

# Reciplet

## The collector of recyclable cans and bottles

Svemir Popić, Branko Miloradović, Miloš D Jovanović, Aleksandar Ćosić, Aleksandar Rodić

Robotics Laboratory

“Mihailo Pupin” Institute. University of Belgrade

Belgrade, Serbia

{svemir.popic, branko.miloradovic, milos.jovanovic, aleksandar.cosic, aleksandar.rodic}@pupin.rs

**Abstract** - This paper presents a new recyclables collecting system for cans and plastic bottles that are used in the production of beverages such as water, juices, beer etc. As a starting solution we used a proposal selected among many ideas received from the children in some Serbian schools, who were drawing his work on how they imagine the appearance of the device in which they would gladly throw the waste, while competing, and, as a reward receiving vouchers that could be used in internet posted computer games and so on.

**Keywords** - ecology, secondary raw materials, collection, recycling

### I. INTRODUCTION

The problem to be solved is the acceptance and disposal of packaging waste such as aluminum cans and plastic bottles used in the Serbian market in the industry of alcoholic and non-alcoholic beverages (soft drinks, water, beer, energy drinks, etc.). Containers for disposal of such waste are existing in the streets or in larger public buildings and shopping malls for a long time, but they are uninteresting to use, especially among the younger population with underdeveloped spirit in general, particularly for environment preservation.

Assuming the trends in the world that a large number of secondary materials suitable for recycling are systematically collected, a number of automated systems that recognize the collected packaging and delivering it to the collector of a certain fee have been developed. Accordingly, we have designed the mechatronic system whose appearance and implemented functions encourages young people to collect these materials, to be inserted in a given device, while competing who will do it in a faster way, and that all registers built light and sound devices (Fig. 1).

### II. STATE OF THE ARTH

These problems are in the focus in the world, especially because of the maintenance of the environment which is very polluted by various, practically with non-degradable wastes. Also, the fact is that the natural resources of the Earth gradually deplete and that more and more new products to the markets around the world are obtained from the recycling materials. For this purpose have been designed the entire systems with aim to collect such materials, as well as accomplish their identification, recording and storage. At the end, the collectors receive an equivalent finance that can be

used for new purchases of consumer goods. These systems are sometimes very complex, composed of elements of pattern recognition, material image, sorting, transport and packaging, and so on. Sometimes we are spoken about full enclosed areas, even parts of public buildings, and sometimes, about individual independent entities, which is devoted to the special design, with the aim to point attention to the users on special benefits and to improve life atmosphere.



Figure 1. RECIPILET on location in front of the Sports Center Vračar



Figure 2. Robot birds

The research in the paper is funded by the Serbian Ministry of Science under the grants TR-35003, III-44004 and III-44008. It is partially supported by the SNSF Care Robotics IP project IZ74Z0\_137361/1 as well by the Serbia-Portugal “COLBAR” research project under the grant 451-03-02338/2012-14/12.

It is not uncommon that these devices provide educational content allowing users access to certain technical solutions in various fields such as science and technology. So far in Serbia, have mainly existed container type devices for certain type of secondary materials, like paper, metal, plastic, or one container with separated partitions for such materials. It is interesting to note that a few years ago in front of the Municipality Vračar have been installed a new device called “Robot bird” (Fig. 2). In fact, this is artistic designed multi-head dragon. Two heads of the dragon can open its jaws and receive and collect inserted aluminum cans. Automatic registration system, with implemented voice recognition system, generates appropriate voice pattern as well as the appropriate printing coupons that could be used as a token for video games on the computer. Searching for similar developed systems we found such similar devices installed in public areas for certain purpose like souvenir machine sale. One such device (Fig. 3) has been installed in Postojna cave in Slovenia to preserve some educational content as well as certain type of service. Regarding the ecology application there were no such similar devices. So we think that our device has some elements of originality.



Figure 3. Device for sale of badges in Postojna cave, Slovenia

### III. DESCRIPTION OF THE DESIGN

Technically, we will describe the problem in next designated tasks. In front of the system there could be two competitors who have to insert successively into the separated drawers, left and right, a plastic bottle and aluminum can. On each side of the system there is a wheel – rudder that competitors should turn as quickly as possible. The rudder is via a shaft coupled to the chain gear. A special designed carrier is mounted on the each chain. With these carriers, the chains could pick up the bottle and the aluminum can that were placed at the bottom of the device, and transport them vertically upward. When they cross the upper point, they are falling into the container that is buried in the ground under the machine.



Figure 4. RECIPILET view of drawers, speakers and locking system

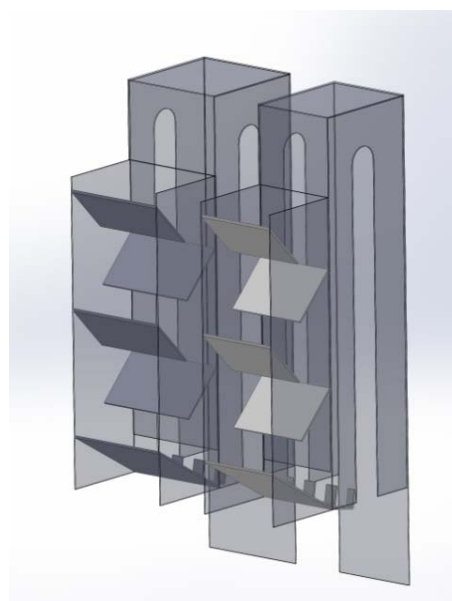


Figure 5. Retarder of freefall – sloping surface - the cascade

Because of large diversity in shape and size of the plastic bottles and aluminum cans, after detailed analysis, a specially designed drawer is developed as an ultimate decision to accept and precisely made the position of the objects. The drawers have side size limiters, so no one can insert objects larger than allowed. With a slight slope and smooth closing drawers, inserted items are positioned into a channel for transportation (Fig. 4).

To prevent a free fall of objects to the bottom of the device, i.e. to a place of acceptance, the rectangular cross-section channels are intersected with retarders that are inclined by about 45°. Smaller angles would give better slow down but deformed bottles or cans, on such small angle slopes, could be retained or even jammed (Fig. 5).

The drawers have mechanical guides for easy opening and they are secured against forced removal, while an installed elastic springs solve the issue of self-closing. Other reason for

this type of design is to minimize the workspace and the total dimensions of the device. It is usual in some containers that bottles and cans could be deposited through circular holes secured with the flaps. We preserved one such hole on the rear side, positioned top right of the device, to accept a great volume bottles (more than 0.5 l). In fact, to accept so huge plastic bottles it is necessary to predict a much larger radius of the transport tube, preventing possible jams, which requires that the device will be significantly longer.

The rudders with outside diameter of 460mm are made by welding of stainless steel tube outer diameter of 22 mm and the rudder spokes are made of the pipe diameter of 18 mm. The drive shaft with the hub bearings diameter of 50 mm is relying on a couple of ball bearings one of which is called "One way bearing". The advantage of this type of bearing is that it allows the torque transmission in one direction, while the rotation in the other direction has free movement. This preserve that the chain with the carriers cannot rotate to the opposite side, preventing possible damage in the system that could occur if the bottle is between the carrier and the catcher in the bottom of the device (Fig. 6).

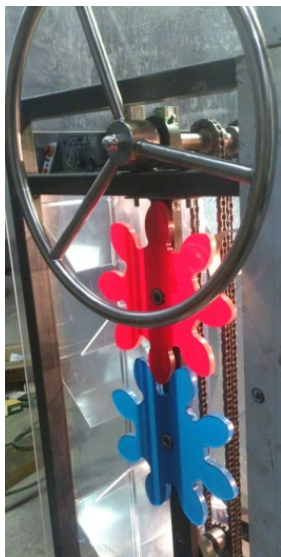


Figure 6. RECIPLET steering wheel with decorative gears

The whole system is incorporated into the housing made of carbon steel welded rectangular tubes dimensions 40x30x2 mm. At the both side of the devices, top and bottom, there are the drive shaft (top) and driven shaft (bottom) to which the sprockets are mounted (the drive sprocket and the driven one) (Fig. 7). The shafts are made of light towed steel, diameter of 20 mm and the ends are inserted into the housing with self-adjusting bearings. On each of shafts are mounted two sprockets with 16 teeth that are driven through the roller chain with pitch 3/8" (9.525 mm) and inside width of 7/32" (5.72 mm). The carriers like a fork are mounted onto the chains, made of stainless steel sheet metal. Two chains are used to prevent rotation of the carrier about a vertical axis during transportation of bottles and cans. The tension of chains is provided via inserted washers – plates that have required thickness and are positioned under the self-adjusting housing.

This system was chosen among the others, because of its constructive simplicity. The whole device is covered by stainless steel plate of 0.8 mm thickness. Other elements made of Plexiglas are incorporated into the cover plate. Using clear Plexiglas, the interior of the device is provided so all internal elements are shown to the visitors. The cover of the whole construction is tightened to the basis by INOX screws.

The other elements of structure like carbon steel tubes are protected from corrosion by powder coating or plasticization in shades of stainless steel.

In order to provide easy access to all components of the device and for easy installation of electronics and also to allow easy possible repair of the whole system the entire device is made of two parts. The upper part that is in the form of a half-cylinder can be easy disassembled from the device. It is secured from disassembling by using locks with a key (Fig. 4).

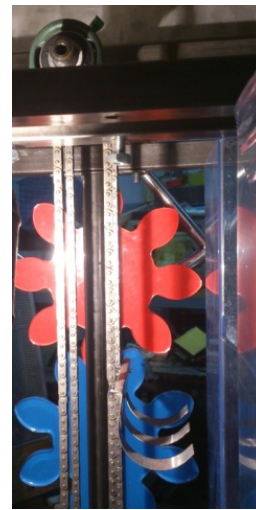


Figure 7. The drive chains of RECIPLET with carrier of cans

This device could be used as well as indoors or outdoors. The only requirement is that under the device must be placed a container to collect cans and plastic bottles. The container is wire basket type that is rolling on the rails positioned directly below the unit. Wire basket is physically partitioned into two chambers so that can goes into the one chamber and plastic packaging in the second one. Location should be chosen in places where large groups of people are usually observed especially children, as well as in places where the usage of such containers is significant. It may be the school, the playground, the bigger shopping centers, sports centers, etc.

The electronic controller of the device is based on ARDUINO DUE controller board. This platform is becoming increasingly popular, inexpensive and relatively easy to program in their own environment, which is based on C / C ++ programming language. The controller board is based on ATMEL ARM SAM3X8E 32-bit controller at 84MHz and has 54 digital input-output (I/O) pins (7 can be used for PWM) and 12 analog inputs (Fig. 8). The customer request is to detect the insertion of bottles or cans, and then speak the corresponding audio message. Also, the electronic circuit should have the option of measuring speed of bottles / cans

when lifting up. This is shown on the bar-graph display. In order to detect the insertion of the bottle and a micro switch are used, whereas in order to detect insertion of the cans an inductive sensor are used. Sensor outputs are connected to the appropriate digital I/O pins of ARDUINO board.

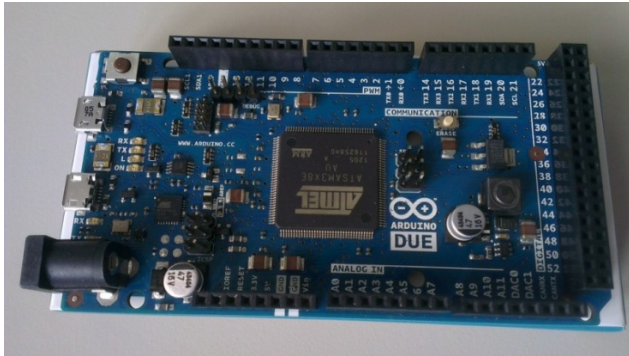


Figure 8. ARDUINO DUE controller board

As a voice message generator it is used ELECHOUSE ARDUINO USB SD MP3 module (Fig. 9), which are directly attaches to ARDUINO board and it can communicate using serial bus, sending and receiving some predefined commands. Messages are synthesized by ALFANUM [4] text to speech modules for speech synthesis.



Figure 9. ELECHOUSE USB-SD MP3 module

The speed movement of the bottles / cans is determined on the basis of encoder signal readings. Incremental encoders are mounted on the drive shaft of top of the device. The pulses obtained from the encoder are counting by interrupt mechanisms, and the angular speed of axis (which is directly related to the lifting speed of the bottles / cans) is obtained by differentiation.

Finally, the resulting speed is visually displayed on the corresponding bar graph display lighting appropriate number of LEDs. Bar graph LED display is driven using MAX7219 LED controller. Communication between ARDUINO board and MAX7219 are realized using serial SPI bus. The whole device is decorated by LED lighting to enhance the aesthetic impression which directly controls the ARDUINO board.

The characteristics of the device are:

Power supply:	220VAC
Internal current consumption:	4 A
Working temperature:	-10 °C... +85 °C
Total weight:	70 kg
Volume of the container:	1.35 m <sup>3</sup>

Possibility of using the device: outdoor spaces, schoolyards, public areas especially in front of shopping malls, institutions, sport field like halls and stadiums, generally in all places where there are a great consumptions of such goods.

#### IV FURTHER FIELD OF RESEARCH

In the future time some following activities are already planned. In order to increase energy efficiency of the device a solar panel power device will be designed and mounted on the column next to the device. In this way, the device will be energy independent ecological unit capable of carrying out their role. Also, besides the initial location where the device are installed, the intention is to manufacture and install a several similar units, primarily in the vicinity of schools that participated in the competition to design solutions and their willingness to have such device in their environment.

During the test phase has been perceived the problem of blurring of the internal surfaces if the outside temperature is low. Reason for that is just the difference of air-temperature inside and outside of the device. Namely, from the ground, warm air is going up and condenses on the internal surfaces and Plexiglas stays opaque. We will try to solve this problem by cutting the metal plate somewhere at the top of housing. Or, some type of heater and forced ventilation could be introduced.

#### REFERENCES

- [1] <http://arduino.cc/en/Main/arduinoBoardDue>
- [2] [http://www.elechouse.com/elechouse/index.php?main\\_page=product\\_info&products\\_id=2193](http://www.elechouse.com/elechouse/index.php?main_page=product_info&products_id=2193)
- [3] <http://www.oktoopus.org/index.php/en/>
- [4] <http://www.alfanum.co.rs/index.php/en/>