Team Project and Professionalism-Report

Facial recognition subsystem

Alexandru-adonis neagu-w18017575

2021

# 1.Introduction

Biometrics based system has gained much importance in the security area. Such systems were developed as a replacement for recognizing individuals instead of using old ways such as passwords, keys, PINs, cards etc. The most common issues regarding the conventional security methods are the possibility to be forgotten or lost. (Khan et al., 2019)

Some biometric-based systems are based on facial recognition, fingerprints, retina, and voice authentication. Among the methods enunciated, facial recognition has some advantages over other methods. To use the fingerprint requires a device that can read the fingerprint. When talking about retina recognition the user needs to adjust the device in a fixed position for identification. As for voice recognition, it is difficult to use in a crowded environment due to the background noise. Facial recognition is a contactless process that has been widely used in human-computer interaction, video surveillance and law enforcement agencies. ( Okokpujie et al., 2017)

Facial recognition proved to be the most reliable way of authentication. This is because is the most economic and easy solution for such a problem. Also, it just requires a camera which is widely used on the modern devices around us. Therefore, I decided to develop an algorithm that performs facial recognition for our e-learning platform, so that the user can benefit from a modern way of authentication.

# 2.Facial recognition system

The facial recognition system that was developed has an accuracy of over 90% which is a very good result. It can successfully recognize people within the dataset and classify new faces as unknown if different persons try to get into the platform. Since facial recognition is a web-based system it was necessary to use the flask library so that the user could run the program on a local server. This is because it uses a high computational power which in many cases cannot be performed on a personal computer. The process is very simple from the user point of view. When trying to log in, that person has to press the register button and the camera would pop up running the facial recognition algorithm. After the verification and identification process, the algorithm will return a value that will be further used to get the user into the system.

An issue that I found during testing the system was that it detected the faces even in pictures or digital images. This can be related to Haar cascade frontal face detection which was trained on different images to detect objects. Haar cascade is a machine learning-based algorithm that was trained using a lot of positive and negative images. ( Kasinski, Schmidt, 2009). A common problem when creating a model is the lighting of the environment. Different angles and light may cause a higher misclassification rate. ( Ramaiah et al., 2015)

The code was created using python language within Jupyter notebook application. The code is well structured and commented so that it can be easy to read and understand. The build of the model does not consist of lots of code lines but in finding the right techniques and values for the hyperparameters. Therefore, it does not require lots of modifications to adapt the algorithm to new situations for example a bigger number of classes. The biggest issue when creating such a model is the computational time that can be up to several days depending on the size of the dataset.

I chose Tensorflow as a framework because it ensures access the powerful APIs such as Keras from where different pre-trained models and functions can be imported to build a robust system. It also can run on both GPU and CPU which decrease the computational time.(TensorFlow, 2021)

# 3.Algorithm process and personal achievement

As mentioned in TOR a Convolutional Neural Network were used to train the model to be able to achieve facial recognition. The system was trained on images taken from team members and a dataset available on the internet. Therefore, I managed to create four classes Alexandru, Sebastian, Diana and Unknown. When the system was tested it was able to fully recognize each o us accordingly. Also, some random pictures of people were used for testing to see what the result would be and in almost all cases they were classified as Unknown.

When training and predicting using image processing it can take a long time when only the CPU is used. For such a system the user would not want to way too long to be authenticated. A common way to reduce computational time is to use the GPU.( NVIDIA Developer, 2021) Therefore, the system achieves a very good time when predicting somewhere under ten seconds. Since my computer was used for training the model, eight GB of GPU, sixteen GB of RAM along a 10th generation I7 processor were needed.

To be able to authenticate on the learning platform flask library were needed to be used. It allows running the program on my PC while it is accessed from another person using ngrok. When a face is recognized as one of the four classes it will return a JSON value which will be used for finding the account according to the right user.

An issue discovered when testing the system was that people would be able to be identified as a person using digital pictures for example photos of that person on their phone.

Overall, the system was able a perform facial recognition as it should even if there are plenty of space for further improvements. For such a system which implies image processing CNN are very commonly used. Also, developing such an architecture that would get very good results can be time-consuming and hard to achieve. Therefore, transfer-learning is used to get over these problems. Transfer learning is a technique where a pre-trained model is used and fine-tuned to solve a specific problem. For this project, a model called ResNet50 was used which was pre-trained on the ImageNet dataset that contains over one million images. Then it was fine-tuned by deleting the top layers and creating new layers accordingly for the problem to be solved. Due to the small dataset used for training I had to find a way to get the best of it. Data augmentation were used to harness more images from the ones that were already there. It takes one image and applies different modifications like rotation, scaling, zooming, changing the brightness, or flipping the picture. Other approaches that were used to increase the model’s accuracy were the use of regularization, tuning the hyperparameters of different optimizations and adding batch normalizations.

The need for improvement of the base model that was created helped me to expand my knowledge about data science the techniques used to build a better CNN model. Furthermore, I was able to learn of to create a local server using python, to run programs on that server and how to make it accessible to other people. Besides practical and theoretical work I was able to evolve my social skills. I managed to communicate with my team in a friendly and professional way which developed a pleasant environment when working together. Also, I am proud that I was able to manage my time in such a way so that I can finish my work as planned so that my team’s member can rely on me when they needed.

# 4.Project management

Time management was not such a big problem for my team’s member when developing the individual subsystem. Also, when working on documents we were able to communicate and meet the deadline that we agreed on. The biggest issue was when trying to put all the individual parts together. Two teammates managed to put together the frontend and backend of the learning platform while the other two did not communicate with us, so their components were not possible to add to the project. Furthermore, when working on integrating my facial recognition with the backend of the system I managed to get the value and send it from my local server on the PC that accesses the link.

When trying to put the individual subsystem together we used GitHub to upload our code there. When any modification was needed a new version was added so that the work can be continued. When working together we used Microsoft Team or Discord so that we could share our screen and see how we can solve any issues.

To test the facial recognition faces of the people within the dataset were used to see if the system can recognize the faces. Furthermore, students were asked in the university’s library to try out the system and see what the results will be. After testing the system, they have completed a google form to share their thoughts about facial recognition. Similar approaches were used for the frontend and backend.

There was no leader in the group. We decided together when our deadline should be but from my point of view, we could have had a leader that was responsible to ensure that everyone respects the deadline and to check the development of the whole project. The absence of a leader allowed the team’s member to more flexible with time management which led to delays.

To check that the whole system works as it should further updates will be released to solved possible bugs that were omitted. These updates should include packages that will improve the user experience from the visual point of view but also the computational point of view. The facial recognition algorithm will be tested periodically to ensure that it works properly and secure. Also, further versions more efficient will be released in the feature.

# 5.Future work

To fully integrate the facial recognition subsystem to make it work properly there should be added a camera on the website so that the user can use their camera to log in. At this moment only the camera of the PC that runs the facial recognition algorithm is working because there was not enough time to add this feature to the website. Also, a more powerful server would be needed to host the whole system so that can run the full capacity. Furthermore, more work can be done at developing a face detection algorithm that will be able to filter if there is a real person or a photo behind the camera.

# 6.Profesional issues

We were able to show professional behaviour regarding this project. This can be seen from the effort and commitment shown by me, Diana and Sebastian, to get all the documentation done right, to work together to implement every subsystem together and to be able to develop the project as a team. The code of conduct was respected by almost all team members which prevented any agues during the project development. Unfortunately, not all the team members respected the rules and did not show the same commitment as others. This could be due to the Covid situation which limited the face to face interaction and communication. If the project is going to be commercial a project manager could solve the problems regarding time management and would ensure that everyone in the team is on the right way. Also, the team should be made up of people that are interested in such a project and are ready to put an effort to build it.

# 7.Legal issues

Like any other website, there will be a database containing all the personal data of a user. Also, if they chose to use facial recognition, pictures with their faces will be needed. Therefore a form that respects the GDPR will be made so that the user can give consent to use its data. Also, the developers of the platform have to ensure that there is a minimum chance of data leakage.

# 8.Social issues

This is an educational platform so both students and teachers should show political and professional behaviour. If there is a chance that a student will write some inappropriate words, those words will be hashtagged and the teacher will have the option to delete that message.

# 9.Ethical issues

Unfortunately, there is the chance that not every student has access to a device from which the platform can be reached. The institution that wants to use such a website should have the responsibility to provide these devices for the students. Furthermore, the headmaster of the institution should be aware of any student that is underaged and ask the permission of the parents before using their data.

# 10. Cybersecurity issues

As a matter of security, all the password from the database were encrypted using bcrypt. Also, as an authentication method JSON Web Token was used which is a standard solution. This limits the access of unauthorized users to information held in the database. Another security measure would be the usage of SQLAlchemy toolkit which does not make the system vulnerable to SQL injections. Some inprovemts can be made in the future. Speaking of facial recognition, a custom facial detection algorithm should be developed which can make a difference between an actual person and a photo behind the camera. A very useful method of improving the security would be the implementation of a system that allows the user to verify their account by receiving an email with a verification link.

# References:

1.K. Okokpujie, E. Noma-Osaghae, S. John and R. Oputa, 2017, "Development of a facial recognition system with email identification message relay mechanism," 2017 International Conference on Computing Networking and Informatics (ICCNI), pp. 1-6, doi: 10.1109/ICCNI.2017.8123776.

2. N. P. Ramaiah, E. P. Ijjina and C. K. Mohan, 2015, "Illumination invariant face recognition using convolutional neural networks," 2015 IEEE International Conference on Signal Processing, Informatics, Communication and Energy Systems (SPICES), pp. 1-4, doi: 10.1109/SPICES.2015.7091490.

3. S. Khan, M. H. Javed, E. Ahmed, S. A. A. Shah and S. U. Ali, 2019, "Facial Recognition using Convolutional Neural Networks and Implementation on Smart Glasses," 2019 International Conference on Information Science and Communication Technology (ICISCT), pp. 1-6, doi: 10.1109/CISCT.2019.8777442.

4. Kasinski, A. and Schmidt, A., 2009. “The architecture and performance of the face and eyes detection system based on the Haar cascade classifiers. Pattern Analysis and Applications”, 13(2), pp.197-211.

5. NVIDIA Developer. 2021. Convolutional Neural Network (CNN). [online] Available at: <https://developer.nvidia.com/discover/convolutional-neural-network> [Accessed 7 May 2021].

6. TensorFlow. 2021. Why TensorFlow. [online] Available at: <https://www.tensorflow.org/about> [Accessed 7 May 2021].

# Appendix:

Weekly logs:

**3rd February 2021:**

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| **Date and time of session** | | **3rd February 2021** |
| **Location and format (i.e. face-to-face/Skype etc)** | | **Microsoft Team Meeting** |
| **Attendees** | | **Sebastian Gabriel Visan**  **Alexandru-Adonis Neagu**  **Oana-Diana Prahoveanu** |
| **Apologies for absence** | | **Mario and Nikolay were not part of the team by this time** |
| **No contact/did not attend** | | **Mario Nemeck**  **Nikolay Nenchev** |
| **Brief description of work done by each group member since last meeting** | | |
| **Being the first meeting the purpose of it was to get to know each other better. The students introduced them self. The supervisor proposed us some project ideas based on the skills presented by students.** | | |
| **Agreed tasks for next meeting for each group member** | | |
| **By the next meeting the students have to come with a project idea.**  **Working on the TOR is also recommended.** | | |
| **Notes on tutor comments and advice (if session occurs in class)** | | |
| **By the next meeting the students have to come with a project idea.**  **Working on the TOR is also recommended.** | | |
| **Student signatures**  i.e. those present or who have actively contributed to the log sheet. | **Sebastian Gabriel Visan** | |
| **Alexandru-Adonis Neagu** | |
| **Oana-Diana Prahoveanu** | |
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**10th February 2021:**

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| **Date and time of session** | | **10th February 2021** |
| **Location and format (i.e. face-to-face/Skype etc)** | | **Microsoft Teams Meeting** |
| **Attendees** | | **Sebastian Gabriel Visan**  **Alexandru-Adonis Neagu**  **Oana-Diana Prahoveanu**  **Mario Nemeck**  **Nikolay Nenchev** |
| **Apologies for absence** | |  |
| **No contact/did not attend** | |  |
| **Brief description of work done by each group member since last meeting** | | |
| **New members added to the team introduced them self. The team came with the idea to develop a e-learning platform with facial recognition.** | | |
| **Agreed tasks for next meeting for each group member** | | |
| **By the next meeting, the students have to split the subsystem components between them.**  **Finish writing the TOR.** | | |
| **Notes on tutor comments and advice (if session occurs in class)** | | |
| **By the next meeting, the students have to split the subsystem components between them.**  **Finish writing the TOR.** | | |
| **Student signatures**  i.e. those present or who have actively contributed to the log sheet. | **Sebastian Gabriel Visan** | |
| **Alexandru-Adonis Neagu** | |
| **Oana-Diana Prahoveanu** | |
| **Mario Nemeck** | |
| **Nikolay Nenchev** | |

**17th February 2021:**

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| **Date and time of session** | | **17th February 2021** |
| **Location and format (i.e. face-to-face/Skype etc)** | | **Microsoft Teams Meeting** |
| **Attendees** | | **Sebastian Gabriel Visan**  **Alexandru-Adonis Neagu**  **Oana-Diana Prahoveanu**  **Mario Nemeck** |
| **Apologies for absence** | | **N/A** |
| **No contact/did not attend** | | **Nikolay Nenchev** |
| **Brief description of work done by each group member since last meeting** | | |
| **The students split the components of the system.**  **Sebastian is doing the backend of the system.**  **Alex is doing the facial recognition for the authentication part.**  **Diana is doing the front end of the system.**  **Mario is doing the schedule component of the platform.**  **Nikolay is doing the gradebook component.** | | |
| **Agreed tasks for next meeting for each group member** | | |
| **By the next meeting, the students have to start the research for their individual parts.** | | |
| **Notes on tutor comments and advice (if session occurs in class)** | | |
| **By the next meeting, the students have to start the research for their individual parts.**  **Any draft examples/designs are welcomed to be presented to the supervisor.** | | |
| **Student signatures**  i.e. those present or who have actively contributed to the log sheet. | **Sebastian Gabriel Visan** | |
| **Alexandru-Adonis Neagu** | |
| **Oana-Diana Prahoveanu** | |
| **Mario Nemeck** | |
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**24th February 2021:**

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| **Date and time of session** | | **24th February 2021** |
| **Location and format (i.e. face-to-face/Skype etc)** | | **Microsoft Teams Meeting** |
| **Attendees** | | **Sebastian Gabriel Visan**  **Alexandru-Adonis Neagu**  **Oana-Diana Prahoveanu** |
| **Apologies for absence** | | **N/A** |
| **No contact/did not attend** | | **Nikolay Nenchev**  **Mario Nemeck** |
| **Brief description of work done by each group member since last meeting** | | |
| **The students start the research for their individual components. They presented their ideas and possible approaches to the supervisor .** | | |
| **Agreed tasks for next meeting for each group member** | | |
| **Has to start working for their individual components.** | | |
| **Notes on tutor comments and advice (if session occurs in class)** | | |
| **Keep continue the work for project and try to contact some of the stakeholders for feedback.** | | |
| **Student signatures**  i.e. those present or who have actively contributed to the log sheet. | **Sebastian Gabriel Visan** | |
| **Alexandru-Adonis Neagu** | |
| **Oana-Diana Prahoveanu** | |
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**3rd March 2021**:

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| **Date and time of session** | | **3rd March 2021** |
| **Location and format (i.e. face-to-face/Skype etc)** | | **Microsoft Teams Meeting** |
| **Attendees** | | **Sebastian Gabriel Visan**  **Alexandru-Adonis Neagu**  **Oana-Diana Prahoveanu** |
| **Apologies for absence** | | **N/A** |
| **No contact/did not attend** | | **Nikolay Nenchev**  **Mario Nemeck** |
| **Brief description of work done by each group member since last meeting** | | |
| **Researching ways of implementing each individual component** | | |
| **Agreed tasks for next meeting for each group member** | | |
| **Start work on implementing the components** | | |
| **Notes on tutor comments and advice (if session occurs in class)** | | |
| **Start implementing the components and try to have some code done till the next meeting** | | |
| **Student signatures**  i.e. those present or who have actively contributed to the log sheet. | **Sebastian Gabriel Visan** | |
| **Alexandru-Adonis Neagu** | |
| **Oana-Diana Prahoveanu** | |
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**10th March 2021:**

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| **Date and time of session** | | **10th March 2021** |
| **Location and format (i.e. face-to-face/Skype etc)** | | **Microsoft Teams Meeting** |
| **Attendees** | | **Sebastian Gabriel Visan**  **Alexandru-Adonis Neagu**  **Oana-Diana Prahoveanu** |
| **Apologies for absence** | | **N/A** |
| **No contact/did not attend** | | **Nikolay Nenchev**  **Mario Nemeck** |
| **Brief description of work done by each group member since last meeting** | | |
| **Started working on the login and registration components(front end and backend).**  **Continued into the facial recognition subsystem** | | |
| **Agreed tasks for next meeting for each group member** | | |
| **Finishing the started components and starting the implementation of the facial recognition model.** | | |
| **Notes on tutor comments and advice (if session occurs in class)** | | |
| **Keep up the work.** | | |
| **Student signatures**  i.e. those present or who have actively contributed to the log sheet. | **Sebastian Gabriel Visan** | |
| **Alexandru-Adonis Neagu** | |
| **Oana-Diana Prahoveanu** | |
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**17th March 2021:**

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| **Date and time of session** | | **17th March 2021** |
| **Location and format (i.e. face-to-face/Skype etc)** | | **Microsoft Teams Meeting** |
| **Attendees** | | **Sebastian Gabriel Visan**  **Alexandru-Adonis Neagu**  **Oana-Diana Prahoveanu** |
| **Apologies for absence** | | **N/A** |
| **No contact/did not attend** | | **Nikolay Nenchev**  **Mario Nemeck** |
| **Brief description of work done by each group member since last meeting** | | |
| **Work continues on the registration and login components (interface and backend)and training for the facial recognition model has started.** | | |
| **Agreed tasks for next meeting for each group member** | | |
| **Look for ways of improving the security of the app and testing as well as testing and optimizing the face recognition model.** | | |
| **Notes on tutor comments and advice (if session occurs in class)** | | |
| **Keep up the work.** | | |
| **Student signatures**  i.e. those present or who have actively contributed to the log sheet. | **Sebastian Gabriel Visan** | |
| **Alexandru-Adonis Neagu** | |
| **Oana-Diana Prahoveanu** | |
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**24th March 2021:**

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| **Date and time of session** | | **24th March 2021** |
| **Location and format (i.e. face-to-face/Skype etc)** | | **Microsoft Teams Meeting** |
| **Attendees** | | **Sebastian Gabriel Visan**  **Alexandru-Adonis Neagu**  **Oana-Diana Prahoveanu** |
| **Apologies for absence** | | **N/A** |
| **No contact/did not attend** | | **Nikolay Nenchev**  **Mario Nemeck** |
| **Brief description of work done by each group member since last meeting** | | |
| **The registration and login prats of the tasks are complete as well as the interface for these components. The facial recognition model is development.** | | |
| **Agreed tasks for next meeting for each group member** | | |
| **Starting work on the backend and interface for the rest of the system as well as testing and optimizing the facial recognition model.** | | |
| **Notes on tutor comments and advice (if session occurs in class)** | | |
| **Continue working on the components and make sure to get the stakeholder feedback for the completed parts.** | | |
| **Student signatures**  i.e. those present or who have actively contributed to the log sheet. | **Sebastian Gabriel Visan** | |
| **Alexandru-Adonis Neagu** | |
| **Oana-Diana Prahoveanu** | |
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**31st March 2021:**

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| **Date and time of session** | | **31st March 2021** |
| **Location and format (i.e. face-to-face/Skype etc)** | | **Microsoft Teams Meeting** |
| **Attendees** | | **Sebastian Gabriel Visan**  **Alexandru-Adonis Neagu**  **Oana-Diana Prahoveanu** |
| **Apologies for absence** | | **N/A** |
| **No contact/did not attend** | | **Nikolay Nenchev**  **Mario Nemeck** |
| **Brief description of work done by each group member since last meeting** | | |
| **The students give an update on where they are in terms of their individual tasks .** | | |
| **Agreed tasks for next meeting for each group member** | | |
| **Finishing the individual tasks and working on putting the project together.** | | |
| **Notes on tutor comments and advice (if session occurs in class)** | | |
| **Continue working on the individual tasks** | | |
| **Student signatures**  i.e. those present or who have actively contributed to the log sheet. | **Sebastian Gabriel Visan** | |
| **Alexandru-Adonis Neagu** | |
| **Oana-Diana Prahoveanu** | |
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**7th April 2021:**

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| **Date and time of session** | | **7th April 2021** |
| **Location and format (i.e. face-to-face/Skype etc)** | | **Microsoft Teams Meeting** |
| **Attendees** | | **Sebastian Gabriel Visan**  **Alexandru-Adonis Neagu**  **Oana-Diana Prahoveanu** |
| **Apologies for absence** | | **N/A** |
| **No contact/did not attend** | | **Nikolay Nenchev**  **Mario Nemeck** |
| **Brief description of work done by each group member since the last meeting** | | |
| **Work on the app functionality and interface is still in progress. Working on how to implement facial recognition on a server.** | | |
| **Agreed tasks for next meeting for each group member** | | |
| **Finishing the individual tasks and working on putting the project together.** | | |
| **Notes on tutor comments and advice (if session occurs in class)** | | |
| **Work on implementing the facial recognition model into the web app** | | |
| **Student signatures**  i.e. those present or who have actively contributed to the log sheet. | **Sebastian Gabriel Visan** | |
| **Alexandru-Adonis Neagu** | |
| **Oana-Diana Prahoveanu** | |
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**14th April 2021:**

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| **Date and time of session** | | **14th April 2021** |
| **Location and format (i.e. face-to-face/Skype etc)** | | **Microsoft Teams Meeting** |
| **Attendees** | | **Sebastian Gabriel Visan**  **Alexandru-Adonis Neagu**  **Oana-Diana Prahoveanu** |
| **Apologies for absence** | | **N/A** |
| **No contact/did not attend** | | **Nikolay Nenchev**  **Mario Nemeck** |
| **Brief description of work done by each group member since last meeting** | | |
| **Work on the app functionality and interface is still in progress. Work for implementing facial recognition on local server done.** | | |
| **Agreed tasks for next meeting for each group member** | | |
| **Finishing the individual tasks and working on using facial recognition on the website.** | | |
| **Notes on tutor comments and advice (if session occurs in** | | |
| **Work on website functionalities and add the facial recognition to the website.** | | |
| **Student signatures**  i.e. those present or who have actively contributed to the log sheet. | **Sebastian Gabriel Visan** | |
| **Alexandru-Adonis Neagu** | |
| **Oana-Diana Prahoveanu** | |
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**21th April 2021:**

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| **Date and time of session** | | **21th April 2021** |
| **Location and format (i.e. face-to-face/Skype etc)** | | **Microsoft Teams Meeting** |
| **Attendees** | | **Sebastian Gabriel Visan**  **Alexandru-Adonis Neagu**  **Oana-Diana Prahoveanu** |
| **Apologies for absence** | | **N/A** |
| **No contact/did not attend** | | **Nikolay Nenchev**  **Mario Nemeck** |
| **Brief description of work done by each group member since** | | |
| **Testing and getting done the last bits of the group work.** | | |
| **Agreed tasks for next meeting for each group** | | |
| **Get done the last bits of the practical work and get done the documentation.** | | |
| **Notes on tutor comments and advice (if session occurs** | | |
| **Start to comment out the code and explain how to get it to work on another device. Get ready for the presentation on 13th of March.** | | |
| **Student signatures**  i.e. those present or who have actively contributed to the log sheet. | **Sebastian Gabriel Visan** | |
| **Alexandru-Adonis Neagu** | |
| **Oana-Diana Prahoveanu** | |
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