





Design of control system for mobile manipulator

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Agenda



- Manipulator design
 - Frame construction
 - Wheels used
 - Motors with encoders
 - Dobot MG 400
 - Arduino MEGA 2560
 - Cytron Motorshield-MDD10
 - Power units
- Required parameters
- Algorithm and task
 - Implementation of algorithm
- Conclusions and future plans







Frame construction

Aluminum profile 30x30 [8]

- 2x 400 [mm]
- 2x 240 [mm]
- 3 x 294 [mm]



Source: https://www.v-slot.pl/environment/cache/images/500_500_productGfx_2960/30x30-V-SLOT.jpg





Wheels used



4 Mecanum Wheels:

- Diameter: 100 [mm]
- Weight: 0.5 [kg]
- Number of rolls: 12





Source: https://ozrobotics.com/wp-content/uploads/2017/11/TB2wstMcFXXXXXIXXXXXXXXXXXXXZ_20394626-e1510408552846.jpg



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Motors with encoders



4 Motors CHP-36GP

- DC motor
- Power supply: 24 [V]
- No-load speed: 440 [RPM]
- Max load: 40 [kg]



Source: https://ae01.alicdn.com/kf/H7725094e9b5646aa913d5f61871beb0fN.jpg

Source: https://ae01.alicdn.com/kf/H6b0d2766e0de4851bd4f6f01ea120e6eN.jpg



"Barrieren reduzieren - gemeinsame Stärken nutzen" / "Redukować bariery – wspólnie wykorzystywać silne strony"

1 – M1 Motor input voltage

3 – C1 Hall sensor B V-out
4 – C2 Hall sensor A V-out

6 – M2 Motor input voltage

[★] 5 – VCC Hall input voltage 3.3/5.0V

2 – GND-Hall GND



Dobot MG 400



Degree of Freedom		4	
Payload		500g (Max 750g)	
Reach		440mm	
Repeatability		0.05mm	
Joint Ranges	J1	160°	
	J2	-25°~105°	
	J3	-25°~105°	
	J4	-180°~180°	
Joint Maxumum Speed	J1	300°/s	
	J2	300°/s	
	J3	300°/s	
	J4	300°/s	
Power		100~240V AC, 50/60Hz	
Nominal Voltage		48V	
Nominal Power		150W	
Communication Interface		TCP/IP, Modbus TCP	
Installation Way		Counter	
Weight		8kg	
Base Size		190mm x 190mm	
Working Environment		0°C~40°C	





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Arduino MEGA 2560





Source: https://www.theengineeringprojects.com/wp-content/uploads/2018/06/webp/introduction-to-arduino-mega-5.png.webp/introduction-5.png.webp/introduction-5.png.webp/introduction-5.png.webp/introduction-5.png.webp/introduction-5.png.webp/intro





Cytron Motorshield-MDD10

Function	Description		
Power Input Terminal	Connect to battery. VB+ : Positive/VB- : Negative		
Motor Output Terminal	Connect to motor terminal. Motor direction is depending on the polarity.		
Power LED	Turn on when power up.		
Motor Status LEDs	Turn on when the motor is running. MA:Forward/MB: Backward		
Error LED	Turn on during undervoltage shutdown or hardware fault.		
OC (Overcurrent) LED	Turn on when current limiting is in action.		
Arduino Reset Button	Press to reset the Arduino.		
Test Buttons	Press to test the functionality of the motor driver. Motor will run at full speed. MA: Forward/MB: Backward		
PWM/DIR Input Pin Selector	Select the Arduino pin for PWM & DIR signal. DIR: Direction input/PWM: PWM input for motor speed control.		
Arduino Female Header	Connect to other shields		



Source: https://cdn.sos.sk/productdata/9f/72/3748880e/arduino-mega2560-rev3-a000067.jpg

Parameters			Max	Unit
Power Input Voltage			30	V
Maximum Motor Current (Bor Channel)	Continous	-	10	А
	Peak	-	30	А
Logic Input Voltage (DW/M & DID)	Low Level	0	0.8	V
Logic input voltage (PVVIVI & DIR)	High Level	1.5	5.5	V
	Standard	DC	20	KHz
P wivi Frequency	Extended	20	40	Khz
DC + 5V Output Maximimum Current			500	mA



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Arduino MEGA + Cytrons connection

For 4 DC motors:

- Arduino MEGA main board
- 2x Cytron Motor Driver Shield



Source: https://cdn.sos.sk/productdata/9f/72/3748880e/arduino-mega2560-rev3-a000067.jpg







Source: https://cdn2.botland.com.pl/67014/cytron-shield-mdd10dwukanalowy-sterownik-silnikow-dc-7v-30v-10a-shield-dla-arduino.jpg



Power units



Battery 12 V x 2 Designed and printed 3D case





https://www.technika-grzewcza-sklep.pl/files/thumbs/MWS-1.3-12_w800_h800.png?1616401430





Parameters required



Required:

- 4 interrupts
- 8 PWM outputs
- Information about:
 - RPM,
 - rotation direction,
 - wheels angle,
 - Impulses number







Algorithm and its task

Mobile manipulator's task was to follow desired trajectory (a circle) holding given angle when facing to the circle's middle all time long

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- First simulations and implementations were prepared in Matlab, however implementation time calculation required too many hours.
- There were many trials to optimize this code but still implementation took too much time.
- Finally, it was decided to use C programming language which significantly increased computation time, from hours to minutes.





Conclusions and future plans

Conclusions:

- Full control on platform (4 DC motors).
- Reception of all data from encoders (RPM, angle, direction).
- Implementation of algorithm is much faster (from many hours to few minutes).

Future plans:

- Synchronize control of DOBOT MG 400 with mobile platform.
- Connect DOBOT MG 400 setup (Arduino + Cytrons) via bridge with Raspberry Pi.
- Extend mobile manipulator with camera to provide vision and detect obstacles.
- Speed up algorithm by optimization (goal is to make this work in real time).









Thank you for attention

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