Thesis:

Control of industrial manipulator Diamond H1 model in the MATLAB.

MADE BY: HRISTO ILIEV GANCHEV
MAJOR: AICT
TECHNICAL UNIVERSITY- SOFIA
BRANCH PLOVDIV

Objective :

- The aim of the thesis is to make communication through serial RS232 interface in MATLAB, serving as managing industrial manipulator Diamond H1.
- To extend the operation of the manipulator by building automatic Control System.

Diamond H1

- Mechanical characteristics.
- Axis and coordinate system.
- Syntax of commands.
- Serial communication RS232.

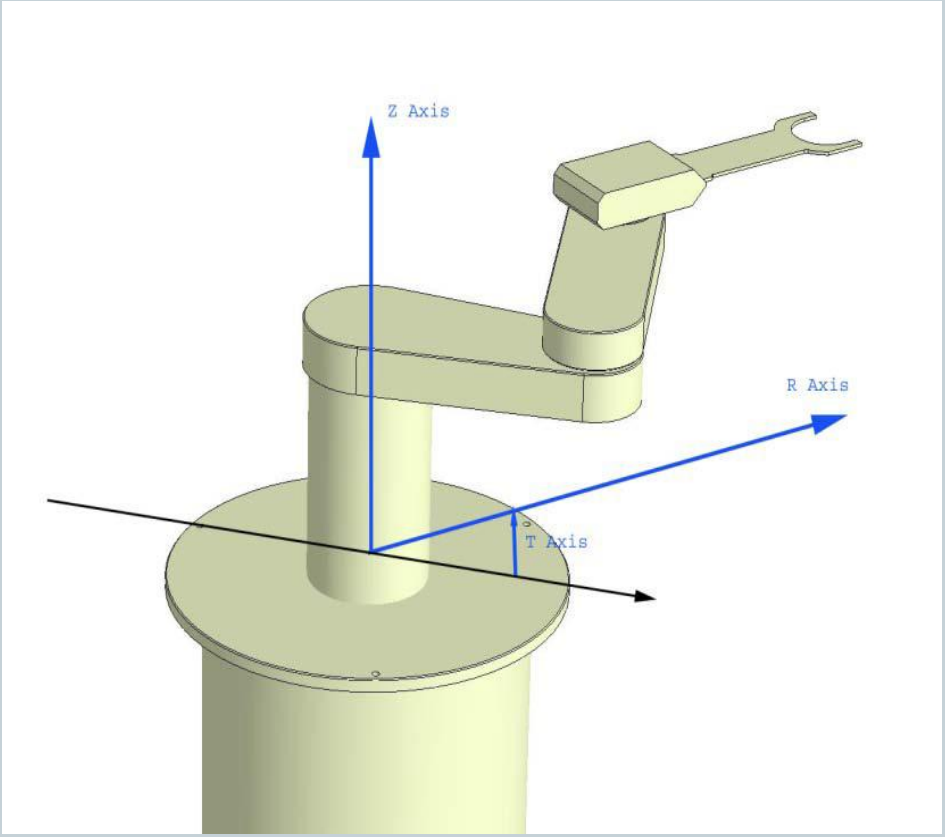


fig.1

Characteristics.

- **Size of the end-effector**
  2”(50mm) to 12”(300mm)
- **Payload**
  2.2 lbs(1.0 kg)
- **Encoders**
  Incremental, 10000 pulse/rev
- **Type of motor**
  Brushless, low inertia ,high reaction
- **Weight**
  40.7 lbs (18.5 kg) for 7” vertical movement
- **Operating temp**
  50°F-104°F (10°C to 40°C)
- **Production requirements**
  Operation voltage:
  100-120AVC, 200-240VAC

fig.2

Sizes.

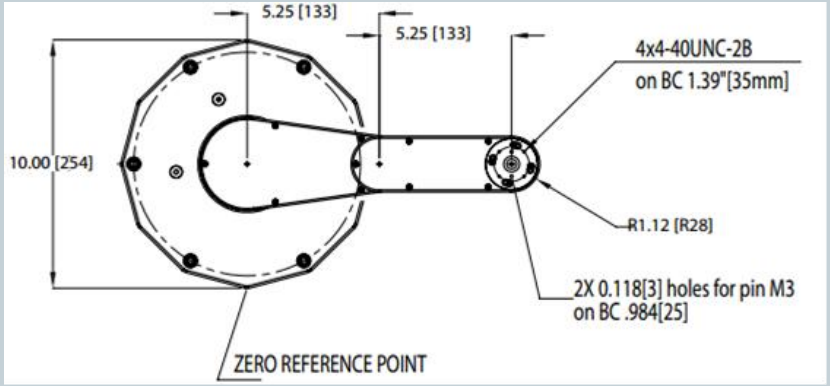


Fig.3

Height of the base	Length of arm	Height of lifting of Z axis
18 inch (457 mm)	5.25 inch (133 mm)	7 inch (178 mm)

Table 1

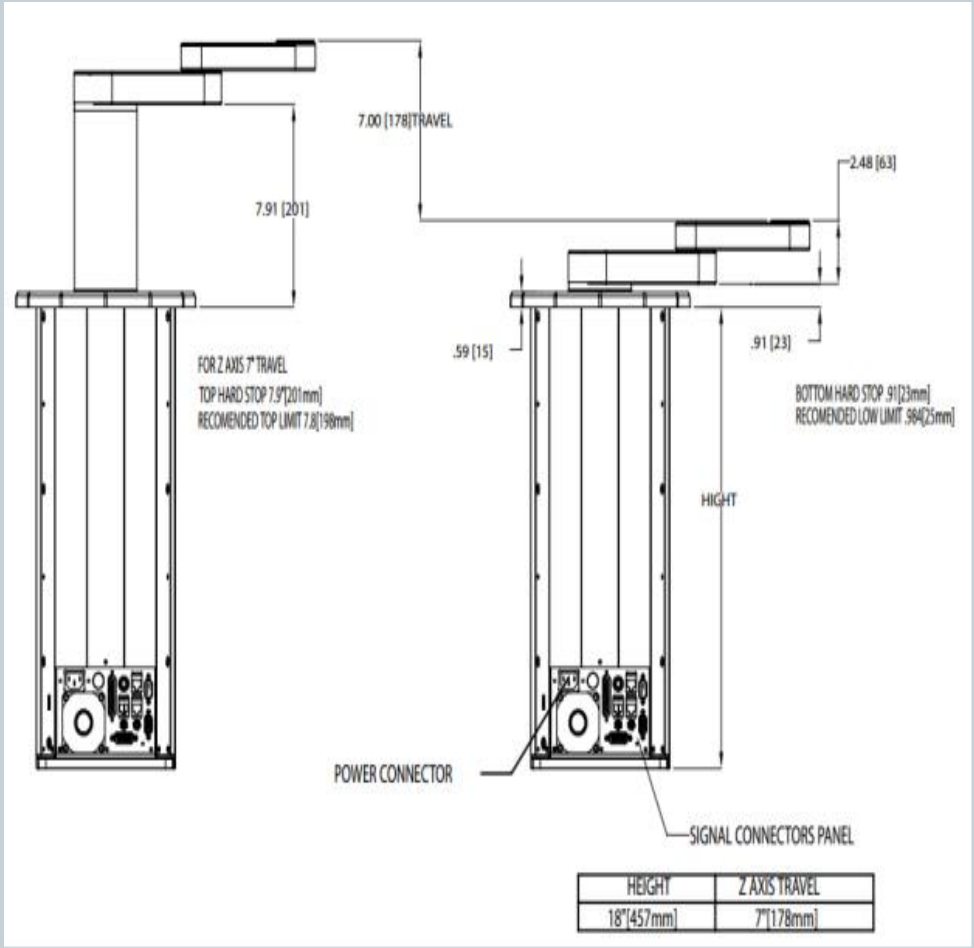


Fig.4

Limitations .

Axis	Limitations on movement	Max velocity	Max acceleration	Repetition
T	to 360° (прието +/-230°)	To 360 °/sec	1500 °/sec^2	±0.01°
R	from ±10.5” to ±14.4” (depending on the arm)	From 35 inches/sec (depending on the arm)	300 inches/sec^2	±0.001” (0.025mm)
Z	7”	to 18 иinches/sec	44 inches/sec^2	±0.001” (0.025mm)

Table 2

Syntax of commands.

- There is several types of commands:
- For movement:

Contains command (**MVA, MVR**) composed of 3 characters followed by distance, name of the axis (**T, Z, R**), which is moving and the value of step (in **units**).

- To set the parameters of the system– write command, distance and parameter value:

- PID parameters (**_KP, _KD, _KI, _IL, _EL, _CL**)
- Velocity parameters (**SPD, ACL, DCL, AJK, DJK**)
- Other

- Info commands– (**STA, INF**)

Serial communication RS232

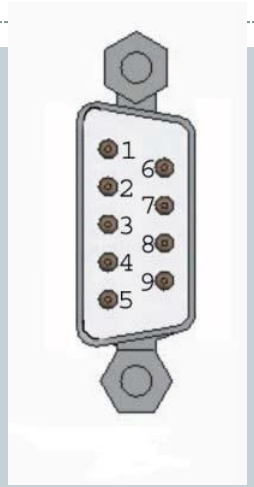


Fig.5 „male“ DB9

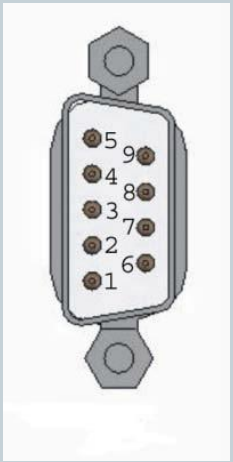


Fig.6 „female“ DB9

9 pin DTE	
Male RS232 DB9	
Number of pin	Signals:
1	Detection of carrier (CD) (от DCE) – from modem
2	Received data (RD) – coming from DCE
3	Transferred data (TD) – going to DCE
4	Ready of data terminal (DTR)
5	Ground
6	Readiness of information to be sent (DSR) – incoming signal
7	Request to send (RTS) – outgoing signal
8	Ready to send (CTS) – incoming signal
9	Indicator (RI) (from DCE) – incoming from modem

Table 3

Types of connection.

- Connecting DTE with DCE :

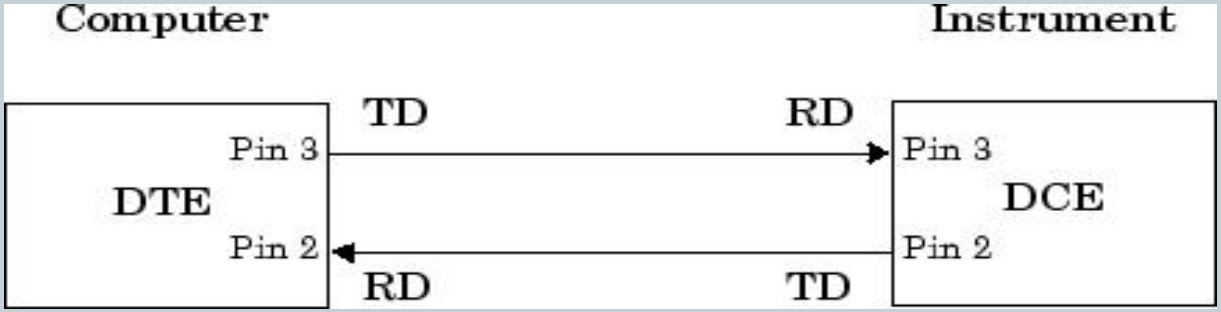


Fig.7

- Connecting DTE with DTE :

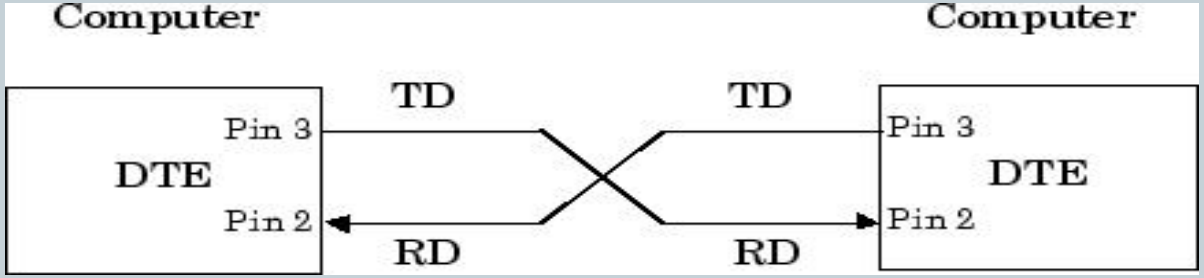


Fig. 8

Approaches used to reach the objective :

- Use of communication features via the serial port of Instrument Control Toolbox. These features have the following purpose:

- **Formation of the object and linking to it:**

```
SerialObject = serial('COM1')
fopen(SerialObject);
```

- Sending and receiving information

fprintf

query

Approaches used to reach the objective :

- **Setting the parameters of communication:**

- SerialObject.Terminator = 'LF/CR';
- Baudrate

- **Output**

- fclose(SerialObject);
- delete(SerialObject);
- clear SerialObject;

Control method:

- The Control is formed trough MATLAB.

There is two types of control:

- “point to point” control
- Closed loop system.

“Point to point” control

- “Point to point" control is done so that the serial object to use commands to move the manipulator.
- Desired "points" for movement along each axis are set manually (by keyboard).

```
Td = input('Desired T position (in units) = ');
Zd = input('Desired Z position (in units) = ');
Rd = input('Desired R position (in units) = ');
```

Closed loop system with visual feedback

- Closed loop (**fig.9**) is based to algorithm for recognizing (SURF) of object (**fig.16)** , which must be centered on the focus of the camera (**fig.14**).
- Feedback provides information about whether or not a subject where is located the area that occupies the camera's focus.

Closed loop system with visual feedback

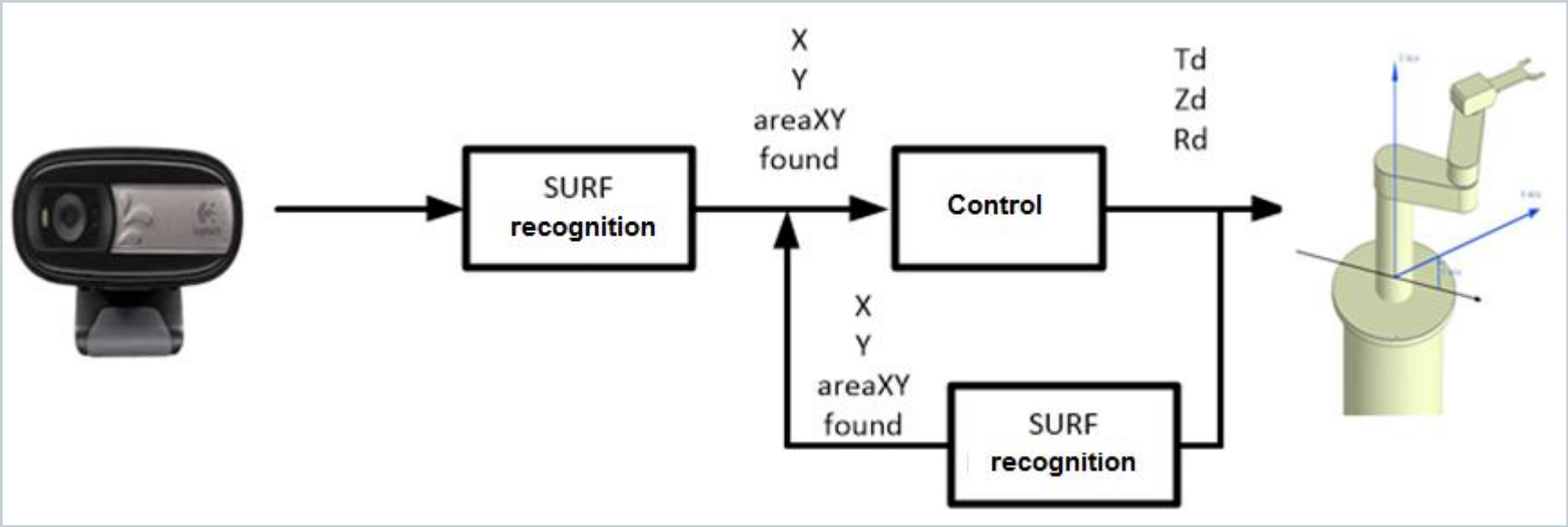


fig.9

Feedback trough serial communication

- Gives information when movement is completed.
- Feedback by sending the command **STA** through the serial port - gives information about the status of stations or action.
- Record information from the manipulator becomes with function **query**:

```
INF = query(SerialObject,'\nSTA')
```

Overall system.

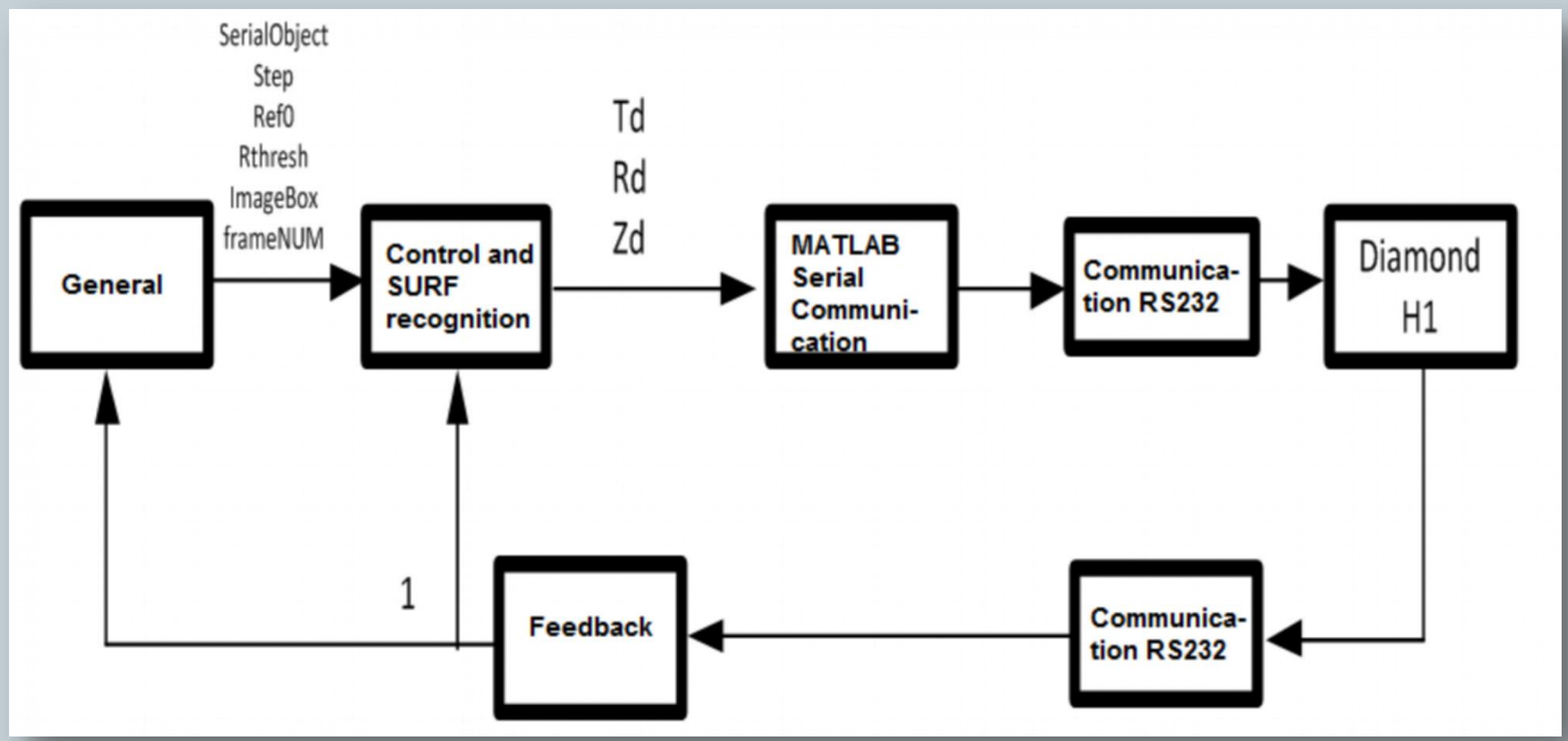


fig.10

Experiments

- Attempted experiments represent the behavior of the manipulator management "point to point" and closed system with visual feedback.

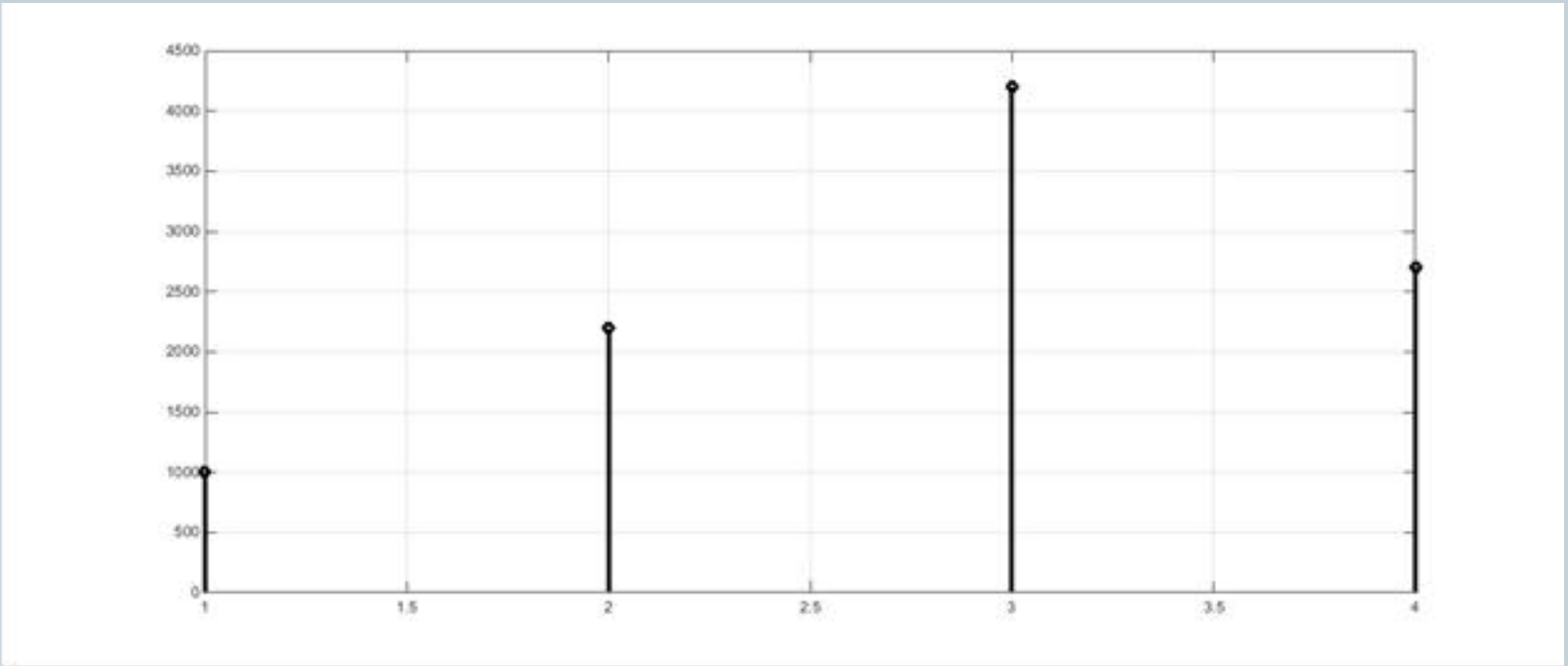
Experiment of “point to point” control

- Assignments:

Moves	Value of Td	Value of Zd	Value of Rd
1	1000	-1500	-
1	-	1500	1000
2	1200	1100	2000
3	2000	600	1500
4	-1500	-1000	-1600

Table 4

Movement the T axis.



Фиг.11 Movement the T axis of each move

Movement the Z axis

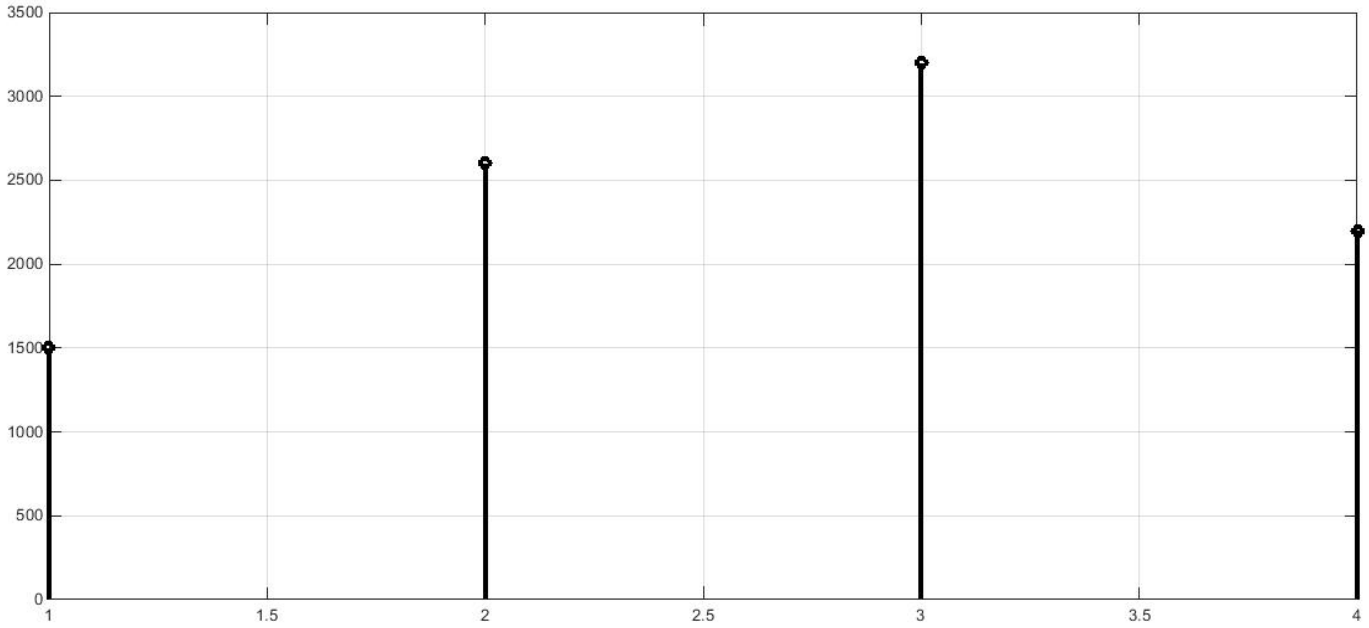


Fig.12 Movement the Z axis for each move

Movement to R axis.

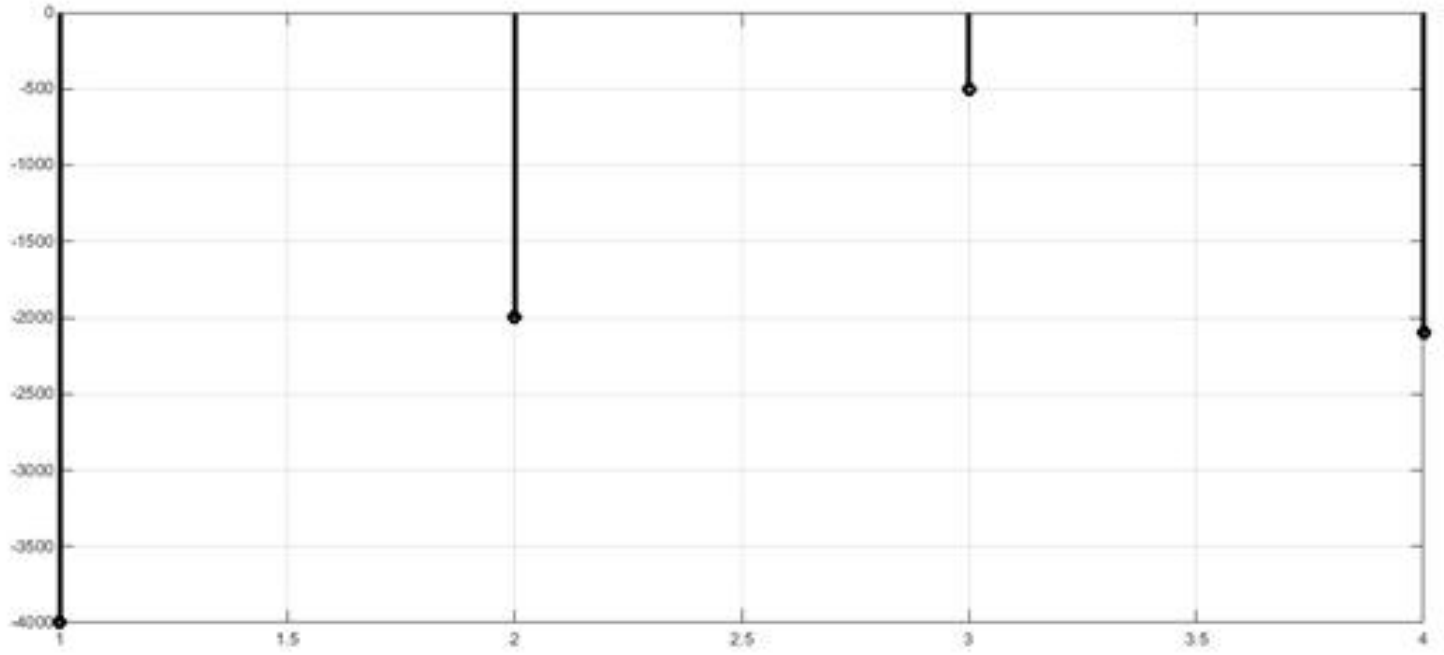


Fig.13 Movement to R axis for each move

Experience in managing a closed system with visual feedback

- Camera:

Fig.14

Fig.15

- Object of recognition –Chinese-Bulgarian dictionary:

Fig.16

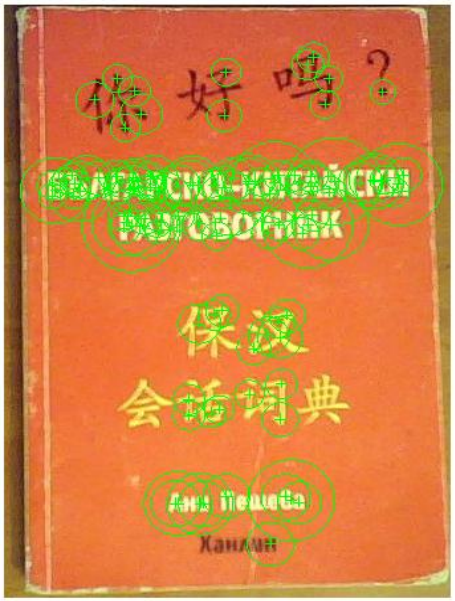
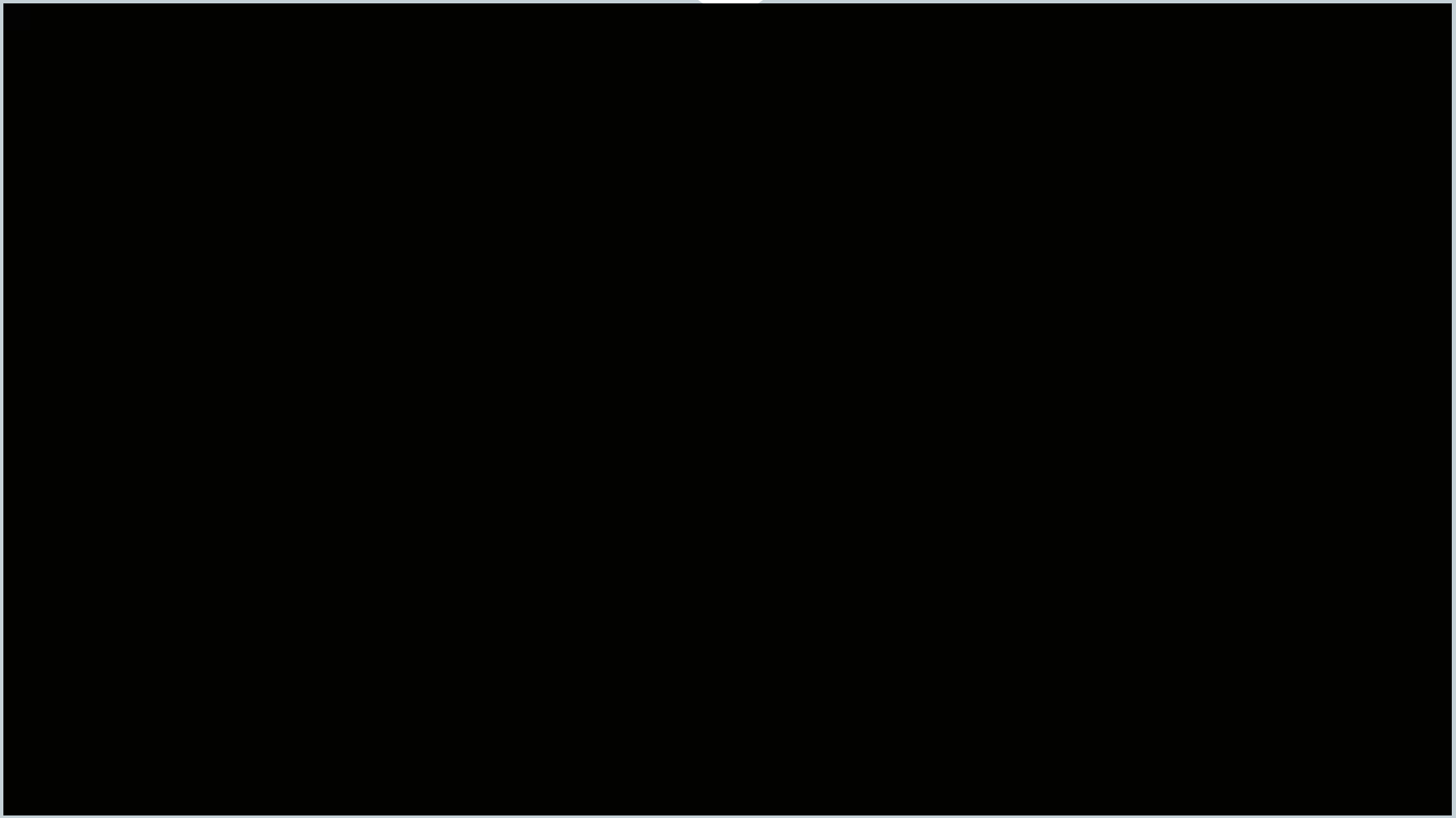


Fig.17

Running of experiment:



Conclusions

- On the basis of experiments shows that serial communication in MATLAB gives good results and the ability to implement methods for managing industrial manipulator Diamond H1.

Thank you for attention!