mHEALTH-AD

Co-funded by the Erasmus+ Programme of the European Union

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Training program for enhancing the adoption of mobile health technologies by persons with mild-dementia

MODULE 2: Mhealth for Tracking and Monitoring for Safety

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1. INTRODUCTION

1.1 What is a tracking and monitoring system?

Seniors who live with dementia experience disorientation temporarily or sometimes permanently. They may forget familiar faces and places, often leading to their wandering off. Wandering may lead to serious injuries or even getting lost, posing a major concern to caregivers or family members of the dementia patient.

Nearly 90% of adults over 50 want to remain at home and age in place. But with the rising cost of home-based care and the vulnerability to diseases that come with age, taking care of the loved ones is not getting easier. Being available around the clock is almost impossible. People have job commitments, travel, and personal lives to work on. For these few - and many more - reasons, one needs to find ways to watch over elderly parents living far away.

Monitoring is the process of continually collecting data points on each item, system or person. Normally, this includes how long a task takes, or how much resource it uses to perform its task, etc. The challenge is that monitoring often tells just that the task produced something, but it doesn't tell if the task is producing the right result. While tracking is the process of looking at the data that is input into an action and the results that are issued, and it will include the timing detail about how long it took as well as what happened inside the process. Obviously, in case of elderly usage, the two processes are used together to make sure that the person is functioning safe and secure.

Fortunately, there are new and innovative tracking systems on the market that are designed to serve caregivers while keeping dementia patients safe. These devices include Global Positioning System (GPS) technology, allowing dementia patients to be found whenever they wander off outside defined areas. Depending on the device, an emergency operator or a tracking application can determine the exact location of a lost dementia patient, because Global Positioning System, developed by U.S. military in 1960's, provides precise positional and velocity data and global time synchronization for air, sea, and land travel using satellites.

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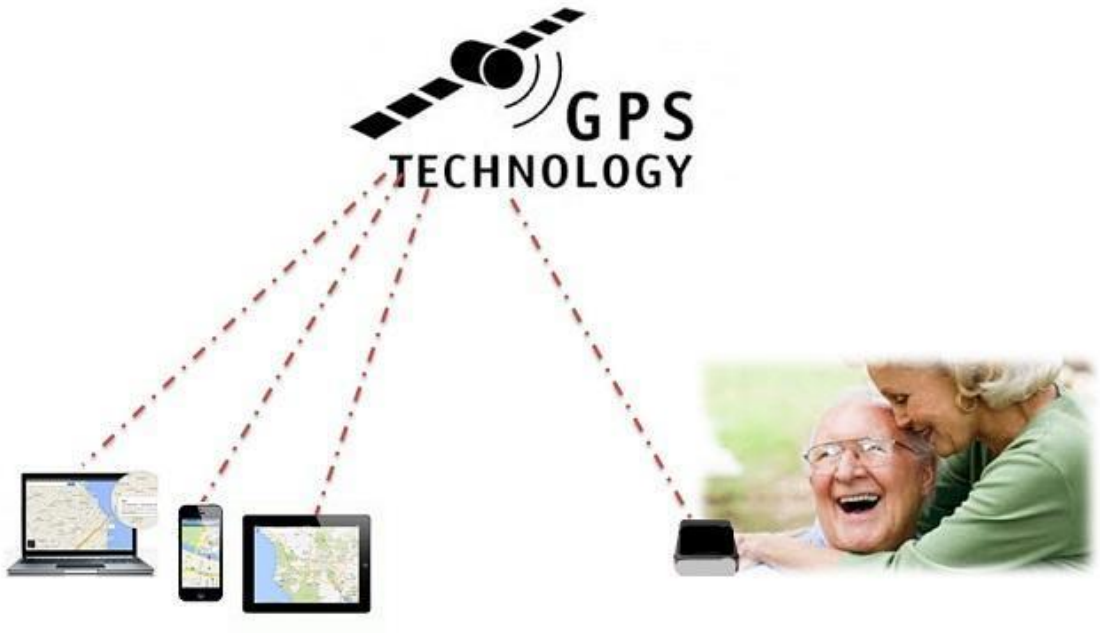

Picture 1

The topic of GPS trackers specifically designed for seniors, which put an emphasis on functions that enhance safety, including emergency buttons that alert caregivers, services that contact emergency responders, and tools to address monitor health metrics. While tracking typically involves GPS, some devices also rely on internet, cellular, or radio technology. There are systems, which allow the caregiver to track the person using an Internet map and geofencing, defining safe boundaries for the person.

When considering tracking and monitoring systems for elderly individuals at home, it's best to research and speak to representatives from each company or brand as all systems have their pros and cons. One should keep in mind that:

- Monitoring systems are not one-size-fits-all devices. Different types offer specific solutions, depending on an individual's needs.
- Some home monitoring systems for the elderly can alert caregivers about health or cognitive issues as well.
- Other home monitoring systems can detect falls and provide a rapid emergency response if needed.
- Not all home monitoring systems connect to outside sources. Some are more private and only alert assigned caregivers via an app.
- Newer technology has created virtual caregivers that can learn a user's behaviors, yet these services usually come at a higher price.

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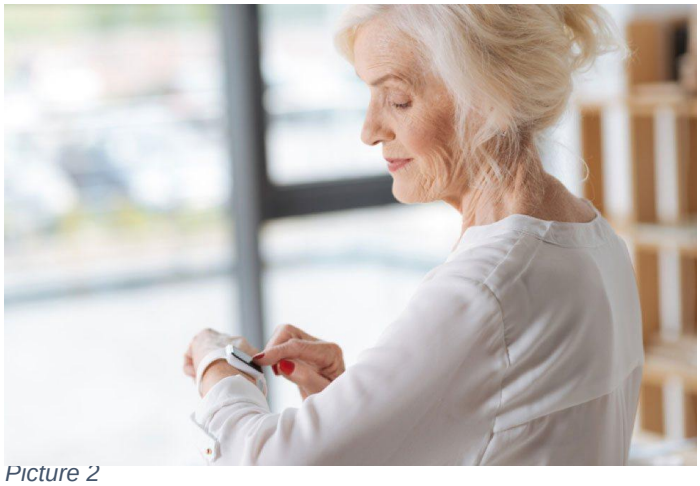

Picture 2

Constantly worrying about the safety and whereabouts of elderly loved ones whenever the carer is not with them is completely understandable. To shave off some of the worries, GPS tracking devices that ensure security of elderly loved ones can be used, because they are immensely helpful to families and caregivers who look after them.

1.2 What do elderly tracking & monitoring systems do?

Medical experts recommend caregivers to utilize a GPS tracking device for real-time monitoring. Some models can be used 24/7 anywhere in the world and are built for emergency situations such as fire accidents, assault, or in the event of slips and falls. Monitoring the location of elderly loved ones with the help of a GPS tracker allows the carer to keep an eye on them on a full-time basis.

Most of the security risks seniors face happen at home and usually when they're left unattended. Here are the most common risks seniors face while at home:

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Slips and falls
Falls are the leading cause of injuries and deaths among elderly. Since they can't be attended all the time to altogether eradicate the possibility of them falling, it is best that they are equipped with the necessary tools to call for help when something bad happens.

Medication
It is essential that seniors take the right dosage of their medicines on time, but this can be a difficult task for the elderly. Therefore, medication management becomes one of the risks seniors face in-home. Overdosing on medicine is also a possibility.

Crime
Seniors are more prone to major security risks like crime, especially when they're left unattended at home. They are defenseless against thieves, fraudsters, and other criminals, which is why homes for the aged are required to have strong security locks in place.

Fire
Persons with frail health conditions are vulnerable to fire-related accidents.

Mental conditions
As they develop cognitive impairment, anxiety, and mood disorders, a decline in language and thinking skills occur, severe enough to interfere with daily life and people with this condition often get disoriented or lost even in familiar places.

Mobile phones, although equipped with GPS tracking apps, are not recommended for elderly use, because the elderly user tend to misplace their phones
On the other hand, wearable GPS devices such as a wristwatch, pendant, or key chain or a tiny GPS tracker, which attach to their clothing anywhere they go, are highly recommended.

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GPS trackers are capable of tracking and recording every address your elderly loved ones have gone to, allowing the carer to create a virtual fence by mapping specific considered safe for the senior and the moment the person leaves the specified place, an alert is sent to the carer. GPS trackers can track a senior citizen 24/7 until its battery runs out.

Some GPS trackers have a panic or SOS button that is proven useful in emergency situations. With this safety feature, it becomes easier for elderly loved ones to ask for help when necessary. The instant the button is pushed, the carer and/or the authorities will receive an SMS or email alert containing location details of the device.

Today, GPS trackers for seniors have some additional features such as wake-up calls and heart rate monitors. Many of the devices also come with a feature that reminds seniors when to take their medicine.

2. CONCEPT

2.1 Tracking and Monitoring Systems

The tracking and monitoring systems used for the general safety of PwD. The goal is to have an overview of the location and activity of the person, so that the relatives and the elderly person have a more reassuring everyday life.
The most commonly used form of tracking and monitoring of PwD is the monitoring of the person's location. The GPS system and the mobile network work together to record an exact location and make this information directly available to the relatives or caregivers.

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This makes it easy to view the location from mobile devices, via compatible apps or websites. Often the general movement behavior of the person can be monitored, for example:

- How long does the person stay at this location?
- How much did the person move today?
    - An important factor in overall health.
- How fast is the person moving?
    - Is the person currently walking? (Low speed)
    - Is bus/ train/ car currently being used? (High speed)

For tracking and monitoring systems, there is now a wide range of devices. These devices are simple designed to prevent excessive demands during use and are therefore easy to integrate into everyday life.
The devices also have their limitations, so safe tracking within the home can't be grant (often), as the location information indicates a radius of a few meters. Thus, activity within the apartment can't be accurately represented. For more accurate monitoring inside the apartment, a home monitoring system can be installed.

2.1.1 What types of systems are available?

The majority of these systems are the result of advancements in communication technology. These systems generally use electronic devices that can broadcast the location via signals, which get monitored. It becomes an essential tool in case of emergency scenarios, rescue operations or monitoring valuable items or people.

Types of tracking technology:

- RFID (Radio Frequency Identification)
- Geofencing

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- Internet Tracking
- Radio Tracking
- GPS (Global Positioning System & Satellite Tracking)
- Cell-Phone Triangulation

The acceptance of the devices in everyday life is a very important factor to grant a successful deployment. Therefore, there are a variety of different systems to find the ideal system for the PwD and their relatives. The most common types of systems are:

- Voice-activated systems
- Movement sensors
- Video monitoring
- Personal emergency response systems
- Medical monitoring
- Comprehensive artificial intelligence home systems.

The most common form is a small tracking device, which must actively be worn by the person in order to be tracked at all times. These devices can often be worn in the form of necklaces and bracelets or simply stowed in a pocket. Wristwatches with a tracking function are also available. These are often more discreet as they look very similar to a normal watch since the tracking system is integrated into the watch. There is often the option of using special wristbands with a safety clasp to prevent the watch from being removed or lost.

Devices that are already integrated or can integrate into clothing are a good option for people who forget to wear the tracker regularly, for example when leaving home. A GPS tracker integrated in a shoe sole can be placed in the favorite pair of shoes, which is especially convenient for forgetful people or people who aren't used to wearing a necklace or watch. If the person uses a walker, a tracker can be attached to it.

HomeSystems integrated into the PwD's home to go beyond GPS monitoring, as accurate GPS tracking is more difficult in small spaces. In this type of system, the PwD's activity is monitored either indirectly by sensors or directly by camera systems.

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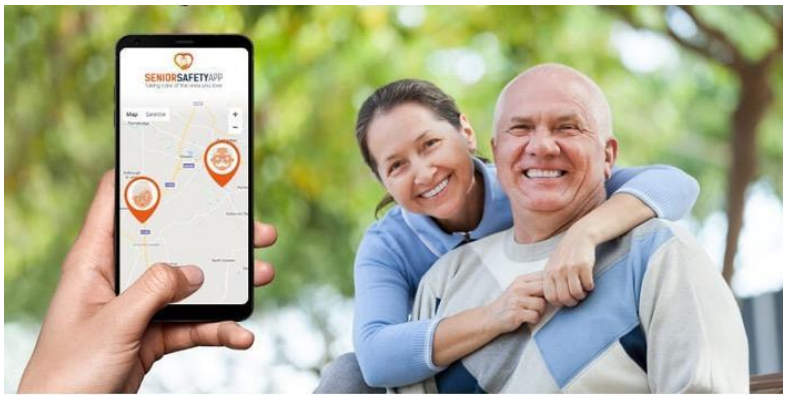
Thermal sensors measure the temperature in rooms, light detection sensors or floor sensors detect falls or conspicuous behavior such as no movement for a long time. Doors and windows can be equipped with sensors to transmit the information whether the door/window is open or not. In these arrangements, either the relatives have direct access to the systems, or a company is responsible for the monitoring and in case of emergency contacting an ambulance or fire department.

The choice of sensors needs to be discussed with the PwD, as the invasion of privacy is even more significant with these systems, than with the use of GPS devices.

2.1.2 What are the needs and expectations of PwD and caregivers from tracking and monitoring systems?

One of the most important aspects in the use of tracking and monitoring systems is the acceptance of this system, without the probability is high that the person won't use the device reliably. Thus, the original idea of more security in everyday life can fail already at the beginning. Therefore, the expectations and needs of those involved must be carefully considered.



Here are important factors a caregiver should consider addressing these needs and expectations:

- **Device compatibility**: Choice of a technology that ensures compatibility with the smart device PwD owns, and one that doesn't require fuss during installation and while in use.
- **User-friendly interface and software**: Choice of a solution that offers a user-friendly software system that allows ease of use even for non-technical users, which most elderlies tend to be.
- **Support**: Search of a system that offers robust customer support and assistance to ensure usability and troubleshooting support in case operational problems occur.
- **Affordability**: Search of a reasonably priced system that offers a good set of features without the high price tag.

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- **Use and purpose**: Considering how PwD uses her/his device, purchase of a solution that offers a good range of features that support her/his needs and lifestyle, ranging from senior fall alert systems to geofencing functions, call logs and SMS history, etc.
- **Distress button**: Search of a senior tracking system that features an easy to access SOS or distress button, so help can be on its way, fast in case of an emergency.
- **Smart alerts**: Choice of a system that features smart alerts so that caregivers can easily monitor the safety and wellbeing of PwD.
- **Low battery alerts**: Seniors may not know on keeping their devices charged at all times. Low battery alerts can configured so the caregivers is notified with a reminder to keep the devices charged.
- **Activity tracker**: GPS tracker apps nowadays come with many additional features like activity trackers, which help monitor their activities, hence, preventing potential online abuse.
- **Inactivity alerts**: Choice of a tracking system that sends out inactivity alerts should the phone have been immobile for extended periods—this is a crucial feature to look for, especially for a senior living alone.

Tracking and monitoring systems are great tools to monitor person location, activity and get other useful information, but it might not work as expected out of the box. Before obtaining or using a device, always read device manual, to make sure that the issues below are covered and PwD can use it effectively without any unease.

Data protection

The data generated by tracking and monitoring systems is regularly personal data, which is protected by law and is therefore an asset worth protecting. Pay attention to the respect of data protection for each person, as well as the consent of the monitored person, because monitoring without the consent of the person is a criminal offense.

General technical knowledge

In order to find a suitable device, this knowledge take into account:

- Do the persons involved independently use devices such as smartphones or smartwatches and have they already developed a feeling for technology?
- Is the use of smartphones/ smartwatches/ or other devices already part of everyday life?

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The less familiar a person is with the use of technology, the simpler the tracking and monitoring system should be.

Updates for the devices

Since the manufacturers regularly improve various operating systems of devices, an update is often necessary here so that the device is always operational. Either the PwD or the relatives should have the knowledge of how and when to perform an update. Often the more complex systems are more likely to need updates.

Insurance

Since the devices are a financial investment, several manufacturers offer insurance in case the device is lost or broken. **Battery runtime**

In addition, look at the previous handling of technical devices here. If a person has no experience with this, it could be difficult to charge a device daily, because the routine for this is missing. A battery with a (very) long runtime is better suited for this case and a relative could charge the device while visiting.

The general activity of the person should also be considered, if the person is outdoors a lot, walks a lot, shops frequently etc. the battery should have a higher capacity. If the battery dies before the lost PwD is located and reached, the tracking system becomes useless.

Ethical approval

The consent of the monitored person is essential because monitoring without the person's consent is a criminal offense. In the case of persons with dementia, each case must be considered individually and discussed as to whether monitoring is permissible. It is also imperative that the nature of the surveillance is communicated and that all persons involved agree. For example, an installed camera is a much higher invasion of privacy than a GPS tracker with a geofencing system.

Inaccuracy

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Since systems vary in accuracy, it is important to know in advance how important accuracy is to the people involved. This can vary depending on the reason for use. Systems that work together with GPS and the mobile network have a more precise location. However, consider that especially in rural or very crowded places, the accuracy of GPS devices can decrease.

2.2 Important (individual) aspects for the use of a device

Apart from the benefits, the systems also have downsides, for instance a misguided safety. Overly relying on the device may give the wearer more freedom but that can come with decreased physical interaction and connection. The fact that requiring the device to be on the person at all times can prove difficult if the wearer simply removes it or leaves it at home.

Another issue related to utilization of GPS tracking devices is inaccuracy; GPS devices rely *upon* a free "line of sight" from at least four satellites. If they connect with only three, the positioning is not fully accurate. Problems can occur when obstacles, such as walls, buildings, skyscrapers and trees obstruct a signal. The satellite signal affects under bridges, with electrical interference or in very dense bush. The devices don't work in underground or underwater. The users must be aware of these drawbacks.

One other potential downside of GPS trackers for the elderly is that they can create a false sense of security. The caregivers should encourage their loved ones to stick to their usual routines and not venture out into new areas or engage in activities that they wouldn't do without a GPS tracking device. Additionally, relying on a locating device may lead family members or caregivers to check in with the person with dementia less frequently.
Another important aspect is the ethical considerations of using a locating device to track and locate a person, such as personal freedom and dignity, independence and safety and their balance. While using a locating device increases personal freedom and safety and gives family members and caregivers more peace of mind, it is also an invasion of privacy.

2.2.1 Selection Criteria for Tracking and Monitoring Systems

Tracking devices for seniors use GPS to help the caregiver keep tabs of PwD. Selecting a GPS tracker for adults can involve many factors that may influence the family's decision. To pick the right product, one should compare different trackers and find out how they work and make sure that it has the essential features, yet it is easy to use.

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Geo-fencing is a highly recommended feature in a tracking device for adults, because it sets an alarm if PwD is entering or leaving the premises assigned by the caregiver, like home or the neighborhood.

The main factors to consider when buying a GPS tracker for a senior:

- **Type of device.** Depending on the caregiver needs, they may want to look for a certain type of GPS tracker. If they prefer something discreet, they'd benefit from a device that can worn as a necklace, watch, or bracelet. There are also conventional GPS trackers available.
- **Monthly fees.** Many GPS trackers have monthly fees. This is because they use cellular technology to pinpoint the location and deliver it to you. There are devices with no fees, although the majority of them are more limited in their tracking abilities.
- **Additional features**. Many GPS trackers have a lot of additional features bundled in. GPS watches, for example, often function as fitness devices, providing health metrics and other measurements. Other features to look out for include SOS emergency buttons, two-way calling, fall detection and audio monitoring.
- **GPS capabilities**. If a GPS tracker that's able to track nationwide is need, then it will be more expensive than a conventional GPS tracker. There are more basic, less-expensive devices if only shorter-range tracking is sufficient.

2.2.2 The best methods for tracking and monitoring elderly remotely

Home monitoring services are designed to give caregivers and their aging loved ones peace of mind while also enabling them to age in their homes as long as possible. Since older adults can have a wide range of health and mobility issues, these systems work differently depending on the type of service. Some alert first responders in the event

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of an emergency. Others notify caregivers if they identify risky behavior, some provide medical data to the user's healthcare team.
Here are some tips on how to monitor a PwD or an elderly parent remotely to make life easier for them while the caregiver can also track their location, health, and personal/ medical needs:

- **Through Technology**: Today, there exists a vast network of devices and applications to help you keep track of elderly's health and wellbeing at all times. A good example is the GPS tracker that pin-points the exact position accurately to up to 1 meter. This way, the caregiver can monitor the movements of PwD and ensure that she/he is always safe.
- **Delivery Services**: Delivery services keep your loved ones safe at home. They never have to worry about their next meal or get exposed to the dangers of the outside world, delivering meals right at their doorstep at the needed time.
- **Help from Friends and Family**: Taking care of the PwD alone is demanding. Hence, the caregiver can always get help from friends and family nearby if an emergency arises. It all begins with reaching out to the people living nearby and discussing a workable plan of action whenever an emergency arises.

In case of employment of technology, the following options considered for the elderly usage:

- Phone Apps
- GPS Trackers
- Cameras
- Virtual Assistants
  Patches that placed on the elderly parents to monitor their vital signs.

In order to be able to use the technological solutions, the family needs:

- Dementia-friendly cell phones. New and flashy technologies can be overstimulating. Finding an easy-to-use cellphone for the loved ones can make communication easier.
- Apps designed just for seniors with dementia. If seniors are familiar with smartphones and tablets, they can try downloading apps that stimulate their brain, track daily tasks, and promote conversation.

2.3 How GPS tracking keeps people with dementia safe?

Many individuals with dementia have a wandering tendency, although the term wandering incorrectly suggests that this behavior happens without a reason. Reasons for wandering are:

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Changed environment
A new environment such as a new apartment or day care center can lead to disorientation. The behavior may stop when the person gets used to the environment after some time. Another reason can be a noisy environment from which the person wants to get away.

Searching for something comfortable
Due primarily to the loss of recent information in memory, the PwD search for places, friends, or family from their past to feel more comfortable.

Relieve stress and boredom
The person may have an excess of energy and would like to reduce it with the movement. Sometimes movement is a need to improve the ability to concentrate, as this decrease with dementia.

Sense of time
Day and night are confused with each other due to the lack of sense of time, so the person may think they have to go shopping in the middle of the night.

Loss of memory
Short-term memory, which is a consequence of dementia, causes people to forget where they were going. This leads to the fact that they walkaround without a destination.

The challenge with this behavior is that due to reduced orientation and memory, the PwD can't find their way home on their own. The risk of the PwD getting lost, robbed or attacked is high in this condition. All this means a lot of stress for the caregivers and the relatives, as they constantly are worried for the PwD, as they are responsible for them. The systems are designed to improve the person and family members/caregivers security and making everyday life easier. Since many systems have integrated SOS buttons, the PwD can call for help in an emergency, even if they don't have a phone with them. In this case, depending on the system, the person who has access to the PwD's location is notified. Functions such as a geofence inform the relatives when the PwD leaves a certain area, such as the city or the residential complex. This allows a quicker response if the PwD wanders unnoticed.

2.3.1 Wearable GPS trackers for dementia patients

Wearable assistive technology is the term that defines systems or devices that enable individuals with physical or communication and cognitive disabilities to improve the quality and capabilities of their life. The advent of wearable technology in recent years has motivated and allowed professionals in the healthcare sector to look beyond the clinic or office to help patients with Alzheimer Disease (AD) and offer therapy or

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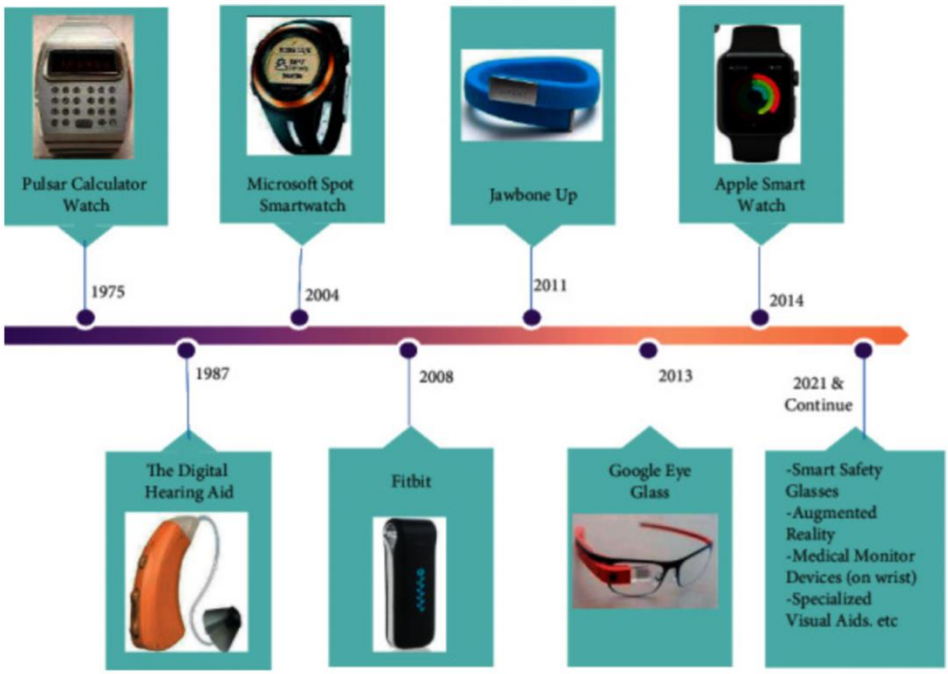

Picture 10

Wearable devices are the next breakthrough in the world of technology, following the advent of smartphones. Wearable devices or wearable technology is a category of electronic devices that can be generally defined as devices that can be used to be worn externally as an embedded or accessory in the person's clothing or implant in the person's body or even can be tattooed in the skin of the body. These kinds of devices are usually used on a real-time basis to track the information. These devices contain motion sensors that are capable of taking day-to-day movement or activity snapshots and synchronizing that information with other devices such as laptops or mobiles.

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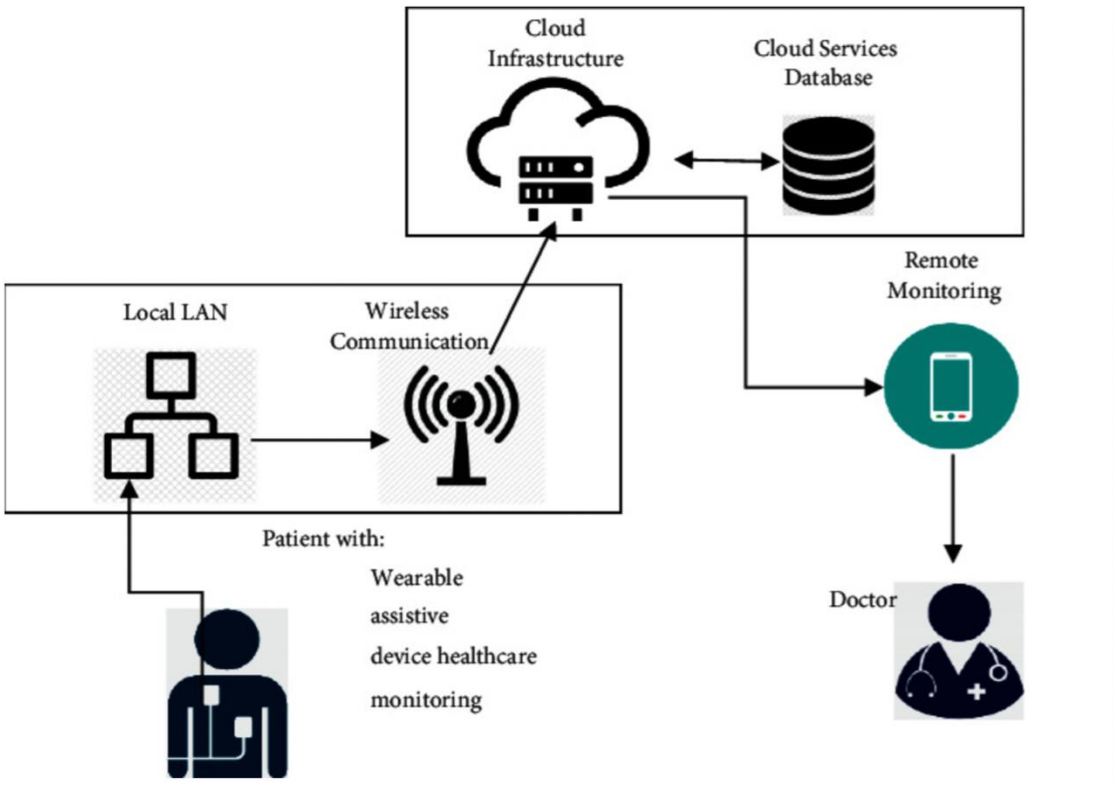

Picture 11

Some of the main limitations and advantages of this technological solution for Alzheimer's patients are listed and described below.

Advantages

- Advancement of social liability
- Increased patient's safeness
- Disability offsetting of AD patients
- Possibly declining treatment costs
- Prolong the self-dependency of the patient at the residence
- Improved physical and psychological health of the patients
- Lastly, possible saving of money on expensive treatments for the community.

Major limitations:

- Deficiencies in the observance of cultural and social differences
- Lack of evidence on a clinical basis
- Primary financing is required
- Concerns regarding the privacy and security of the data.

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2.3.2 Improvement of Self-Management and Empowerment

Empowerment aims to enable people to shape their social environment and their lives themselves by using their own personal and social resources. In empowerment processes, hierarchical or paternalistic levels are abandoned, and people's existing strengths and resources are sought and emphasized. The results of successful processes are the elimination of powerlessness and a strengthened self-confidence.

Since many older people have less experience with technical devices, the PwD must be informed about the different systems, only in this way the PwD can decide for themselves which device they would like to integrate into their everyday life. This is essential, as the PwD is revealing part of their privacy when they're tracked and monitored. This shouldn't create a feeling of oppression, but a feeling of empowerment by deciding how their information is used.
Therefore, the person must be taught on an equal footing how the devices work and what differences there are. It's best if devices can be tried out on-site instead of only seeing them on a presentation. This activates more senses, such as the sense of touch, which makes it easier to retain knowledge about the device. In addition, the PwD can directly apply the theoretically learned knowledge in practice and gains a better insight into the use of tracking and monitoring systems. Only through education, the person can be enabled to integrate himself into the device finding process and is more empowered for the later use and in deciding which device to integrate into everyday life.

The self-confidence and increased feeling of security in everyday life through the systems, the PwD is able to lead an everyday life they like to pursue, they can go for a walk, meet with friends or do other things with the knowledge that they will be helped faster in an emergency or is better found when they get lost.

3. COMPLEMENTARY VIDEOS

How does GPS work?
Click here for the video.

General tips for the safety of persons with dementia.
Click here for the video.

GPS Trackers explained.
Click here for the video.

Top 10 GPS Trackers for elderly.

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Click here for the video.

4. CONCLUSION

The trainer summarizes the content of the session and tries to clarify possible doubts and questions. After that, a short summary of the training program is given. Each trainer asks for feedback for the training program, e.g. with an App such as Kahoot.

5. REFERENCES

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