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Proposal of Control Algorithm for Electromotoric Swivel Walker

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Abstract Swivel walkers was base only on a mechanical structure that was physically demanding especially for people with complete paralysis of the lower limbs. This article describes the algorithm for motion of an electromotoric modules that are used to flip the rocking plate up to full-step cycle. Classic swivel walker is not designed for people with higher degrees of disability. Just a design of this modules is an innovative and modern solution of swivel walker.

Keywords: *swivel walker, electromotoric modules, control algorithm*

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1. Introduction

The first attempt to create a swivel Walker was an experiment for children with amputated limbs at the University of California (1963). He consisted of platform, columns and rocking plates. The movement was very hard and it has not brought the progress of research subject, progress has been slow and the child they prepared for this great energy. Swivel Walker with electromotoric modules (Figure 1) is meant for users with higher degrees of disability e.g. complete paralysis of the lower limbs or muscular dystrophy at a later stage of progress. This module uses as a partial replacement of wheelchair and lets you feeling re-experience of walking. The article described subsystem of motion sensors and control algorithm. Control algorithm consists of functions: balancing and by detecting the direction of the joystick is done by the program running forward, right or left [1,2,3].

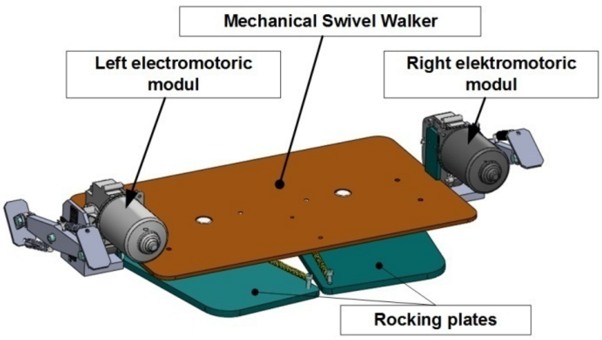

Figure 1. Design of swivel walker with electromotoric modules

The control system is designed of components for controlling selected motors. This consist of selecting a microcontroller, h - bridge, sensors, voltage source, and a method for motor control.

2. Proposal of Subsystem Sensors

To sense the position of the tilting structure was selected by inverting magnetic sensor that is placed on motor holder, see Figure 2. Perpendicular to the magnetic sensor module is magnet placed at a distance of 0.1 to 1 mm, which is required detection distance module. The number of modules needed to ensure every position of tilting structure are 4 magnetic sensors for each electromotoric module [4].

To control the direction and speed of the motor has been selected joystick Figure 3 - two axes X, Y with dimensions 4 x 2.6 x 3.2 cm. It consists of two potentiometers and a button. Module operating voltage is 5V [5].

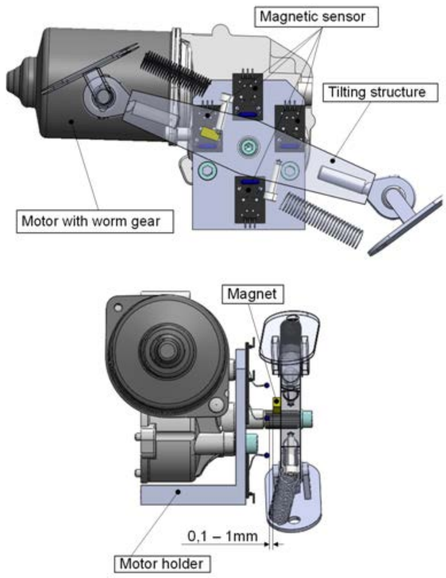

Figure 2. Proposal of magnetic sensors and magnets

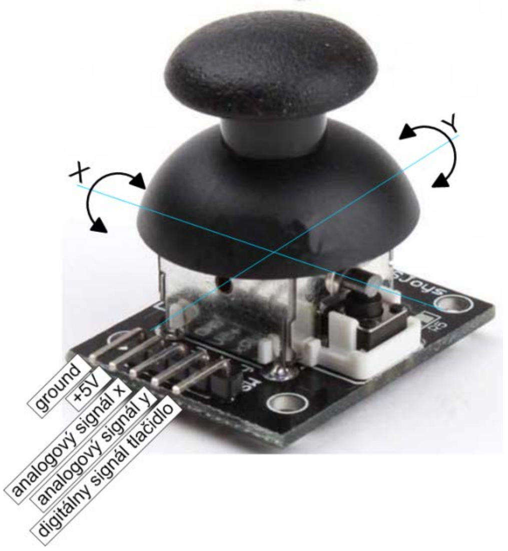

Figure 3. Design of swivel walker with electromotoric modules

2.1. Connection Diagram

The motors are controlled by shield monster moto, with two bridges VNH2SP30, which are essentially PWM controllers, shield is located on the Arduino microcontroller. Power system using 24V batteries. Motor position is sensed by electromagnetic sensors. Joystick can control motors in the functions of the mechanism: go forward, turn right and turn left. Block diagram of the control system shown on Figure 4 was created in the program Fritzing.

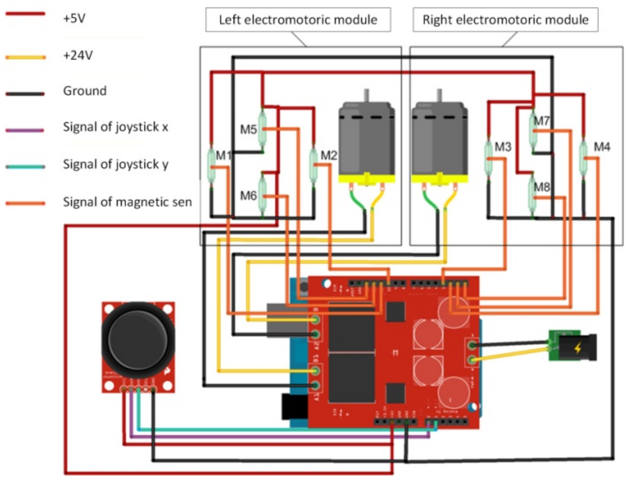

Figure 4. Connection diagram

3. Control Algorithm

Next is described main control algorithm for three functions of swivel walker and it goes forward, turn left and turn right. The important algorithm is for function of balancing tilting structure to the starting position (for left and right electromotoric module). Next are shown algorithm for functions go forward and turning. Algorithms are based from placement electromagnetic sensors at the module Figure 5. Where M1 – M8 are magnetic sensors [6].

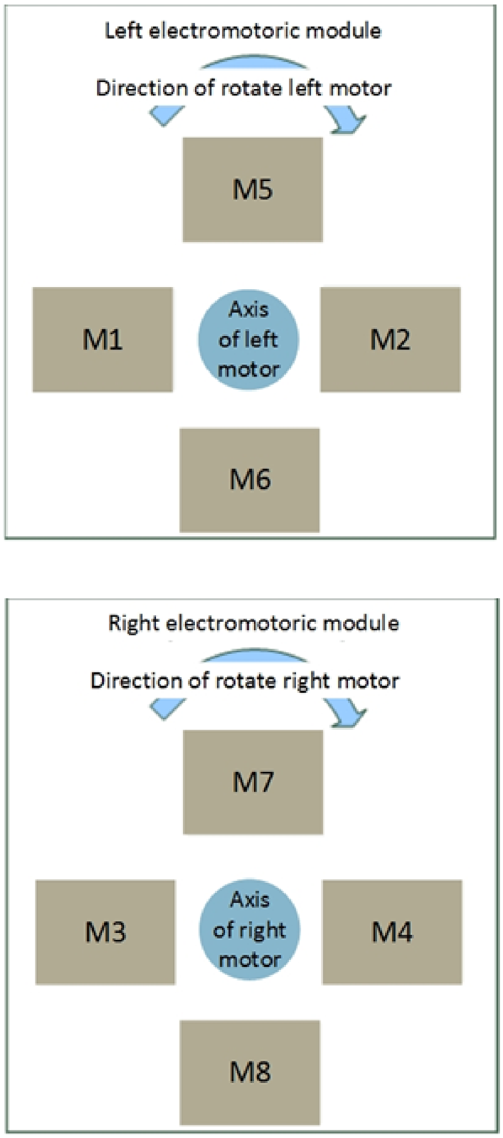

Figure 5. Placement of magnetic sensors

It is essentially a simple non-contact magnetic sensors for which there is the change status of the magnetic field around them. The four sensors are placed every 90° on a circle of radius designed as to cause switching of the sensors of the Table 1 Balancing position is 0° in the horizontal position when the magnet which is directly above the sensor M1/M3. Positive rotation is clockwise [7].

Table 1. Sensing of magnet

Sensor	M1	M5	M2	M6
Rotate	M3	M7	M4	M8
0°	**1**	0	0	0
45°	**1**	**1**	0	0
90°	0	**1**	0	0
135°	0	**1**	**1**	0
180°	0	0	**1**	0
225°	0	0	**1**	**1**
270°	0	0	0	**1**
315°	**1**	0	0	**1**

3.1. Main Control Algorithm

In Figure 6 is shown the control algorithm of walking, which is balanced after the start tilting structure in a horizontal position (function Balancing ()). Then there has to sensing the current position of the lever joystick. The user chooses from three options: walk forward - lever forward, turning to the left side - lever to the left, turning to the right side - lever to the right. Walking backward is missed from safety reasons.

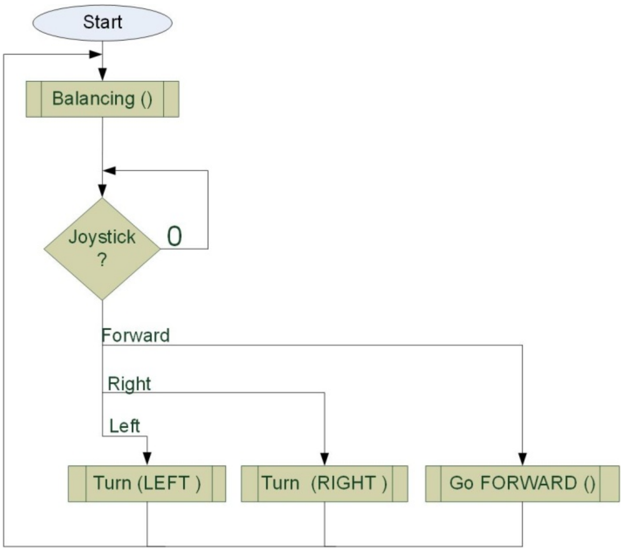

Figure 6. Main algorithm

3.2. Algorithm for Balance Position

Balancing algorithm for balance tilting structure is shown in Figure 7 for Right position and Figure 8 for Left position. His call is especially important after start.

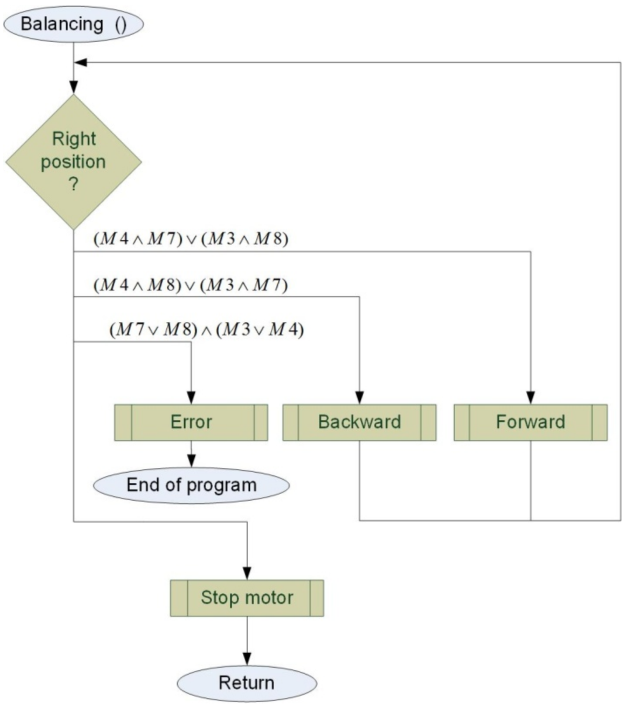

Figure 7. Algorithm for balancing right position

If a rotation of approximately 60 °, then the program ensures horizontally flipping over easiest way. If the rotation close to the upright position and program the state considered hazardous and signals error. It is for this reason that flip of tilting structure at the moment the whole structure, and therefore in the establishment of a horizontal position could result in unexpected movement and thereby jerking the patient.

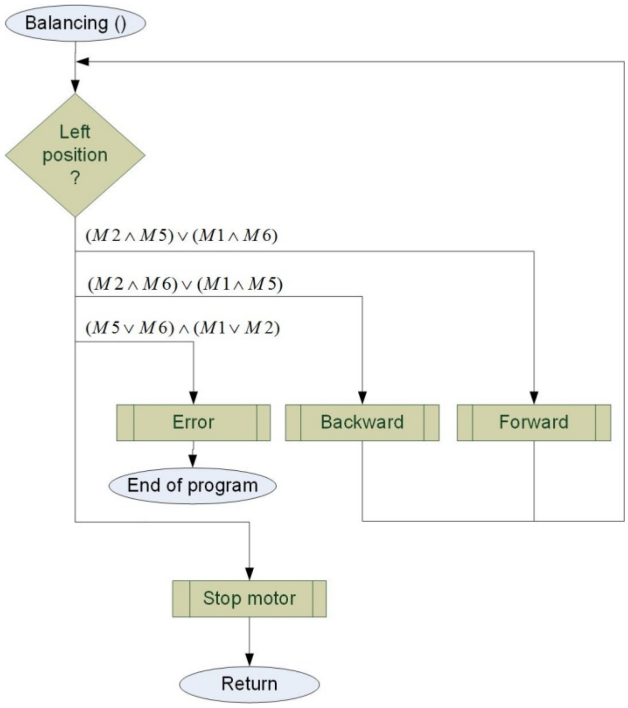

Figure 8. Algorithm for balancing left position

3.3. Algorithm for functions: Go forward and Turning

Function Go forward (Figure 9) is called from the main program at a time when the user presses the lever joystick forward. It was necessary to design a program so as to complete his function even though during sudden return lever joystick to zero. When you press the lever joystick backward - immediate stopping of the system.

Step always starts with the help of the left tilting structure. Subsequently, the complete step by flip right rocking plate and there is a rotation in the vertical axis of the left rocking plate. Both tilting structure flip to 180 degrees.

Algorithm Turn (side) in Figure 10 consisted of an initial branching depending on which way you can. If the patient chooses the rotation to the right, then the first tilting structure flip about 180° and then second tilting structure rotate about 90° and second rocking plate return to base position via spring and second rocking plate return to the horizontal position. Both rocking plates are in contact with ground. Repeating this algorithm ensures the user's rotation around the vertical axis of second rocking plate. This algorithm can be used for turning to another side.

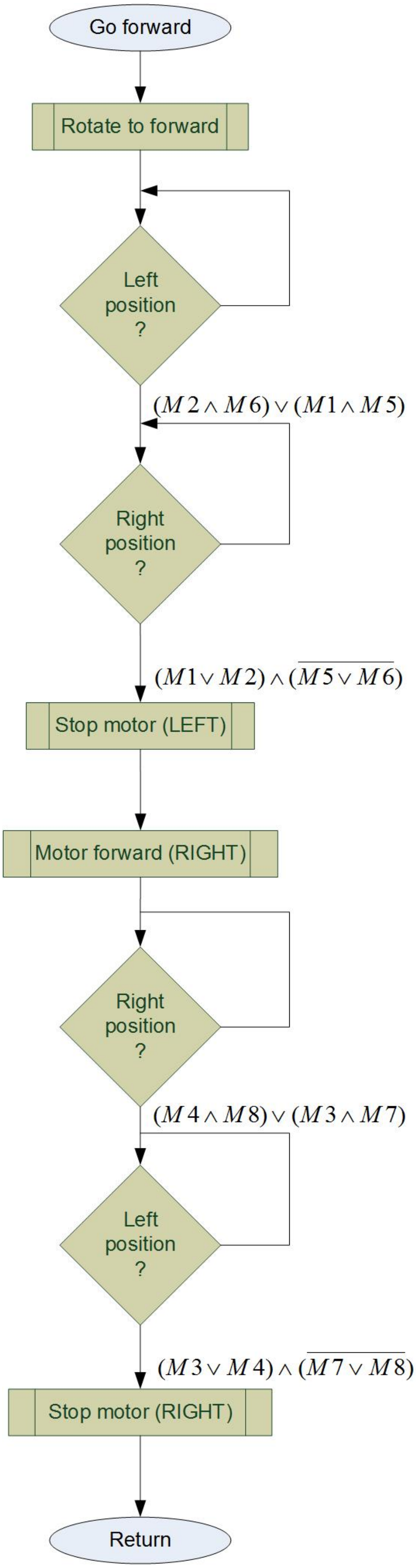

Figure 9. Algorithm for function Go forward

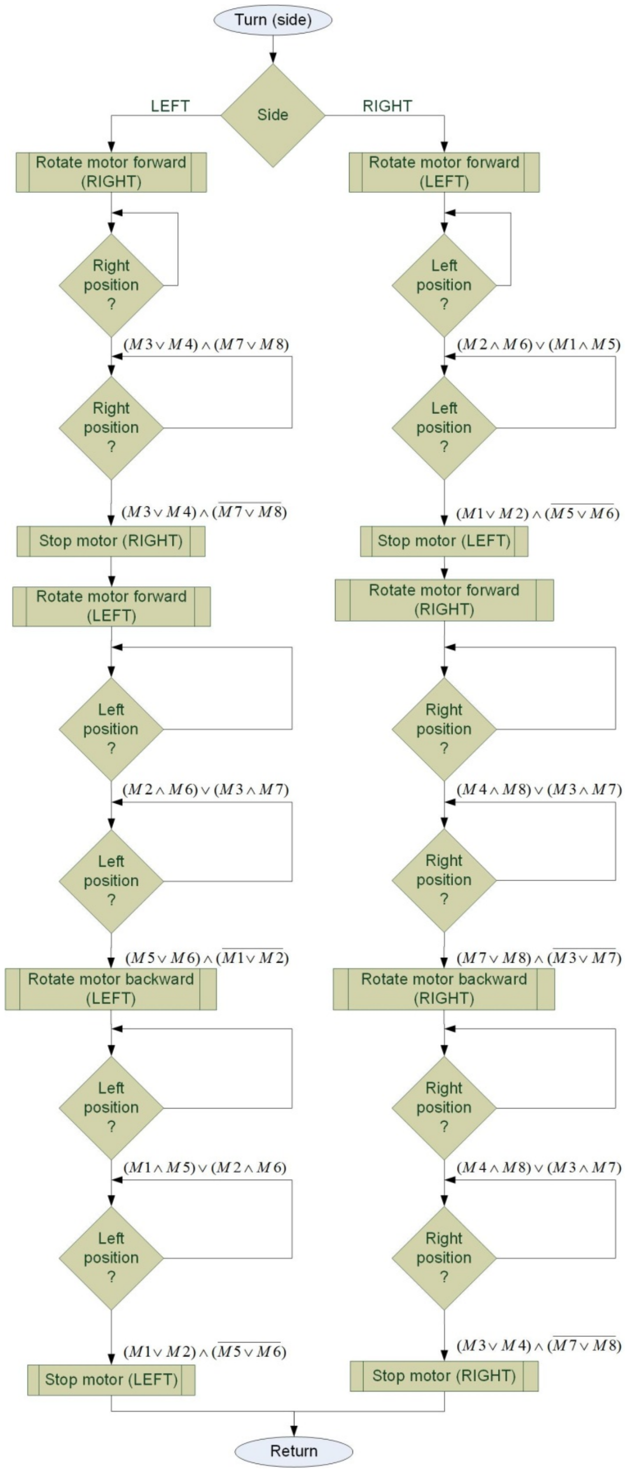

Figure 10. Algorithm for function Turning

4. Conclusion

This paper defines swivel walker design with electromotoric modules for people with disabilities. This algorithms was using for programing ATMEGA and tasted. Tastes was positive and movement was smooth and lightly. In the future will be better using current sensing of motors and read signals of motor encoder.

This contribution is the result of the project implementation: KEGA 059TUKE-4-2014 Rozvoj kvality života, tvorivosti a motoriky hendikepovaných a starších osôb s podporou robotických zariadení.

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