

TECHNICAL AND SCIENTIFIC REPORT, STAGE 3 (2020)

PROJECT 5

Component project: Pr.5 Intelligent driving, with advanced techniques and navigation based on high-performance sensors, video-biometric system and visual servoing system of the complex autonomous system SAC-SI integrated in the technology of assisting people with severe neuro-motor disabilities

Stage 3 (2020)

The results of the laboratory testing of the intelligent driving structure, the navigation structure (based on high-performance sensors) and the real-time visual servoing of the SAC-SI advanced driving structure based on systems integrated in the technology of assisting people with severe neuromotor disabilities

Stage 3 - P5. The researches of Stage 3 respond to the research objectives related to Activities 3.17, 3.18, 3.19, 3.20, from the realization plan of the complex project, and finally led to the implementation and testing in laboratory mode of the real-time management of the complex SAC-SI system, autonomous robotic system consisting of a wheelchair and a robotic manipulator with 7-DOF integrated in the technology of assisting people with neuro-motor disabilities. In this stage, the hardware structure of the management system was finalized, respectively the existing system was completed, with a laser type sensor. The researches for implementation / testing required the establishment of a procedure for planning the trajectory of the complex SAC-SI system. An algorithm for planning the trajectory of the complex SAC-SI system was developed, which can avoid obstacles, and which was tested on the laboratory system. The scientific balance of this stage is the following: 1) Autonomous robotic system consisting of a wheelchair type "Cirrus Power Wheelchair" and robotic manipulator with 7-DOF, integrated; 2) Software package for planning the trajectory of the complex SAC-SI system; 3) Obstacle avoidance software package (based on laser sensors); 4) Real-time management of the complex SAC-SI system, using a video camera; 5) The control based on visual servoing system of the robotic manipulator with 7DOF.

Activity: Act 3.17 - Implementation and real-time testing of the intelligent driving structure (based on advanced techniques) and navigation structure (based on high-performance sensors) of SAC-SI integrated in the technology of assisting people with severe neuro-motor disabilities ;

Achievement indicators:

- Testing in laboratory conditions the management structure and the navigation structure for SAC-SI integrated in the technology of assisting people with severe neuro-motor disabilities;
- Reports with the results of SAC-SI testing integrated in the technology of assisting people with severe neuro-motor disabilities, in laboratory mode;

Laboratory testing of the steering structure and navigation structure for the complex autonomous system SAC-SI involved:

- Modification of the "Cirrus Power Wheelchair" wheelchair platform by adding and connecting a video camera that can transmit data in real time, so that a recognition of the user's head movement necessary for SAC-SI driving was possible.
 - Integration of the 4th floor map of building Y to achieve / generate the desired trajectory of the complex autonomous system SAC-SI.
- During this activity, a management structure of SAC-SI was tested using the head movements of a person with severe locomotor disabilities. By adding and connecting a video camera to the wheelchair, equipped with electric motors and computer equipment needed to perform face detection, the SAC-SI driving (simple, safe and easy to learn for a person with severe locomotor disabilities) was achieved. The application was physically designed and implemented so that it can be easily extended so that in the future it can be used to facilitate the movement of people with disabilities on other types of mobile platforms.

Activity: Act 3.18 - Implementation and real-time testing of the obstacle avoidance structure (based on high-performance sensors and video system) of SAC-SI integrated in the technology of assisting people with severe neuro-motor disabilities;

Achievement indicators:

- Laboratory testing of the obstacle avoidance structure (based on laser and video sensors) of the "Cirrus Power Wheelchair" (SAC-SI) integrated in the technology of assisting people with neuro-motor disabilities severe. During this stage, an algorithm was tested for the automatic determination of a trajectory (which allows to avoid fixed obstacles) for a wheelchair / wheelchair with two wheels using PSO (Particle Swarm Optimization) and a Lidar type sensor.

Activity: Act 3.19 - Implementation and real-time testing of the intelligent driving structure based on visual servoing systems (for the robotic manipulator with 7DOF) of SAC-SI integrated in the technology of assisting people with severe neuro-motor disabilities in conditions of laboratory;

Achievement indicators:

- Testing in laboratory conditions the intelligent driving structure based on visual servoing system of the Cyton 1500 manipulator that equips SAC-SI;
- Laboratory testing of the driving structure and navigation structure for the complex autonomous system SAC-SI involved modifying the wheelchair platform type "Cirrus Power Wheelchair" by adding the robotic manipulator with 7DOF and connecting a video camera that can transmit real-time data (visual servoing system).
- Testing the robotic manipulator with 7DOF was performed in laboratory conditions using various types of objects.



Fig.5.1 Laboratory testing of the navigation structure for the complex autonomous system SAC-SI using the head movements of a person: a) graphical interface, b) the real time testing of complex autonomous system SAC-SI

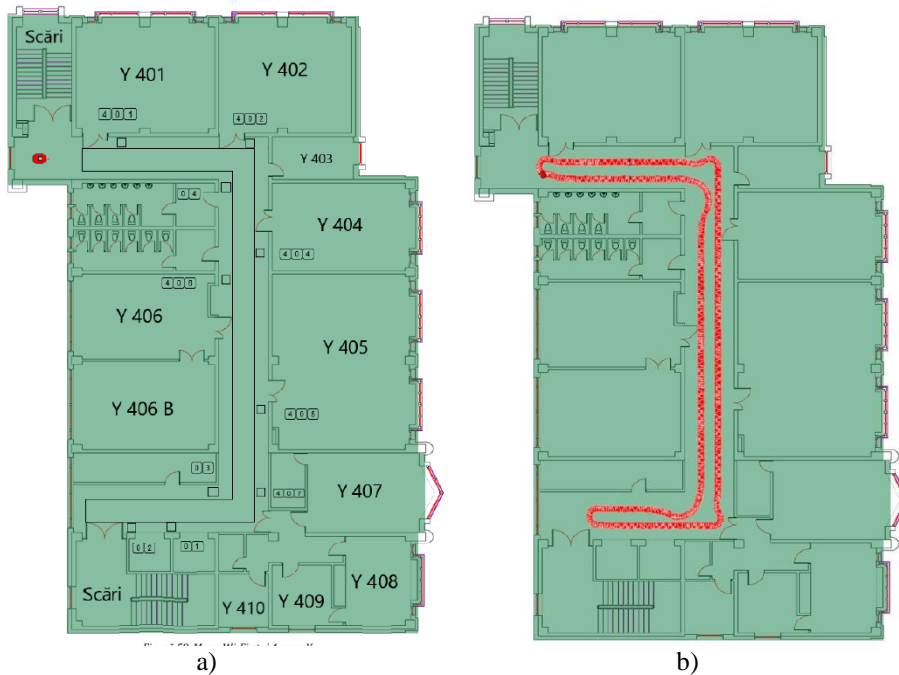


Fig.5.2 Testing in laboratory conditions of mobile platform with two wheels a) the real map of the 4th floor of Y building, b) the route traveled by the mobile platform in real time

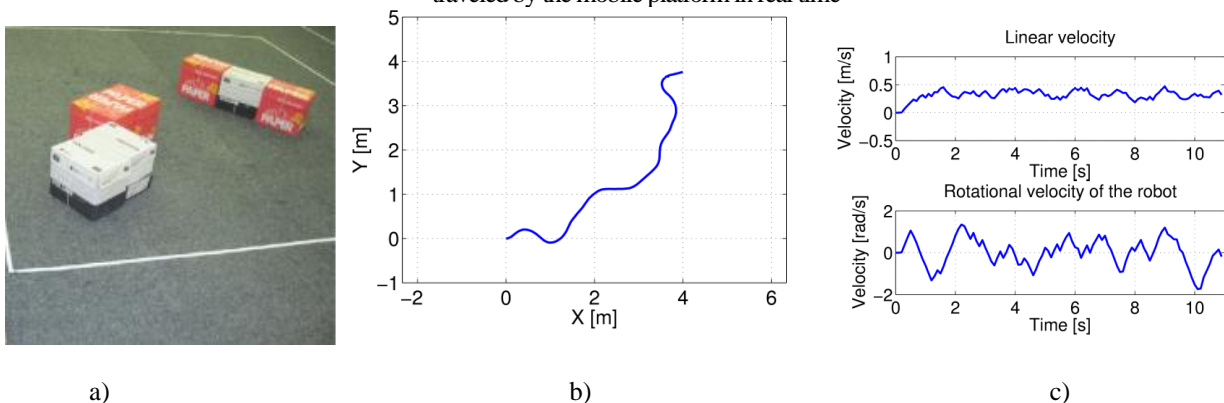


Fig.5.3 Laboratory testing of the obstacle avoidance structure (based on laser sensors), a) types of obstacles, b) the route followed by the mobile platform, c) the linear and angular velocity of the mobile platform.

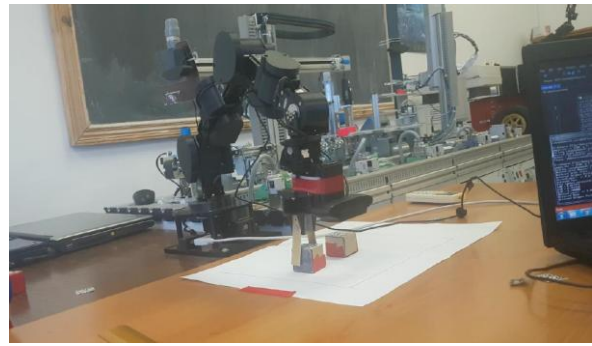


Fig. 5.6 Laboratory testing of the 7DOF robotic manipulator using boxes with QR codes attached.

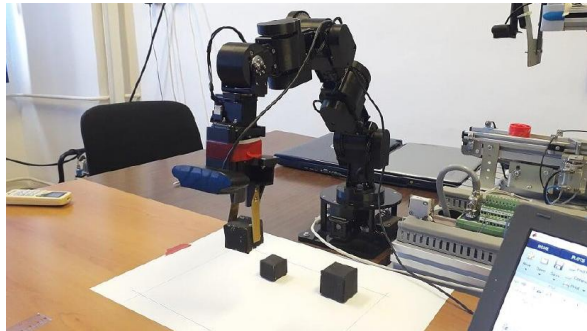
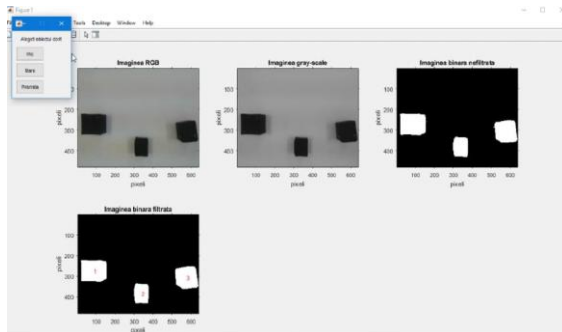


Fig. 5.7 Laboratory testing of the 7DOF robotic manipulator using boxes of different sizes / heights.

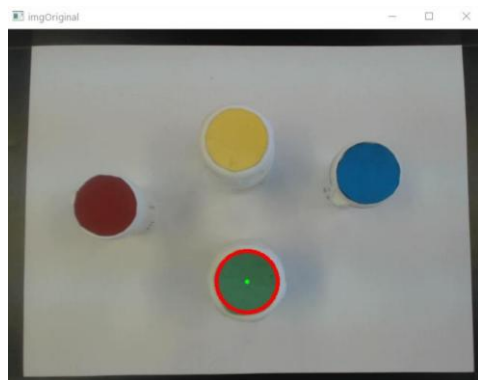


Fig. 5.8 Laboratory testing of the 7DOF robotic manipulator using boxes with variously colored.

Activity: Act 3.20 - -Testing the management structure, navigation and obstacle avoidance for the complex autonomous system SAC-SI integrated in the technology of assisting people with severe neuro-motor disabilities in laboratory conditions at UVT and UCV;

Achievement indicators:

A structure of offer of research services regarding SAC-SI integrated in the technology of assistance to people with severe neuro-motor disabilities present in the erris platform of the partner institutions in the consortium was created:

UVT: <https://erris.gov.ro/Valahia-University-of-Targoviste>

UCV: <https://erris.gov.ro/Computer-Aided-Design-CAD--C>

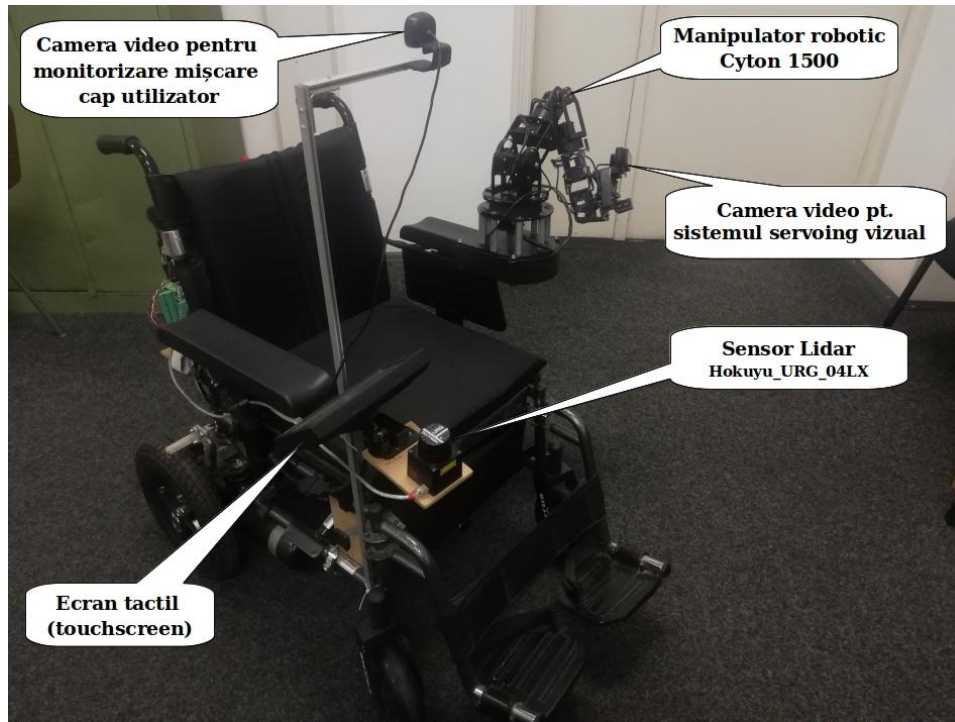


Fig. 5.9 The complex autonomous system SAC-SI integrated in the technology of assisting people with severe neuro-motor disabilities (front view).

Sistemul autonom complex SAC-SI integrat în tehnologia de asistare a persoanelor cu dizabilități neuro-motorii severe (vedere din față).

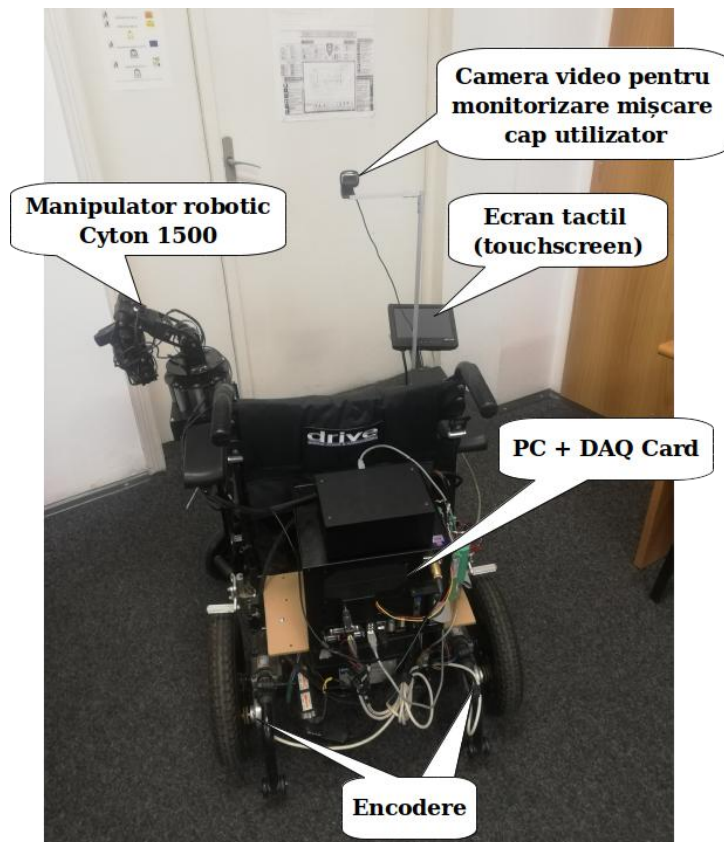


Fig. 5.10 The complex autonomous system SAC-SI integrated in the technology of assisting people with severe neuro-motor disabilities (rear view).

CONCLUSIONS

The scientific report highlights the solutions that the Project 5 work team offers for the requirements of Stage 3. In the detailed scientific report uploaded on the P5 project platform (<http://www.cidsacteh.ugal.ro>), you can view the solutions and results research related to Stage 3. „The results of the laboratory testing of the intelligent driving structure, the navigation structure (based on high-performance sensors) and the real-time visual servoing of the SAC-SI advanced management structure based on systems integrated in people with severe neuromotor disabilities”.

RESULTS STAGE 3

The following results were obtained:

- Autonomous robotic system consisting of a wheelchair type "Cirrus Power Wheelchair" and robotic manipulator with 7-DOF, integrated;
- Software package for planning the trajectory of the complex SAC-SI system;
- Obstacle avoidance software package (based on laser sensors);
- Real-time management of the complex SAC-SI system, using a video camera;
- Visual servoing system control of the robotic manipulator with 7DOF.

DISSEMINATION

Articles (ISI Proceedings or BDI)

1. Daniela Cristina Cernega, Solea, Razvan, “*Hybrid Control Application Using Mobile Visual Servoing for Flexible Manufacturing Mechatronics Line*”, 2020 - 24th International Conference on System Theory, Control and Computing (ICSTCC), Sinaia, Romania, 2020, pp. 636 -641, **ISSN:** 2372-1618 , **DOI:** 10.1109/ICSTCC50638.2020.9259644.