Journal of Applied Technical and Educational Sciences jATES

ISSN 2560-5429

http://jates.org

jATES Journal of Applied Technical and Educational Sciences

Processing sensor data from the NAO robot

Enikő Nagy [1]*

1 Óbuda University Antal Bejczy Center for Intelligent Robotics, John von Neumann Faculty of Informatics 96/b. Bécsi road H-1034 Budapest, Hungary*

nagy.eniko@nik.uni-obuda.hu ORCID: 0000-0001-5553-2627

Abstract: *The paper presents the processing of sensor data from the NAO humanoid robot, with a focus on the use of Python and the NAOqi API to capture and analyze visual data. The robot is equipped with advanced sensors, such as accelerometers, gyroscopes, touch sensors, and a camera, which enable complex interactions in the human environment. The solution allows for live video streaming to be captured and displayed using OpenCV, while the user can intuitively control the process. In addition, the paper discusses the diverse application areas of the NAO robot, such as education, research, entertainment, and healthcare, all of which offer innovative solutions to meet different usage needs. The interactive capabilities of the NAO robot allow students to easily learn the basics of programming and artificial intelligence, while researchers can use it to develop new algorithms in the field of machine learning and AI. The paper emphasizes the importance of technological integration, which makes robotics play an increasingly important role in everyday life. The study opens new perspectives in the field of data processing and application possibilities of robots, contributing to the development of future autonomous systems.*

Keywords: *NAO robot ; sensor data processing; NAOqi API; Python; OpenCV; humanoid robot; interactive education; machine learning; autonomous systems;*

Introduction

The development of humanoid robots has reached significant milestones in the last decades and they have become versatile devices that offer innovative solutions in many fields. One of the best known and most popular of these robots is Nao, developed by SoftBank Robotics. The Nao robot was originally designed for research purposes, but over time it has become increasingly popular in education and entertainment. Its versatility is due to its programmability, numerous sensors and humanoid design, which allows it to perform complex interactions in a human environment (Softbank Robotics, 2008).

One of the greatest advantages of the Nao robot is that it is both easy to use and highly advanced. It is used in education, for example, to teach programming, participate in robotics projects and support interactive learning activities (Nagy, Karl & Molnár, 2024). The popularity of this type of robot highlights the rapid pace at which robotics is becoming part of everyday life, while creating new opportunities for engineering and computer science research. The teaching of topics supported by robots and unmanned (UAV) robotic systems (Szabolcsi, Molnár, & Wührl, 2024) can be implemented in a modern, interactive way, which greatly supports the informal learning dimension (Molnár, 2013) and the process of learning through group work (Molnár, .2014). This also contributes significantly to the development of students' digital competences (Holik et. al., 2023).

A key element in the operation of robots is the use of sensors, which are essential for collecting and processing environmental information. Sensors enable robots to sense the world around them, collect data on movement, touch or visual stimuli and make decisions based on this information. The Nao robot, for example, is equipped with sensors such as accelerometers, gyroscopes, touch sensors and cameras that provide a variety of data for the device's operation and interaction with the environment.

Technological advances are increasingly integrating the processing of sensor data into cloud-based services. Cloud services allow the data collected by robots to be centrally stored, analysed and made easily accessible for further processing. This is particularly important in modern robotic systems, where efficient data management and storage are essential for advanced functionality.

The aim of this paper is to describe in detail how the sensor data of the Nao robot can be retrieved using Python and then transmitted to a cloud environment. The analysis focuses not only on data management, but also on how the integration of robots and cloud technology can become a cornerstone of innovation. The application of this type of technology can open up new perspectives not only in research, but also in education and industry (E. Nagy, 2020).

1. Introducing the Nao robot and the NAOqi API

1.1. Features of the Nao robot

The Nao robot is a humanoid robot developed by SoftBank Robotics. Its design follows the humanoid form: two arms, two legs, head and torso, which together can simulate human movements and behaviour. The robot is about 58 cm high and weighs 5 kg, making it easy to carry but capable of stable movement.

Hardware features of the Nao robot include advanced sensors and complex motion mechanics. The robot features:

- accelerometers and gyroscopes needed to maintain balance.
- Camera that enables face recognition and visual object detection.
- Touch sensors on the head, arms and legs that can be used to receive interaction commands.
- Microphones and speakers that enable the robot to recognise and generate speech.
- LEDs that provide visual feedback.

The integration of these sensors and devices makes the Nao robot suitable for complex tasks such as use in education or research environments.

1.2. The NAOqi software platform

The Nao robot is supported by the NAOqi API, which is the official development framework for the robot. NAOqi provides communication between the hardware and software components of the robot and allows the robot to be programmed in different languages, such as Python or C++.

Main functions:

- Motion control: the API allows the robot's movements to be precisely programmed. NAOqi supports the simulation of walking, arm and head movements, as well as balance maintenance.
- Sensor data management: the NAOqi API provides access to data collected by the robot's sensors, such as accelerometer or camera data.
- Communication: the API makes it easy to program speech recognition, text reading and interaction with human users.
- Application development: NAOqi allows the creation of custom applications that can be tailored to different tasks.

1.3. Development opportunities and the role of Python

One of the biggest advantages of the NAOqi API is its support for Python, one of the most widely used and easiest to learn programming languages. With Python, developers can easily write scripts for the robot, such as motion commands, sensor data readouts or even more complex algorithms to analyse data.

The combination of Python and the NAOqi API allows developers to:

- Access the robot's sensors.
- Program user interactions such as speech recognition or visual analysis.
- Store data and integrate it with external systems such as cloud services.

Example 1: Motion programming

The code snippet below shows an example of how a robot can be programmed to raise its arm:

```
from naoqi import ALProxy
motion = ALProxy("ALMotion", "<robot_ip>", 9559)
motion.setAngles("RShoulderPitch", -1.0, 0.2) # Raise right arm
```

Example 2: Speech generation

The following example shows how to make the robot speak:

```
from naoqi import ALProxy
tts = ALProxy("ALTextToSpeech", "<robot_ip>", 9559)
tts.say("Hello! I am Nao, your friendly robot!")
```

Example 3: Using a camera

The following Python code can be used to capture frames from the camera:

```
from naoqi import ALProxy
video = ALProxy("ALVideoDevice", "<robot_ip>", 9559)
client_name = video.subscribe("camera", 2, 11, 5) # Camera settings
frame = video.getImageRemote(client_name) # Get frame
video.unsubscribe(client_name)
```

1.4. Areas of application of the Nao robot

The versatility of the Nao robot means it can be used in many different fields, particularly in education, research and entertainment. The advanced sensors and accessible programming capabilities allow Nao to be used in a variety of interactive and educational applications, as well as in artificial intelligence and robotics research. Below, I will describe in more detail some of the commonly known applications and practical case studies of the use of the Nao robot in different fields. These types of case studies are documented in a number of research and projects, particularly in the field of educational robotics and STEM education (Bano, S., Atif, K. & Mehdi, S.A, 2024).

1.4.1 Education

The Nao robot plays a prominent role in education by helping students understand programming, robotics, artificial intelligence and other technology topics. The robot can interact with students, helping them to stay motivated while learning new skills (Fig.1).

Example case study - Teaching programming to children

In a school project, the Nao robot can be used to help students learn the basics of programming. Students program the robot in Python to perform simple tasks such as walking, holding out their hand or telling a simple story. The robot makes programming engaging for students because they are able to see the robot move and respond to commands in real time. The teacher can use the Nao robot to easily illustrate different elements of programming, such as loops and conditions, while the students have fun learning. This is supported by Eduporium's two e-books that help educators to effectively integrate the NAO robot into the curriculum, with a focus on STEM and special education (Eduporium, 2025).

As another example, the NAO robot Higher Education Pack offered by RobotLAB is specifically designed for higher education institutions and allows students to learn programming and robotics hands-on (RobotLab, 2025).

At the same time, several studies point out that the proper training of teachers is key not only in the transfer of technological knowledge, but also in the way they interpret and accept technological tools in a social and cultural context. Lack of training can encourage teachers to use the robot as a mere entertainment tool, which can reduce learning effectiveness and teacher confidence (Gardenghi C. & Gherardi L, 2024).

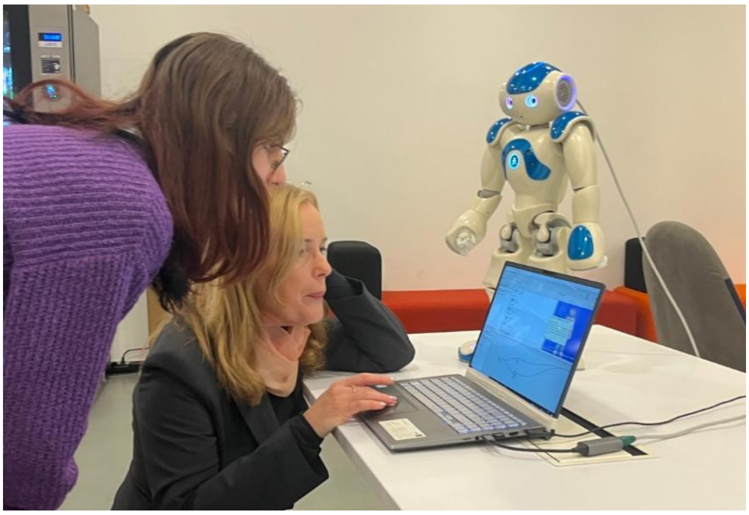

Figure 1. NAO are used in classrooms to teach robotics. Photo: Own Editing

1.4.2 Robotic research

Nao robots are an excellent tool for robotics research, especially in the fields of artificial intelligence (AI), machine learning and social interaction. Robots are able to continuously learn and adapt to their environment, providing researchers with the opportunity to develop new algorithms that facilitate communication, cooperation and intelligence between robots.

Example case study - Using the Nao robot in visual attention and therapeutic behaviour research

In a study, researchers from the University of Parma have investigated the use of the NAO humanoid robot in memory training for elderly people with mild cognitive impairment. The aim of the study was to explore the impact of robot-led exercises on the cognitive performance and behaviour of the participants. The NAO robot was programmed to perform memory exercises that were familiar during therapy sessions, while the researchers used special software to analyse the participants' reactions, in particular the direction of their gaze and the frequency of their smiles towards the robot and the therapist.

The results of the study showed that participants made significant improvements in prose memory and verbal fluency after the robot-led training sessions. In addition, the studies showed that patients paid increased visual attention to the robot, which was a motivating factor for their participation in the tasks. The presence of the robot not only reinforced positive therapeutic behaviours, but also helped to reduce unwanted behaviours. The results of the study suggest that the NAO robot can be effectively integrated into memory training programmes and may be a useful tool in the treatment of cognitive decline in older adults. The interactive and motivating environment provided by the robot can significantly contribute to the success of the therapeutic process (Pino, O.; Palestra, G.; Trevino, Rosalinda & De Carolis, B., 2019).

1.4.3 Entertainment industry

The Nao robot can be used not only for educational and research purposes, but is also being given a prominent role in entertainment applications. It offers interactive and entertaining experiences that have been presented at various events and exhibitions. The robot can give simple presentations, dance or tell stories.

Case study - Interactive demonstration in an exhibition

Nao robots are also presented at various international exhibitions, where visitors can interact with the robot. The robot answers questions, dances to music and performs entertaining sketches. The aim of these events is usually to raise awareness of the development of robotics and to showcase future applications of robots. Visitors enjoy the direct interaction, and many make videos that are shared on social media, so the robot also acts as an entertainment and educational tool. The NAO robot has been presented at several events at Óbuda University. For example, at the annual Educatio exhibition, visitors to the university's stand can take part in interactive demonstrations where the NAO robot dances and performs various tasks. In addition, the NAO robot is also used at university open days and in secondary schools, where participants can learn about the robot's capabilities and applications (Óbudai Egyetem, 2024).

The Nao robot was developed by SoftBank Robotics and has become known worldwide, particularly in the fields of education and research. The robot's interactive capabilities, such as speech, dance and facial recognition, allow users to communicate directly with it (Aldebaran, 2025).

1.4.4 Care for the elderly

Some research and applications have also used the Nao robot in elderly care. It can help elderly people to perform routine daily tasks, provide reminders and communicate with them interactively. Robots can perform tasks such as providing medical reminders or even help provide companionship to those who are lonely.

Example case study - Home for the elderly

In a nursing home, the Nao robot was used to help residents with their daily routines. The robot reminded them to take their medication, chatted with them and was able to entertain them with simple games and stories. Residents responded positively to the robot's interactive capabilities and many felt that the robot kept them company. The home's management saw this as a big step in incorporating technology into everyday care (B. H Abery & R. Ticha, 2025).

1.5. Technological features of the Nao robot

The Nao robot is a highly advanced humanoid robot used for a variety of research, educational and entertainment purposes around the world. Its compact size and lightweight design make it one of the most suitable tools for use in educational institutions. The Nao robot is approximately 58 cm high and weighs 4 kg, which allows it to operate in small spaces while providing sufficient stability for various interactions and movements. The robot has a number of built-in sensors that play an essential role in interacting with its environment. These include accelerometers, gyroscopes, infrared rangefinders, and an advanced camera, all of which contribute to Nao's ability to sense and react to its environment.

The operation and control of the Nao robot is provided by the NAOqi Software Development Kit (SDK), which allows the robot to be controlled by supporting a wide range of programming languages. The SDK gives users full access to the robot's various capabilities, including motion, speech and sensor data. The Python programming language is particularly popular for working with the NAOqi SDK, as its simplified syntax and wide range of applications make it easy to control the robot and process data. Using the Python API, users can query the robot's sensors and automate robot behaviour such as movement, sounds and responses.

The Nao robot is equipped with various sensors that form the basis of its interaction. The accelerometer and gyroscope allow the robot to sense its motion and stability, which are essential for navigation in dynamic environments. In addition, the robot's range-finding sensors help Nao to detect approaching obstacles and other objects, thus avoiding potential collisions. The robot can retrieve and process this data using Python, which gives developers the ability to create different applications that take into account the robot's environment and movements. Managing sensor data is crucial to increasing the robot's interactive capabilities, as accurate data collection is essential to developing successful applications, whether for educational, research or entertainment purposes.

The Nao robot is therefore not just a simple humanoid robot, but a highly advanced technological tool that is an integral part of modern robotics research and applications. The combination of various sensors and the NAOqi SDK allows robots to react intelligently and dynamically to their environment and can be used in a wide range of applications.

2. Processing and storage of sensor data

In this chapter, we will describe in detail how to retrieve and prepare the sensor data of the Nao robot, and how to process and store the data in different formats so that it can be easily used later. The solution is also demonstrated through a practical example of saving to image and video files.

2.1. Retrieving and preparing sensor data

The Nao robot contains a number of sensors that provide data about the robot's environment and status. These sensors generate different types of data, such as accelerometers, gyroscopes, rangefinders, infrared sensors, touch sensors, cameras, etc.

The camera as a sensor in robotics

One of the most important questions in modern robotics is how different sensors can help machines to accurately and efficiently sense their environment. Sensors play a key role in this process by enabling robots to react to external stimuli. Most people traditionally think of sensors as devices that provide specific measurements, such as temperature, distance or pressure. In this context, the question arises: can a camera be considered a sensor?

Sensors are defined as any device that detects physical signals and converts them into an electronic data format. A camera fits this definition as it captures and transmits visual data in digital form. Modern cameras use light-sensitive sensors, usually CMOS or CCD technology, to convert incoming light into pixels. This feature makes the camera particularly important in robotics, as it allows machines to process and react to visual information.

For the NAO humanoid robot, the camera acts as a key sensor. It not only captures visual data, but also provides a means of interpreting the environment. For example, the camera can help the NAO recognise faces, track moving objects or even identify objects using artificial intelligence algorithms. These capabilities allow the robot to interact with its environment in a way that would not be possible with a traditional sensor, such as a temperature or range finder.

Nevertheless, the camera is different from sensors in the classical sense. While a temperature sensor returns a specific numerical value, a camera captures a complete image that requires further processing. To process the image information, advanced algorithms and computing power are needed to draw useful conclusions from the data. This differentiates the camera from other sensors, but does not reduce its importance in the field of sensing.

The greatest benefits are achieved when the camera is combined with other sensors. For example, when used in combination with an ultrasonic rangefinder, it can provide more accurate spatial sensing. The visual information can then complement the data measured by other sensors, giving the robot a more complex and accurate picture of its environment.

2.2. How the NAO Robot Camera Works and OpenCV-based Image Processing

A key element of modern robotic systems is visual perception and its efficient processing. The NAO humanoid robot's built-in camera provides the ability to perceive the environment, which can be used in a wide range of applications such as interactive education, object recognition and navigation. This paper presents a Python-based solution that can capture and display a real-time video stream using OpenCV and the NAOqi API.

Structure of the system

The first step of the implementation is to import the necessary libraries. The OpenCV (cv2) is responsible for image processing and video display, while the numpy library provides efficient data conversion and storage. From the NAO robot API, the ALProxy class is used to connect to the robot's camera.

To establish the connection, we first need to specify the IP address of the NAO robot and the corresponding port. This allows the program to access the camera via the ALVideoDevice service. The resolution, colour mode and frame rate settings determine the quality and format of the image data received. The current implementation uses a resolution of 640×480 pixels in RGB colour mode and a frame rate of 20 frames per second.

Real-time frame processing

The program processes frames from the NAO robot's camera in a continuous cycle. Using the getImageRemote function, the current image seen by the robot is retrieved and the binary data is converted into a numpy array. The transformed data is converted to a three-dimensional matrix, which is converted to the appropriate format using OpenCV and set to RGB colour order.

Once the program receives valid image data, the live video stream is displayed in a separate window via the OpenCV imshow function. At the same time, the frames are also saved in an AVI video file, which allows the data to be played back and analysed later. Using the XVID compression format, the video recorder handles the frames efficiently and ensures the right quality.

User interaction and safe shutdown

For the user, the program offers a simple and intuitive control: pressing the 'q' key stops the video stream and the program releases resources accordingly. The implementation also includes an exception handling mechanism to ensure that the flow will complete properly in case of any interruption (e.g. a user shutdown or an unexpected error). Camera access is revoked, the video file is closed and all OpenCV windows are closed.

2.3. Interpreting the code

The following Python code captures and displays a live video stream from the NAO robot's camera using OpenCV. It also saves the data to an .avi video file. Let's take a closer look at what it does!

1. **Importing libraries**

import cv2 cv2 (OpenCV) – Used for image processing and visualization.

import numpy as np numpy – Converts the NAO camera data to a numpy array for easier handling.

from naoqi import ALProxy naoqi.ALProxy – The NAO robot API that allows you to connect to the camera and retrieve images.

import sys – Although sys is not used here, it is usually used to handle command line arguments.

2. **Configuring the NAO robot camera**

NAO_IP = "169.254.20.238" Sets the IP address and port of the NAO robot to communicate with it.

NAO_PORT = 9559

camera_proxy = ALProxy("ALVideoDevice", NAO_IP, NAO_PORT) Creates a proxy object for the NAO camera service using ALProxy.

3. Camera settings

resolution = 2 # 640x480 The camera records in 640×480 resolution.

color_space = 11 # RGB color mode NAO renders the image in RGB color space.

fps = 20 # Frame rate The video runs at 20 frames per second.

4. Video stream access

video_client = camera_proxy.subscribe("Camera", resolution, color_space, fps)

Accesses the NAO camera through the ALVideoDevice service and receives live frames in a video_client object.

5. Video save settings

fourcc = cv2.VideoWriter_fourcc('XVID')* Uses XVID codec to compress the video.

video_filename = 'nao_camera_video_02.avi'

The recorded video is saved as nao_camera_video_02.avi.

video_writer = None The video writer object is initially None and is only created if there is a valid frame.

try:

while True:

result = camera_proxy.getImageRemote(video_client)

Continuously requests images from the robot's camera.

6. If the image is successfully read

if result:

width = result[0] Stores the width of the image.

height = result[1] Stores the height of the image.

image_data = result[6] Stores a list of the raw binary data of the image.

7. Image transformation and OpenCV display

if len(image_data) > 0:

image = np.frombuffer(image_data, dtype=np.uint8)

Converts the data to a numpy array.

image = image.reshape((height, width, 3))

Formats the array into an RGB image of the appropriate size.

image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)

Converts the default BGR format of OpenCV to RGB, because that is how NAO returns it.

8. Save video to file

if video_writer is None:

video_writer = cv2.VideoWriter(video_filename, fourcc, fps, (width, height))

video_writer.write(image) If the video writer object has not been created yet, initialize it. It writes each frame to the video file.

9. Display image in OpenCV window

cv2.imshow("Nao Camera Feed", image) OpenCV displays the camera image in a window.

if cv2.waitKey(1) & 0xFF == ord('q'):break If the user presses the “q” key, the program exits.

10. Exception Handling (Program Stopping)

except KeyboardInterrupt:

print("Program is stopped") If the user presses CTRL + C, the program stops with a message.

11. Freeing Resources

finally: camera_proxy.unsubscribe(video_client)

Unsubscribes from the NAO camera.

if video_writer is not None: Stops and frees the video writer resources.

video_writer.release()

cv2.destroyAllWindows() Closes the OpenCV windows.

So this script allows you to stream live images from the NAO robot's camera and display them using OpenCV. It also saves the captured video in AVI format. The program provides intuitive control: the user can exit by pressing the 'q' key, while the system takes care of releasing resources as needed. In the event of an unexpected interruption of the run (e.g. CTRL + C), the script ensures that the camera is shut down and all open windows are closed properly.

3. Future development and application opportunities

This solution provides an efficient and versatile way to process and capture NAO robot visual data in real-time, which is of particular importance in both robotics and computer vision. By integrating OpenCV with the NAOqi API, it is possible to interactively analyze the live video stream from the robot's camera, opening up a wide range of applications, including real-time object tracking, gesture recognition, face recognition, and the development of human-robot interaction.

Visual processing is a key component of autonomous systems, enabling robots to dynamically adapt to their environment and respond to environmental stimuli. The development of such systems is particularly important in education, where the NAO robot can be used to teach students about artificial intelligence and computer vision, and in research, where the robot may be able to perform complex data processing tasks. From the perspective of autonomous systems development, such technologies enable robots to make more autonomous decisions, for example, when navigating in an obstacle-ridden environment.

Further development opportunities cover a broad spectrum. One possible direction is the integration of image recognition algorithms that would enable the robot to identify and categorize different objects in its environment. Another important area of development is the deployment of object tracking systems that would allow the robot to track, for example, a moving person or a specific object with its camera. With the development of artificial intelligence, the incorporation of machine learning models could be feasible, allowing deeper analysis and prediction when processing visual data.

The potential of the NAO robot extends beyond research and education. As artificial intelligence and computer vision technologies advance, the robot can be used to develop algorithmic thinking, create interactive learning environments, and teach programming. In healthcare, NAO could contribute to therapeutic programs for children with autism spectrum disorder, engaging them in interactive activities that enhance social and communication skills. It could also support elderly care by providing companionship, reminding individuals to take medication, and guiding them through physical exercises. Additionally, integrating motion analysis and guided exercise routines could assist rehabilitation programs, offering personalized and interactive rehabilitation exercises.

The robot's applications in entertainment and consumer technology are also expanding. It has been used in museums, exhibitions, and events for engaging demonstrations, storytelling, and educational entertainment. Future development may integrate NAO with IoT devices, enabling it to assist with home automation, voice-controlled tasks, and personalized digital assistance. With AI-driven behavior adaptation, NAO could function as a social companion, responding to user preferences and adapting its interactions accordingly.

As artificial intelligence, machine learning, and robotics technologies continue to evolve, NAO's capabilities will expand, making it even more versatile and autonomous. Enhanced machine learning integration will allow the robot to refine its behavior based on real-world interactions, while cloud-based AI processing could offload computationally intensive tasks, improving efficiency and scalability. Additionally, its integration into professional environments could enable NAO to assist employees with repetitive tasks, conduct interactive presentations, or act as an AI-powered research assistant.

The NAO robot is not merely an educational or research tool but a continuously evolving platform that integrates cutting-edge AI and robotics innovations. As these technologies progress, NAO's role in education, healthcare, entertainment, and assistive services will expand, making it an indispensable tool for learning, research, and daily human interaction. The ongoing development of AI-driven robotics ensures that humanoid robots like NAO will play an increasingly significant role in shaping the future of human-robot collaboration and intelligent autonomous systems.

4. Summary

This paper provides a comprehensive analysis of the processing of sensor data and the utilization of the camera in the humanoid robot NAO using OpenCV. The NAO robot is equipped with a variety of advanced sensors, including accelerometers, gyroscopes, touch sensors, and a high-resolution camera, enabling real-time visual data collection and processing. The paper explains the process of accessing the robot’s camera in Python via the NAOqi API and presents a program capable of capturing and displaying a live video stream. By leveraging OpenCV and numpy libraries, the image data is transformed and saved in an AVI file format, ensuring efficient data management. The implemented program also offers an intuitive interface for real-time video viewing, incorporating a simple keyboard shortcut for termination (pressing 'q'). Additionally, robust exception handling mechanisms are integrated to ensure the proper disconnection of the camera and the closure of the video file, enhancing system stability and reliability.

Beyond technical implementation, the study explores the broad spectrum of applications for the NAO robot. In educational settings, the robot serves as an interactive tool for teaching programming, robotics, and artificial intelligence through engaging, hands-on learning experiences. Its ability to execute predefined movements and respond to commands enhances student engagement and fosters a deeper understanding of computational thinking. In research, NAO plays a crucial role in the advancement of AI and machine learning, particularly in the exploration of social interactions, human-robot collaboration, and autonomous decision-making processes. The robot is also instrumental in therapeutic applications, such as cognitive training and emotional support for individuals with autism spectrum disorder, contributing to improved social and communication skills.

In addition to education and research, NAO has significant potential in the entertainment industry, where it is utilized in interactive presentations, exhibitions, and public events. The robot's ability to perform complex gestures, speak, and even dance makes it an attractive feature in various public engagement initiatives. Furthermore, in healthcare and social care settings, NAO has been deployed to assist the elderly and individuals with special needs by providing companionship, aiding in memory exercises, and facilitating social interactions. As artificial intelligence and robotics technologies continue to evolve, NAO's role in these domains is expected to expand, further enhancing its versatility and impact.

The document underscores the ongoing advancements in artificial intelligence and robotics, positioning the NAO robot as a pivotal tool in the convergence of technology and human-centered applications. With continuous development, NAO is expected to play an increasingly influential role in education, research, healthcare, and entertainment, driving innovation and expanding the frontiers of intelligent autonomous systems. These technological innovations not only highlight the growing significance of humanoid robots in various industries but also pave the way for future breakthroughs in interactive and autonomous robotics.

References

Aldebaran (2025). Nao Support https://aldebaran.com/support/nao-6/ [2025.02.04]

Bano, S., Atif, K. & Mehdi, S.A. (2024). Systematic review: Potential effectiveness of educational robotics for 21st century skills development in young learners. *Educ Inf Technol* 29, 11135–11153. https://doi.org/10.1007/s10639-023-12233-2

B. H Abery & R. Ticha (2025). Enhancing Physical Activity Among Older Adults Using Nao, a Socially Assistive Robot at College of Education and Human Development, University of Minnesota, Institute on Community Integration, University of Minnesota https://ici.umn.edu/projects/2Oo1qdvWT_e5Xbv9wvTVfg?utm_source [2025.02.04]

Eduporiom (2025). Two eBooks for Teaching with SoftBank Robotics' NAO Robot https://www.eduporium.com/blog/two-new-ebooks-for-educators-interested-in-teaching-robotics-with-nao [2025.02.04]

E. Nagy (2020). Robots in education and training processes, TRAINING AND PRACTICE 18: 3-4 pp. 176-186., 11 p. DOI: 10.17165/TP.2020.3-4.18

E. Nagy, É. Karl & Gy. Molnár (2024). Exploring the Role of Human-Robot Interactions, within the Context of the Effectiveness of a NAO Robot ACTA POLYTECHNICA HUNGARICA 21: 3 pp. 177-190. , 14 p. DOI:10.12700/APH.21.3.2024.3.12

E. Nagy & I. Holik (2023). Educational robots in higher education -findings from an international survey, *2023 IEEE 17th International Symposium on Applied Computational Intelligence and Informatics (SACI)*, Timisoara, Romania, pp.15-20, DOI: 10.1109/SACI58269.2023.10158668.

I. Holik, T. Kersánszki, Gy. Molnár, I. Dániel Sanda (2023). Teachers' Digital Skills and Methodological Characteristics of Online Education, INTERNATIONAL JOURNAL OF ENGINEERING PEDAGOGY 13: 4 pp. 50-65.

Gy. Molnár (2013). Formal and informal network-based learning environments and the role of their learning potential, In: J. Ollé (ed.) V. Education-Informatics Conference: proceedings, Budapest, Hungary: ELTE PPK Institute of Educational Sciences pp. 196-201.

Gy. Molnár (2014). Experiences of pedagogical renewal in professional teacher education - new ICT-based tools and concepts in teacher education, In: J. Ollé (ed.) VI Conference on Education and Informatics, Budapest, Hungary: ELTE PPK Institute of Educational Sciences pp. 434-452.

Gardenghi C. & Gherardi L. (2024). "Teaching With the Nao Robot: Teacher - Users' Attitudes" *Italian Journal of Sociology of Education*, 16(1), 71-86. DOI: 10.14658/PUPJ-IJSE-2024-1-4

Óbudai Egyetem (2025). Robotok találkozása a műszaki pályaorientáció jegyében https://uni-obuda.hu/2024/12/14/robotok-talalkozasa-a-muszaki-palyaorientacio-jegyeben/ [2025.01.17]

Pino, O.; Palestra, G.; Trevino, Rosalinda & De Carolis, B. (2019). The Humanoid Robot NAO as Trainer in a Memory Program for Elderly People with Mild Cognitive Impairment In: INTERNATIONAL JOURNAL OF SOCIAL ROBOTICS. ISSN 1875-4805., pp. 1-13. [1007/s12369-019-00533-y]

RobotLab (2025). NAO robot Higher Education Pack Robots as a teaching-aid tool https://www.robotlab.com/higher-ed-robots [2025.02.04]

R. Szabolcsi, Gy. Molnár, T. Wührl (2024). Conceptual Design of a UAV-UGV Autonomous Collaborative Robot System, In: Óbuda University (ed.) 2024 IEEE 7th International Conference and Workshop Óbuda on Electrical and Power Engineering (CANDO-EPE): Proceedings, Budapest, Hungary, IEEE Hungary Section pp. 207-211.

Softbank Robotics (2008). Robots Nao https://robotsguide.com/robots/nao [2025.02.04]

Brief Professional Biography

Enikő Nagy is an associate professor, computer science engineer, English-computer science teacher, currently teaching at Óbuda University. She leads computer science courses in Hungarian and English, ranging from advanced spreadsheets to database development, from business informatics to educational robotics. She completed her higher education at the Dunaújváros College Faculty of the University of

Miskolc and the Faculty of Informatics of the Eötvös Loránd University. She completed her doctoral studies at the "Education and Society" Doctoral School of Educational Sciences of the University of Pécs, obtaining the PhD degree. Her professional and research interests focus on robotics applied to education (robot programming and the role of robots in education), as well as databases and corporate information systems (Oracle, SQL, ERP). The subjects she teaches cover both applied and development IT disciplines, including business and economic IT, database systems, SQL, tourism software knowledge, digital pedagogy, web programming and educational robotics. Her IT activities extend not only to education, but also to participation in development projects. In these, she deals with the planning and coordination of IT development processes, as well as development support and documentation tasks. In addition, she is also involved in the implementation of new business opportunities. For nearly two decades, she has been conducting research activities. Her main research areas include the application of IT in various disciplines (education), as well as the role and application of social robots in economic and educational environments. She is a member of the "Multimedia in Education" section of the John von Neumann Computer Science Society, the secretary of the Didactics Subcommittee at Pedagogical Scientific Committee of the Hungarian Academy of Sciences. She has been hold the position of executive chairman of the Robotics Section of the Hungarian Pedagogical Society. Her announced PhD, MSc and BSc research topics:

- Efficiency testing of educational robots, promoting their suitability, technical and infrastructural integration in educational environments.
- Development of educational applications supported by robots.
- Aspects of databases and database systems.
- Informatics in education and pedagogical work.

Enikő Nagy uses education to help understand and embrace informatics, related aspects and its modern challenges, both in theory and practice, to create innovative learning environments.