Alzheimer Assistance Project

SEMESTER PROJECT

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Table of contents

[1 Introduction 2](#_Toc153126994)

[1.1 Project context 2](#_Toc153126995)

[1.2 Objectives 2](#_Toc153126996)

[1.3 Specifications 2](#_Toc153126997)

[2 Bibliographic research 3](#_Toc153126998)

[3 Implementation 4](#_Toc153126999)

[3.1 Hardware configuration 4](#_Toc153127000)

[3.2 Arduino + Web Server 6](#_Toc153127001)

[4 User’s manual 9](#_Toc153127002)

[4.1 Installing the IDE and setting up the hardware 9](#_Toc153127003)

[4.2 Using the application 9](#_Toc153127004)

[5 Conclusions 11](#_Toc153127005)

[5.1 Results 11](#_Toc153127006)

[5.2 Possibilities of improvement/further development 11](#_Toc153127007)

[6 Bibliography 12](#_Toc153127008)

# Introduction

## Project context

The Internet of things (IoT) today represents a vast and rapidly evolving field that encompasses a wide range of technologies, devices and applications. IoT connects everyday objects to the internet, allowing them to send and receive data. This interconnectivity has led to significant advancements in various sectors, such as Smart Home Automation, Healthcare and Wearable Technology, Industrial IoT, Smart Cities, Agriculture etc.

An important cornerstone in the IoT field (and the Healthcare and Wearable Technology field) is an Alzheimer’s assistance system, that provides an innovative solution to enhance the daily lives of individuals with Alzheimer’s disease and their caregivers. This system includes a wearable device for the patient, equipped with an IMU that alerts the caregivers in case of the patient falling and a pulse sensor for vital signs monitoring, ensuring the safety and well-being of the individual.

## Objectives

The main goal of the Alzheimer Assistance Project is to design and implement a piece of wearable technology that can offers continuous health monitoring of the patient and alerts the caregiver shall any problems occur, a fall detection system and a user friendly interface on the bandwatch display, with the aim of creating a comprehensive Alzheimer's assistance system that maximizes the capabilities of the limited sensors while providing essential support and safety features in the form of a bandwatch designed for all-day wear and confort.

## Specifications

The main component of the project is Arduino MKR1000, a development board that is highly popular duet o its many functionalities, ease of use and high versatility.

We connected a HW-487 photoelectric switch sensor to it, which we used as a pulse measurement sensor, in order to check the patient’s vital signs regularly and a ADXL345 accelerometer that is used in order to check if the patient has fallen and alert the caregiver by sending them a notification. Moreover, the connectivity part was achieved due to the integrated Wi-Fi shield of the Arduino MKR1000, which allowed us to send data wirelessly to the Blink project that we have created prior. Blynk is a digital platform widely used for building IoT (Internet of Things) projects. It provides a mobile app and a server platform that allows users to control hardware remotely, monitor sensor data and build complex IoT applications.

# Bibliographic research

The *Healthcare and Wearable Technology* field refers to any kind of device that was designed to be worn by the user, embedded into the user’s clothing or implanted in the user. They have a potential to track information and communicate with others. This is an extension of the Internet of Things concept that specialises in tracking the user’s body levels and vital signs [[1]](https://onlinelibrary.wiley.com/doi/abs/10.1002/9780471740360.ebs1326).

The history of wearable technology began in 1955 with Sony’s production of its first transistor radio which provides a template for portable energy in today’s age.

After their debut, wearables jheld a little impact on the market unil 1977, when the technology went mainstream. Having a tremendous mass market impact, the calculator wrist watch by Hewlett Packard led to an increase of popularity for watches; this led to more and more companies designing smart watches. As the popularity of wearable devices grew, so did the companies creating them, now with approximately 20% of American adults taking advantage of this tech.

O imagine care conține ceas, de interior

Descriere generată automat

Fig. ‑ - The Hewlett Packard calculator wristwatch

The decades following the release of the calculator wristwatch in 1975 provided for tremendous growth and achieved worldwide popularity in 2002. In 2002, the innovation of Bluetooth headphones came into existence and the market never looked back. Between 2006 and 2013, well-known brands took their shot at the market with the introduction of developed smart watches, smart glasses, and other models of wearable technology[[2]](https://synapse.koreamed.org/articles/1075870). From 2014 to 2020, right after major brands released their wearable technology for the first time, the market has shown exponential growth as its yearly global revenue has increased from less than 5 billion to upwards of 30 billion. This market is constantly becoming more advanced and continues to incorporate more specific purposes into the hardware of the devices. These are effects due to the increasing focus of manpower into this field [[3]](https://ietresearch.onlinelibrary.wiley.com/doi/10.1049/htl.2014.0104).

# Implementation

The application overview and components can be seen in the figures below.

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Fig. ‑

O imagine care conține electronice, Inginerie electronică, Cabluri electrice, cablu

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Fig. ‑

## Hardware configuration

The circuit diagram which will be implemented using physical components can be seen in the schematic in Fig. 3-1-1.

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Fig. ‑1-1-Alzheimer Assistance System – circuit and wiring diagram

The components used in the hardware configuration can be seen in fig. 3-1-2 – 3-1-5:

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Fig. ‑1-2-Arduino MKR 1000

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Fig. ‑1-3 - ADXL345 accelerometer

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Fig. ‑1-4 - HW-487 Light Interruption Sensor

*A close-up of a cell phone

Description automatically generated with low confidence*

Fig. ‑1-5 - Breadboard

## Arduino + Web Server

The development environment used for for writing the code in this project is Arduino IDE. The application includes both use cases: the offline mode, in which the vital signs (pulse) and the state of the patient (whether it has fallen or not) are taken, and the online mode, in which the web server is created, where the updates regarding the state of the patient are displayed (and eventually the caregiver alerted) via the webpage.

The following part is focused on the main program (for the central Arduino board).

The libraries used by this application are:

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The first elements to be declared and initialized were the Blynk template ID, template name and authentication token. These are needed in order to connect to the application. We also defined the Blynk Print as Serial, in order for it to be possible to be seen on the Serial Monitor. Then, we added the authentication token, SSID and password.

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Next up, the accelerometer and the sensor pin is initialized, taking into consideration the datasheets of the components, as well as the BPM and lastTime that will further be used for calculating the pulse.

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The following part of the code is the *setup()*, where the Serial monitor was initialised with 9600 baud rate and the beginning of the acceleration and the Blynk connection were set up.

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The *loop* function runs the Blynk server and virtually writes the three coordonates of the acceleration event.

Based on the values of the accerelation and some arbitrary values that were determined experimentally, an „if” instruction was used in order to write on the Blynk server whether the patient has fallen or is currently in a stable position or as per displayed, happy.

The value of the pulse sensor was next read through an analog pin that was initialised in the setup and a formula was used in order to calculate the BPM which was then displayed on the Blynk server.

The loop continues, of course, after a delay of 1s (1000ms).

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The following part of the function is the Accelerometer part of the function.

The initialisation and the setup part of the function is exactly the same, but in the *loop* part of the function the debug serial monitor was initialised and used and all the different values of the acceleration (roll, pitch, yaw) were displayed on the Blynk server.

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# User’s manual

## Installing the IDE and setting up the hardware

Arduino IDE can be downloaded from <https://www.arduino.cc/en/software>. The user chooses the version corresponding to their operating system and installs it based on the instructions in the installation wizard. After this step is finished, the code file provided in the project can be opened as a new sketch inside the IDE.

The hardware configuration can be seen in fig. 3-1, fig. 3-2 and in fig. 3-1-1. The user will also need some cables to connect the components between each other.

After all the parts are interconnected, the user will have to compile the program and upload it to the board by pressing the Verify and Upload buttons in the IDE (Fig. 4-1-1). At this point, the application should start and the initial message can be seen in the serial monitor.



*Fig. 4-1-1 - Arduino IDE menu*

## Using the application

The application is meant to be used at all times by the patient in the form of a smartwatch, 3D printing a case being one of the first future improvements. Their vital data shall be constantly sampled and monitored.

The data of the patient can be viewed by the caregiver on the Blynk website.

The following data will be displayed and depending on the data taken from the accelerometer and processed using the pre-established algorithm, it will display a different notification.

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Fig. ‑ - Fallen patient stats

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Fig. ‑ - Happy patient stats

The Blynk server page can be accessed on the Blynk website, and it displays informations for up to 1 week prior to the current day, with different tabs. As explained in the implementation, it is connected in real time to the hardware setup due to the Wi-Fi connectivity of the Arduino MKR1000.

# Conclusions

## Results

Having the hardware components listed in section 3.1 and following the diagram in Fig. 3-1, with the help of the instructions in the User Manual in Chapter 4, the application can be implemented with the code from section 3.2. and tested by anyone.

As shown in the figures, the Alzheimer’s Assistance System provides a useful IoT solution for both for patients needing constant supervision and their caregivers, who can check the state of the patient from afar.

## Possibilities of improvement/further development

Some possibilities of further improvement of this project might include:

* Display for showing the stats in real time;
* Dedicated mobile app instead of browser webpage;
* More sensors implemented for the purpose of monitoring of the patient;
* Sending notifications to the web application through the Internet.

# Bibliography

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