One of their aims is to understand the rules of neuroplasticity and to investigate, how sensory-motor training processes can positively influence healthy musicians. Furthermore the institute seeks to exploit the potential of music induced neuroplasticity in neuro rehabilitation.

Projects of interest:

- Real Imaging of brass-players
- Neronal Correlates of time Precission in Scaleplaying
- Neuroplasticism among pianists

Forschungscentrum Ultraschall – Halle (Saale)

This non-profit ultrasound research institute is initiated and supported by small and medium-sized enterprises in the region. The goal is to transform ideas and results from basic research into new products and processes to improve the competitiveness of companies in the field of ultrasound technology. They offer a wide range of services. In addition, they take part in research of application-oriented projects such as:

- Non-destructive testing
- Ultrasound in Medical Technology
- Acoustic Basic Research
- Education and Training

OFFIS Germany - Oldenburg

The OFFIS structure consists of three application-oriented research and development divisions in the fields of Energy, health, and transportation. Approx. 280 employees are currently working in numerous ongoing ICT projects. OFFIS also introduced six competence centres that concentrate technological knowledge across the three research and development divisions. The competence centres serve as incubators for new innovative developments in attractive application domains and secure know-how a head start. The Health division offers consultancy in:

- Interactive Systems
- Data Management and Data Analysis
- Integration Technologies
- Medical Device Technologies
- Automated Nano-handling

8. Research Projects within AAL, Assistive Technologies and Monitoring

For this report, we aimed to generate a list of 10 research projects, all related to assistive sound technologies, monitoring and diagnostics. As stated earlier in the geographical overview, Oldenburg is central in sound technologies in Germany, therefore also reflected in a vast number of public-private-partnerships, German and EU-funded projects. That noted, research projects under these themes entail a number of different fields of study or sound-technologies might be a sub-technology under a different research project. An example hereof is Fraunhofer projects focusing on future mobility (LINK). Sound is here acting as a tool for acoustically orientation in open space, as well as a practical an easily recognisable sound of an electrical car.

Below we have listed 10 out of more than 30 interesting research projects we found while studying the German sound technology landscape. We have tried to include project with strong German and international partners, here including Danish, and projects with a broad use of technologies, focus area and applicability.

AALADIN: Application of acoustic recognition technologies to assist care providers

In the "Aaladin" project, an emergency call system is being developed that is able to detect critical situations using acoustic event recognition and to automatically trigger an emergency call. A further goal is to link acoustic recognition technology to existing documentation and invoicing software in order to reduce the effort required for care documentation through voice input, thereby lessening the workload of care staff. Professional care workers as well as patients and their relatives were integrated in the development process in order to ensure the acceptance of the new emergency call and documentation system. The goal of the project is to develop inexpensive technology that can be easily integrated into existing home emergency call systems.

Responsibilities of Fraunhofer IDMT
In the project, the Project Group Hearing, Speech and Audio Technology of Fraunhofer IDMT is responsible for developing robust acoustic detection and classification systems that are able to reliably work in varying acoustic conditions by self-calibration processes. In addition, the group is investigating new combinations of keyword spotting and speech recognition systems with a large vocabulary. Various single and multi-microphone configurations are being examined for signal acquisition.

More information:

www.aaladin.de
Fraunhofer IDMT

Project partners

- Bosch Sicherheitssysteme GmbH/ Robert Bosch Healthcare GmbH (Koordinator)
- MICOS – Micro Computer Systeme und Vertriebs-GmbH, Oldenburg, Germany
- Fraunhofer Gesellschaft zur Förderung der angewandten Forschung e.V. Projektgruppe Hör-, Sprach- und Audiotechnologie, Oldenburg, Germany
- Johanniter-Unfall-Hilfe e.V., Berne, Germany
- Universität Bielefeld
- Fakultät für Gesundheitswissenschaft, Bielefeld, Germany

EAR-IT: Experimenting Acoustics in Real environment using Innovative Test-beds

Within the scope of the European research project »EAR-IT«, potential solutions and methods are being investigated that will allow use of acoustic data in intelligent buildings and networked cities for applications in the fields of security, traffic management and energy efficiency. Two test beds from the project Future Internet Research & Experimentation (FIRE) are available for this project. One system is the HobNet test bed in Geneva, Switzerland, for development of interior applications, e.g. determination of building utilisation for energy-efficient regulation of lighting, ventilation and heating. The other test bed is the SmartSantander project in Santander, Spain. This features large-scale networked outside areas where processes for traffic management or detection of security-critical situations are being developed.

Responsibilities of Fraunhofer IDMT
As part of the EAR-IT project, the Project Group Hearing, Speech and Audio Technology of Fraunhofer IDMT is responsible for specification and development of hardware and software for acoustic data acquisition and processing for the existing test environments. The focus is on localisation of sound sources, acoustic event recognition as well as secure and stable exchange of audio and meta data with other system components. The Acoustics department at IDMT is responsible for real-time visualisation of the acoustic data, so-called flow mapping.

More information

www.ear-it.eu
Fraunhofer IDMT

Project partners

- Uninova - Instituto de Desenvolvimento de Novas Tecnologias
- Fraunhofer - Institut Digitale Medientechnologie
- Easy Global Market
- Mandat International
- Universidad de Cantabria
- Lulea Tekniska Universitet
- Wuxi Smart Sensing Stars

MOSQUA: Models for Objective Speech and Audio Quality Assessment

In many situations, acoustic communication can be restrained by background noise (e. g. machine noise), strong echo (e. g. in a station building) or bad transmission quality (e. g. intercom). To consider these interferences already when planning communications environments and to initiate appropriate counter measures, it is necessary to estimate speech intelligibility, perceived loudness or the hearing effort by applying hearing models. Models are also used for the design of operating and operation noises to assess the sound quality according to real hearing. In the MOSQUA project, hearing models for different dimensions of sound quality are analyzed and developed, for example for intelligibility, loudness, hearing effort and perceived acoustic value of a noise. The goal is to allow a significantly more precise prediction of the human hearing experience than is possible with current models and standards. Potential applications are e. g. planning of office acoustics, the use as intelligent noise indicator in schools, psycho-acoustic quality assessment of operation noises or the improvement of the communication acoustics in a car or in video chat systems.

Responsibilities of Fraunhofer IDMT
In the MOSQUA project, the Project Group Hearing Speech and Audio Technology combines its experience in auditory modelling with procedures of digital signal processing. For this, evaluation models for audio quality assessment are developed and practically evaluated and later implemented in a common framework to become a mature product (SIP toolbox). Some models are analyzed for real-time capability in combination with technologies for signal classification and implemented accordingly (SI-Live).

More information

Fraunhofer IDMT

Project partners
- OFFIS e.V. - Institut für Informatik
- Technische Universität Braunschweig
- Medizinische Hochschule Hannover
- Carl von Ossietzky Universität Oldenburg
- HörTech - Kompetenzzentrum für Hörgeräte-Systemtechnik
- Universität Vechta - Zentrum Altern und Gesellschaft
- Universität Osnabrück
- Charité Universitätsmedizin Berlin - Forschungsgruppe Geriatrie
- Friedrich-Schiller-Universität Jena

S4ECoB: Sounds for Energy Control of Buildings

The "S4ECoB" project researches, how acoustic information can be used to measure the occupancy level of large buildings, e.g. airports, shopping centers, and from this to derive an efficient control of the building technology. Technologies for position detection, sound and scene classification shall detect, how many people are located where within the building. The measures parameters can then be used for an automated, fit-tailored control of the heating and air conditioning. It is the goal of the project to develop a simple and inexpensive solution for energy-efficient buildings.

Responsibilities of Fraunhofer IDMT

In the course of this project, the "project group Hearing, Speech and Audio Technology" in cooperation with the "Acoustics" department of Fraunhofer IDMT develop procedures for extracting acoustic data and analyse them with respect to the utilization of a building. For this, novel networks of audio sensors are developed as well as algorithms for localizing and identifying noise sources are applied. One further task is connecting the developed technology to existing building technology.

More information

www.s4ecob.eu
Fraunhofer IDMT

Project partners

- Muficata S.L.
- Institut für Mikroelektronik- und Mechatronik-Systeme gGmbH
- D'Apollonia SpA
- Austrian Institute of Technology
- Solintel M&P SL
- Società per Azioni Esercizi Aeroportuali SEA SpA
- Corio NV

ECHO2ECO: A novel sound absorption technology to enable energy efficient construction techniques and promote the health and wellbeing of occupants

The building sector consumes 40% of Europe's energy. With rising energy prices and greater focus on energy efficiency the building sector offers the single largest potential for energy savings. This is reflected in the Energy Performance of Buildings Directive, EPBD, 2002/91/EC. This Directive strongly encourages the use of passive heating and cooling techniques such as thermal mass in building construction and refurbishment. Passive techniques such as thermal mass offer the potential to save up to 50% of energy used in heating and cooling. However, there is a barrier to its effective implementation. In order for thermal mass to work effectively the concrete and brick surfaces must be in contact with ambient air and kept free of insulation, including conventional mineral wool type sound absorbers. The acoustics reverberations (echos) however caused by this can affect the health and work efficiency of inhabitants and in some severe cases rendering the building uninhabitable. Whilst there are some high end solutions to the problem, primarily thick polymer or metal panels, these are too expensive in all but high end applications. There is an urgent and growing need for a low cost, high performance acoustic absorber that allows thermal mass techniques to work effectively yet is at a price comparable to low end mineral wool solutions. The SMEs in this proposal have come together as a supply chain to develop just such a new type of sound absorber, for public and commercial non-residential buildings, Echo2eco. This solution will use an array of laser cut micro slits, of width 100 micron in 200 micron film. There are significant technical challenges in achieving this solution, however with our research partners and innovations in multi-layer polymer material formulation/lamination and novel laser beam/optics configurations we are confident we will be successful. In so doing we aim to generate additional sales revenue of 112m within 5 years post project completion.

More information:

www.cordis.europa.eu/project/rcn/100300_en.html

Project partners

- Nowofol Kunstsoffprodukte Gmbh & Co Kg, Coordinator, Germany
- Deamp AS, Norway
- Acoustic Grg Products Ltd, United Kingdom
- Skelly & Couch Llp, United Kingdom
- MLT Micro Laser Technology Gmbh, Germany
- National University Of Ireland, GALWAY, Ireland
- Anglia Ruskin University Higher Education Corporation, United Kingdom
- Norner AS, Norway
- Norner Innovation AS, Norway

TWO!EARS

TWO!EARS replaces current thinking about auditory modelling by a systemic approach in which human listeners are regarded as multi-modal agents that develop their concept of the world by exploratory interaction. The goal of the project is to develop an intelligent, active computational model of auditory perception and experience in a multi-modal context. Our novel approach is based on a structural link from binaural perception to judgment and action, realised by interleaved signal-driven (bottom-up) and hypothesis-driven (top-down) processing within an innovative expert system architecture. The system achieves object formation based on Gestalt principles, meaning assignment, knowledge acquisition and representation, learning, logic-based reasoning and reference-based judgment. More specifically, the system assigns meaning to acoustic events by combining signal- and symbol-based processing in a joint model structure, integrated with proprioceptive and visual percepts. It is therefore able to describe an acoustic scene in much the same way that a human listener can, in terms of the sensations that sounds evoke (e.g. loudness, timbre, spatial extent) and their semantics (e.g. whether the sound is unexpected or a familiar voice). Our system will be implemented on a robotic platform, which will actively parse its physical environment, orientate itself and move its sensors in a humanoid manner. The system has an open architecture, so that it can easily be modified or extended. This is crucial, since the cognitive functions to be modelled are domain and application specific. TWO!EARS will have significant impact on future development of ICT wherever knowledge and control of aural experience is relevant. It will also benefit research in related areas such as biology, medicine and sensory and cognitive psychology.

More information:

www.cordis.europa.eu/project/rcn/110385_en.html
www.twoears.eu/

Project partners

- Technische Universitaet Berlin, Coordinator, Germany
- Universitaet Rostock, Germany
- Ruhr-Universitat Bochum, Germany
- Danmarks Tekniske Universitet, Denmark
- Centre National De La Recherche Scientifique, France
- Universite Pierre Et Marie Curie - Paris 6, France
- Technische Universiteit Eindhoven, Netherlands
- The University Of Sheffield, United Kingdom
- Rensselaer Polytechnic Institute, United States
- Universite Paul Sabatier Toulouse III, France

EARS: Embodied Audition for RobotS

The success of future natural intuitive human-robot interaction (HRI) will critically depend on how responsive the robot will be to all forms of human expressions and how well it will be aware of its environment. With acoustic signals distinctively characterizing physical environments and speech being the most effective means of communication among humans, truly humanoid robots must be able to fully extract the rich auditory information from their environment and to use voice communication as much as humans do. While vision-based HRI is well developed, current limitations in robot audition do not allow for such an effective, natural acoustic human-robot communication in real-world environments, mainly because of the severe degradation of the desired acoustic signals due to noise, interference and reverberation when captured by the robot's microphones. To overcome these limitations, EARS will provide intelligent 'ears' with close-to-human auditory capabilities and use it for HRI in complex real-world environments. Novel microphone arrays and powerful signal processing algorithms shall be able to localise and track multiple sound sources of interest and to extract and recognize the desired signals. After fusion with robot vision, embodied robot cognition will then derive HRI actions and knowledge on the entire scenario, and feed this back to the acoustic interface for further auditory scene analysis. As a prototypical application, EARS will consider a welcoming robot in a hotel lobby offering all the above challenges. Representing a large class of generic applications, this scenario is of key interest to industry and, thus, a leading European robot manufacturer will integrate EARS's results into a robot platform for the consumer market and validate it. In addition, the provision of open-source software and an advisory board with key players from the relevant robot industry should help to make EARS a turnkey project for promoting audition in the robotics world.

More information

www.cordis.europa.eu/project/rcn/110771_en.html

Project partners

- friedrich-alexander-universitat,erlangen Nurnberg, Coordinator, Germany
- Humboldt-Universitat Zu Berlin,Germany
- Institut National De Recherche En Informatique Et En Automatique, France
- Aldebaran Robotics Sas, France
- Ben-Gurion University Of The Negev, Israel
- Imperial College Of Science, Technology And Medicine

HurDig: Network for multilingual Hearing and speech intelligibility diagnostics

The University of Oldenburg is a European leader in the field of speech based hearing diagnostics, particularly in the field of speech intelligibility tests in noise. In addition to the German testing methods (Oldenburg Sentence Test, Oldenburg Children's Rhyme Test, Oldenburg Children's Sentence Test, Göttingen Sentence Test), foreign language tests (English, French, Dutch, Polish, Swedish) were also developed as part of the European Hearcom Project. These tests were developed in cooperation with European partners and implemented in the Oldenburg audiological software. The first version of the software is available as an addition to a commercially available audiometer since the beginning of 2007. A number of development and provision steps (some in close cooperation with the industry) are still necessary to make the use of these tests practical and widely used. They are part of the research project "HurDig".

Objectives

- Development and sustainable implementation of hearing tests by telephone
- Development and sustainable implementation of speech-listening tests for professional audiologists
- Development and sustainable implementation of speech-based measurement and verification procedures for technical hearing aids
- Implementation of this development in a speech intelligibility measurement station
- Implementation of education and training to support users of the testing methods at home and abroad Evaluation and validation of testing methods based on incoming data

More information

www.hurdig.de/

Project partners

- Acoustic Office Oldenburg
- Auritec Ltd.
- University of Applied Science Oldenburg
- Ostfriesland, Wilhelmshaven
- HörTech GmbH
- Center of Hearing Oldenburg GmbH
- Kind Hearing Aids
- Medical School Hannover (MHH)
- University of Oldenburg

Hearing in daily life Oldenburg (Hallo)

A reduction in the hearing is not only expressed in a deteriorated speech understanding, which can be detected with existing research methods in clinical settings. Even at a sufficient understanding speech complaining individuals with mild to moderate hearing loss on a special stress in everyday communication situations that can lead to avoid this situation, and to an increasing isolation. The goal is to develop metrics and procedures and to evaluate which can quantify these issues and thus to adapt the Diagnosis of hearing and review of technical hearing on the needs of the hearing-impaired people. For this purpose, a highly interdisciplinary composition of the research group is necessary to achieve the objectives. The study draws on disciplines like audiology, otolaryngology, health services research, engineering, and psychology.

More information:

www.tgm.jade-hs.de/web/file/Forschungsnetzwerk_Medizintechnik/Projekte.php

Project partners:

- FH Osnabrück
- Jade Hochschule
- FH Emden/Leer
- GewiNet e.V.
- Aphasiezentrum Vechta
- Netzwerk Gesundheit
- Rehabilitationszentrum für Kardiologie
- Neurologie und Orthopädie Oldenburg

Fraunhofer System Research for Electromobility II

"Fraunhofer System Research for Electromobility – FSEM II" is the follow-up project to "FSEM I" which ran from 2009 through 2011 and was funded by the German federal government. Within this joint project "FSEM II" (running from 2013 to 2015), 16 different Fraunhofer institutes are pooling their expertise. Funded by Fraunhofer-Gesellschaft, the research focuses on a clearly defined range of applications for electromobility. Project activities are grouped in three clusters: "Drivetrain / Chassis", "Battery / Range Extender", and "Body / Infrastructure". The project aims to extend the representation as well as the expertise of Fraunhofer-Gesellschaft in the field of electric mobility. Furthermore, the strengthening of the potential acquisition for industrial projects by developing innovative technologies and components for hybrid and electric vehicles as well as the cooperation in the exploitation is in focus. In addition the expansion of substantive cooperation of the Fraunhofer-Instituts is to be continued in the direction of a system recovery approach.

Objectives

- Development of efficient rendering Algorithms in a integrated car-pc
- Situation-dependent generation of Interior sounds
- Creating synthetic sonorous Sounds with the help of Free-Choice Profiling hearing tests
- Derivation of the results for objective evaluation algorithms
- Designing and implementing a suitable configuration interface
- Development of appropriate hardware- architecture for mobile use

More information:

http://www.elektromobilitaet.fraunhofer.de/en.html

Project partners:

- Fraunhofer ICT
- Fraunhofer IFAM
- Fraunhofer IIS
- Fraunhofer IISB
- Fraunhofer ILT
- Fraunhofer IPA
- Fraunhofer IPT
- Fraunhofer ISE
- Fraunhofer ISIT
- Fraunhofer IVI
- Fraunhofer IWES
- Fraunhofer IWM
- Fraunhofer IWU
- Fraunhofer LBF
- Fraunhofer UMSICHT

9. CONCLUSION

Through this study we find that Germany clearly is an interesting and relevant market for asisstive sound, monitoring and diagnostic technologies. All technologies see broad support from the German government, as well as from the states - often in combination with stratigic EU-projects.

Germany has a strong tradition in MedTech and Sound technologies. This study provides an overview over relevant German states where MedTech and Sound technologies have best settled. This entails local research institutes, infrastructure through funding possibilities, clusters and networks as well as focus on start-up support.

For MedTech the states of Bayern, Berlin, Niedersachsen, Nordrhein-Westfalen and Schleswig-Holstein are frontrunners. For Sound Niedersachsen, Nordrhein-Westfalen and Schleswig-Holstein are the key states to focus on. It is important to note that the technologies overlab a great deal and we therefore advice to bare all the above mentioned states in mind (Figures 1 and 2).

The strongest partners for the Innovation Network Danish Sound will the cluster regions Auditory Valley (Niedersachsen), Forum Medtech Pharma and Medical Valley (Bayern). They provide the important network to peer research and research institutes like Max-Planck and Fraunhofer and companies active in their region.

NOTES

Ministry of Foreign Affairs of Denmark

INNOVATION CENTRE DENMARK
SENDLINGER TOR PLATZ 10
D-80336 MÜNCHEN
PHONE +49 (89) 545 8540
DIRECT +49 89 54585423
MOBILE +49 171 3096335
WWW.ICDK.UM.DK