

Electronic Interface for Pneumatic Grippers Using USB Port

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Abstract. The paper deals with an electronic interface built on Arduino electronics. The interface allows controlling several pneumatic grippers using a PC. The grippers are connected to the PC using the mentioned interface which is connected to PC through USB port. The authors are continuing a work developed since 2005 when a LPT electronic interface was developed.

Keywords: pneumatic gripper, electronic interface, robot's end effectors.

1. Introduction

The present paper presents some aspects regarding gripper control using the USB port of the PC. The authors developed in 2005 a similar interface using LPT1 port [1]. Using the parallel PC port was at that time a very convenient solution because it has used the computer resources and was not very expensive. Nowadays, the solution for controlling robot's end effectors through PC is USB ports.

There is well known that robotic devices and implements have been used in a variety of fields where direct human involvement is either too hazardous, too inefficient, or too monotonous and tiring. Examples of such fields include manufacturing where robots are used to carry out, pickup and assembly parts, welding, nailing and riveting, etc., handling of hazardous material such as radioactive products where direct human handling could pose a health risk, and remote handling or manipulation of articles, control panels, or other structures where onsite location of humans is desirable or possible.

End effectors, sometimes referred to as mechanical hands, robotic hands or grippers, are employed for a wide range of applications where mechanical manipulation is required. In particular, virtually any industrial or other application of robotics requires an end effector of some type to provide a manipulation capability. Accordingly non-specific end effectors are typically complex, have a large degree of freedom and employ complex actuation mechanisms. They may attempt to emulate the human hand, and are often referred to as robotic hands.

Robotic grasping implements currently available range from the simple two jaw gripping device formed similar to the jaws of a pair of pliers, to the more complicated artificial hands having three or four fingers and a thumb which may be operated to curl about objects to be grasped. In both the simple and complicated grasping implements, while larger objects can oftentimes be handled, smaller or thinner objects cannot be, especially if such objects must be picked up from a flat surface (conveyor) for example. Also, the number of positions or orientations in which graspable objects can be held is generally very limited with currently available grasping implements.

The authors developed three different pneumatic grippers: for sacks (maximum 50 kg weight), for lead ingots (maximum 40 kg weight), and for boxes or pet bottles (maximum 40 kg. weight). These end effectors were developed for several industrial applications such as: palletization of load sacks with chemical fertilizers for example, lead ingots for auto power supplies and boxes with bottles. The design of each gripper depends on dimensions of the manipulated object. A description of these end effectors will be given in the next paragraph.

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2. Pneumatic Grippers. Experimental Setups

2.1. Pneumatic gripper for manipulation sacks

The gripper is dedicated to an industrial robot, such as RIP 63, COMAU, or KUKA. Thus, robot is integrated in an industrial manufacturing process (including palletization or pallet operation) where it has to



Fig. 1: Gripper for sacks manipulation

manipulate / transport bags, sacks, or other loads. The maximum load (mass) for manipulation is about 50kg. This gripper was designed by authors for an industrial application [2], where sacks filled with powdery materials have to be manipulated. For example, the robot picks up the sack with powdery materials from the conveyor and puts it on the stack. In Fig. 1 is presented the pneumatic gripper for sacks manipulation.

2.2. Pneumatic Gripper for manipulation lead ingots

The pneumatic gripper was developed by authors in order to manipulate heavy lead ingots used in car's electric power supplies. The gripper design was developed for KUKA robot. In Fig. 2 it is shown the pneumatic gripper.

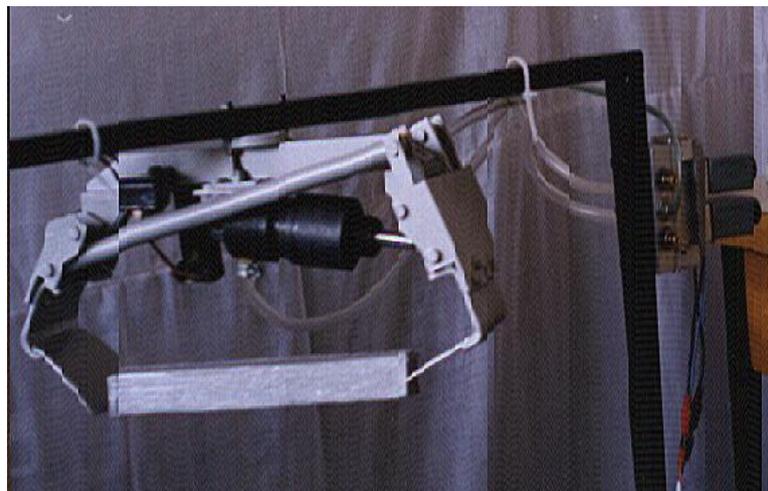


Fig. 2: Gripper for lead ingots

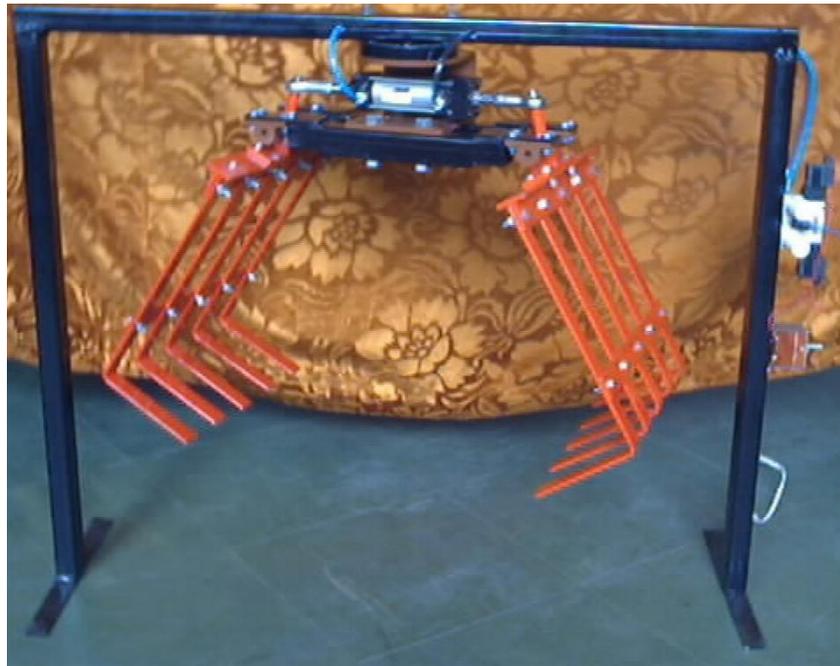


Fig. 3: Gripper for boxes

2.3. Gripper for boxes manipulation.

The pneumatic gripper is designed by authors for manipulating boxes or packages with pet bottles. Also the gripper design considered the Kuka robot for manipulating boxes. In Fig. 3 there is presented the pneumatic gripper.

The main advantages of these grippers are:

- a strong grasping force using small size pneumatic cylinder;
- a small dimensions mechanism, about 50% of other grasping similar mechanism dimensions;
- synchronous movement of the grippers arms with certain benefits for objects grasping.

3. Electronic interface

The electronic interface is based on the Arduino board. The Arduino Duemilanove, Fig. 4, is a microcontroller board based on the ATmega168 or ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

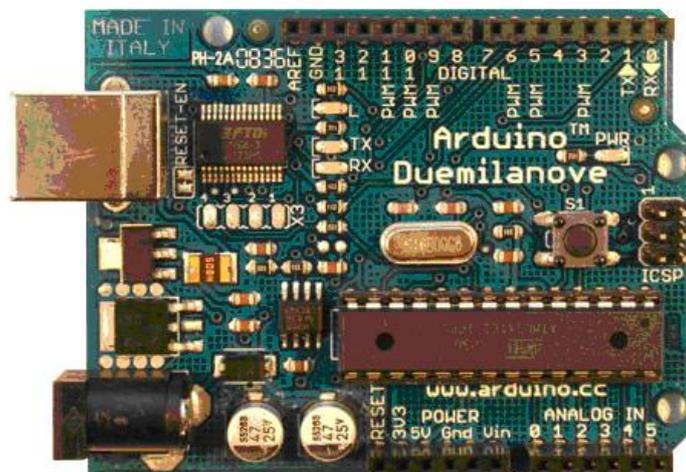


Fig. 4: Arduino Duemilanove Board

For controlling the opening and closing gripper operations there was developed another board, special designed for SMC pneumatic electro-valve which controls the air flow in pneumatic cylinders. On this board there are placed some push buttons (NO) for manual operation of the grippers. Assemble of these two boards represents the electronic interface and it is shown in figure 5. In Fig. 6 there is presented the sketch of the connections between these two boards. The interface is connected to the PC through an USB port. For controlling the gripper from PC, the authors have developed a graphic user interface in Matlab environment. The operator can choose from a menu the type of gripper and then to operate with selected one, see Fig. 7. All grippers use the same electro valve for pneumatic cylinder controlling and are controlled through the same graphic user interface.

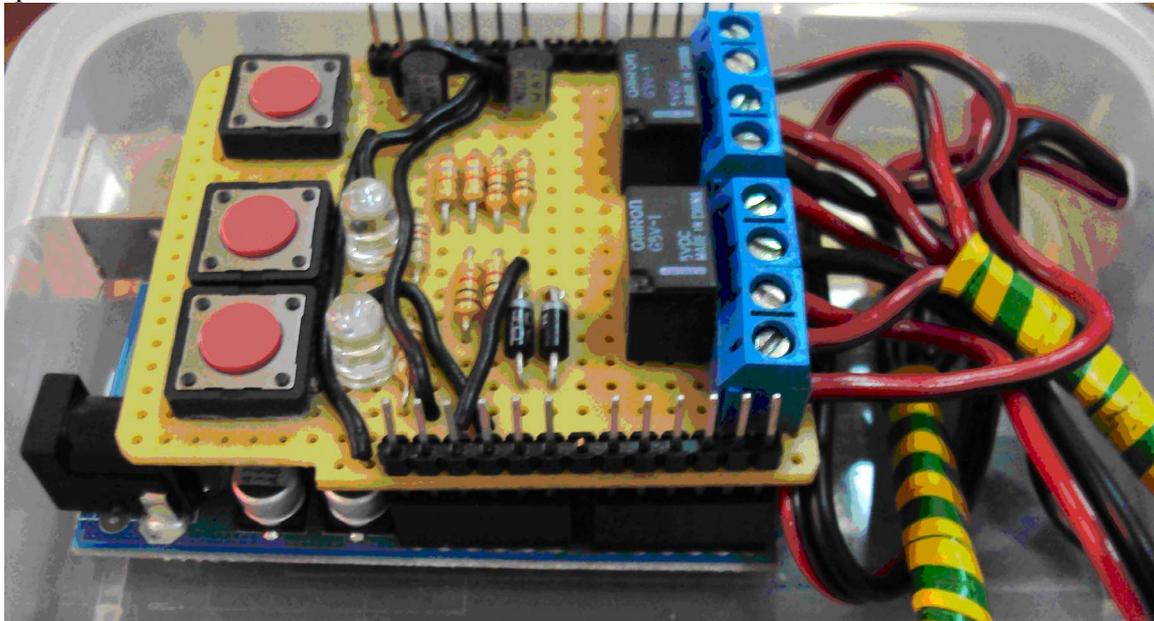


Fig. 5: The electronic interface

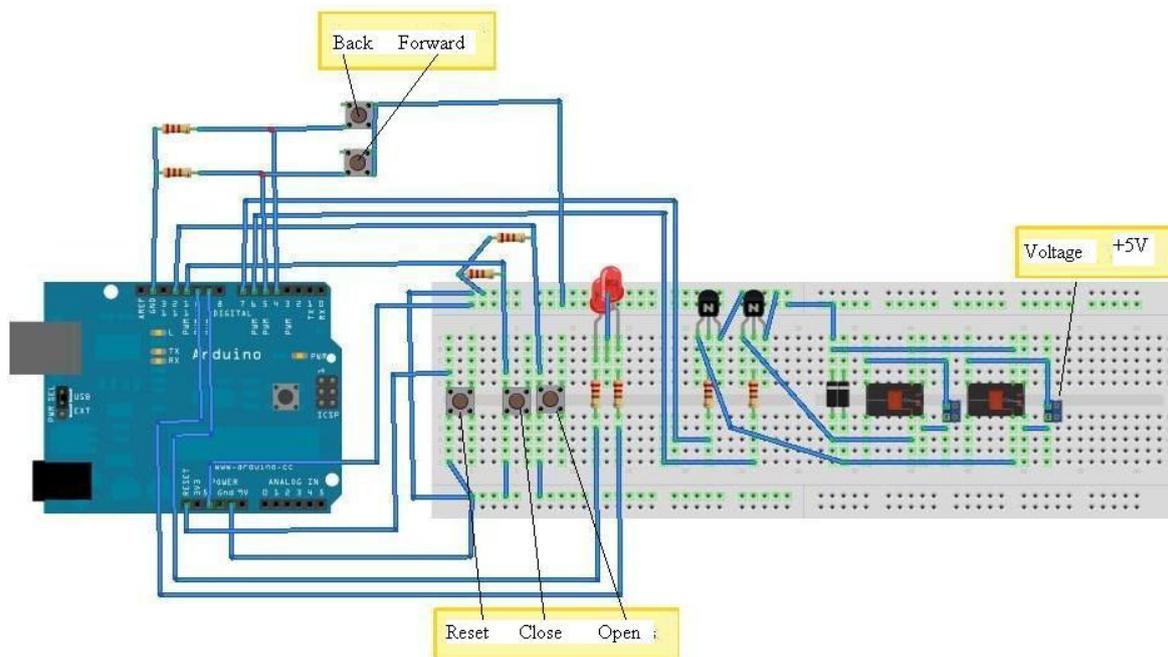


Fig. 6: Connections between the two boards of the electronic interface



Using this interface it is possible to make an analysis of parameters for these three grippers. Besides analyzing and visualizing the animation the user can understand the operating principles of these systems.

To visualize the simulation of a certain gripper click on the specific image.

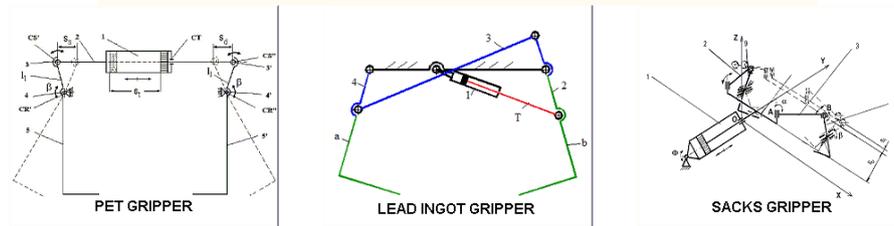


Fig. 7: Matlab main graphic user interface

On the designed electronic board there are two light emitting diodes (LEDs) which signalize open / closed positions of the pneumatic gripper. If the gripper is in an intermediary position between closed and open positions the two diodes are flickering until one of the ends is reached.

There are two operation modes for each pneumatic gripper: *manual* from the electronic interface if the operator pushes the close / open buttons and *automatic* if the operator uses the PC and Matlab GUI. The electronic interface, the graphic user interface are developed by authors and represent the original contribution for this paper.

4. Conclusions

The work started in 2005 with controlling pneumatic grippers with PC via parallel port LPT1 was continued with present paper where the grippers are controlled via USB port. The three pneumatic grippers, which also represent the personal contribution of the authors, are equipped with the same electro valve and the same electronic interface set the connection with PC. The next step is to develop a secure wireless connection to control the grippers.

5. Acknowledgements

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6. References

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