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Research article

# WATER AND FOOD DISPENSER FOR DOGS

*Przemysław Filipek*[1]✉

[1] Lublin University of Technology, Faculty of Mechanical Engineering, Nadbystrzycka 36, 20-618 Lublin, Poland
✉ corresponding author: p.filipek@pollub.pl

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**ABSTRACT**

The subject of the article is the design and construction of a water and food dispenser for dogs. Its main goal is to present the design of the device adapted to both the requirements of the owners and the dogs themselves. The goals set for this project are to ensure its functionality in all weather conditions. The configuration methods described guarantee the versatility of the device. Design assumptions, a 3D model of the structure, electronics and a fragments of the control program are presented. The actual implementation of the dispenser, possibilities for its modification and, in conclusion, comments and conclusions are presented.

**KEYWORDS**: water and food dispenser, 3D model of the structure, real execution, food feeder

## 1. Introduction

The motivation for carrying out this project was to provide dogs with constant access to clean water and to enable regular feeding. In addition, the automation of the dispenser was intended to make pet care easier for pet owners. In the case of dogs living outdoors (and the dispenser was dedicated to them), another factor that makes it difficult to meet their basic living needs is low temperatures, which deprive them of access to water in a short period of time. In terms of large animals, there is also the problem of wasting water during water changes. These dogs, due to their size, they have large vessels that provide them with constant access to water. After several uses, however, it becomes unfit for further drinking due to contamination, making it necessary to replace it. Due to the conditions in which the device will work, it was necessary to ensure the safety of the users themselves and the operator. Taking into account that the dispenser is intended for animals, it was necessary to make the activation of the mechanism by the dog as simple as possible, which also involved the use of solutions that do not interfere with its freedom [1].

## 2. Design assumptions

The basic assumption during the construction of the feeder was to take care of the safety of the animals and the people operating the device. The feeder was planned to be located outdoors. Thus, the main problems that interfere with its proper operation are low temperatures and unfavourable weather conditions such as precipitation or high humidity. These can cause short circuits, electric shocks or burning of the system. For this reason, the external cable supplying power to the device is very short, so that it is constantly in the air and inaccessible to animals. It is protected by insulation to protect it from moisture. The socket into which it is plugged has also been adapted to adverse outdoor conditions and, like the cable, is located in the rear part of the housing inaccessible to the

dog. Both of these elements are IP 65 rated giving protection against both dust and water spray directed at them [2].

Inside the device there are two components connected to the mains voltage - it is a 50 W aquarium heater and a water pump. The power of the heating element was adjusted to the size of the water tank. The number of components that are potentially dangerous to both the animals themselves and those operating the feeder have been reduced to a minimum. Replacing them with replacements that draw less current was impossible due to the large amount of energy that is required for the dispenser to function properly. This is most important in the case of the heater, whose lower power might not be sufficient to heat the contents of the tank especially at its maximum filling. The components are connected permanently, directly under the socket using a terminal strip with a screw connector located on the rear panel of the housing. The individual wires of the pump and heater are properly insulated from each other. The element that protects the system from short-circuiting and ensures its proper functioning is a module with two SRD-5 relays. The Arduino Mega 2560 microcontroller itself and the other parts of the control system connected to it are contained in a plastic housing [3]. Another important consideration was the reliability of the feeder regardless of the conditions. The most important at this point was to ensure constant access to water regardless of the negative ambient temperature. For this purpose, the described heater was used. It allows the water to be heated to a temperature allowing it to remain continuously in a liquid state. The tank is also properly insulated with 30 mm polystyrene foam from the ground and on the side of each wall. This allows the water temperature to drop more slowly. In addition, proper functioning in adverse conditions is to be supported by the way the housing is constructed. A cover for the display and keyboard on the top panel protects their proper functioning. The flap of the food tank has a seal preventing water from getting inside. All actuators are located inside the housing. Only the ends of the tunnels supplying food and water to the bowls protrude outside. They are directed at such an angle that they are not clogged by jamming snow, and water that might get inside can flow out of them freely.

Another of the objectives was to be able to recognize dogs and determine what they want to do at any given time by approaching the feeder. For this purpose, two pressure plates placed in front of the water and food bowls were used. This solution is not ideal due to the changing weight of the dogs and the inaccuracy of the sensors. A simpler one would be to equip the animals with an RFID module, however, this would involve the dog having to wear an ID tag, which would slightly affect its freedom.

The last but most important thing that was to be achieved during the carrying out this project was the proper dosage of food and ensuring that the water was changed regularly in the bowl, after a certain number of attempts to consume it. The pressure plates proved to be helpful, as well as the conducted process of configuring the device to give the dogs information.

## 3. Design

The design of a water and dog food dispenser includes a 3D model, electronic components including an electronic schematic, and software.

### 3.1. Description of operation

The dispenser is divided into two basic segments: the water feeder and the feed feeder.

Diagram of the operation of the device:

After switching on, it is necessary to briefly configure the feeder. The information to be entered is: the time, the number of dogs, the weight of each dog, determining how many times each of the dogs is to be fed, and determining how much food is to be fed at one time to a given dog. All these

operations will be done from the 16-button keypad buttons available on the top of the enclosure. Transitions between successive steps configuration are possible by pressing the "*" button. All information regarding settings being saved are continuously displayed on the LCD display monochrome 20x4 located near the keyboard.

The next, already automatic stage of program execution is checking the air temperature. By default, the feeder has a choice of two modes "summer" when the air temperature is above or equal to 2 $^{o}$C and "winter" when the temperature drops below 2 $^{o}$C. In the first one, the assumption is that the water in the bowl is changed every 4 approaches. This is to ensure constant access to clean water. Successive waterings are counted and stored in the microcontroller's memory and reset after the water is changed.

By comparing the weight of the dog to the weight of the lightest stored animal, the program checks if the controlled object is one of the dogs. The counting is done only after 30 seconds so that the dog has enough time to drink, and one of the drinkers is not counted several times in case of prolonged stay on the pressure plate.

If the number of feeds set at 4 is reached then after the dog leaves ie weight on the plate drops below the value assigned to the lightest one, the process of water exchange begins. For this purpose, a 1/2" ball drain valve is opened. Its operation is possible thanks to the installed servo Tower Pro MG995, with a torque of 12 kg to the valve lever by means of an orifice provided by the manufacturer. The drained water drains through a pipe connected directly to the elbow of the roof gutter. The next step in the process is to close the valve and turn on the water pump. This occurs by sending a signal to the relay module. The working time of the pump is determined in such a way that it is possible to fill the bowl to the level of 1,5 l. After completion of these activities the number of feeds is counted again.

The most important premise of the "winter" mode is to prevent the water from freezing both in the bowl, tank and in the supply and drainage lines. Activation of the entire process is analogous to the summer mode. The dog shows its desire to drink water by stepping on the pressure plate. The difference is that in the idle state, the water bowl is constantly empty and, in addition, the drain valve is open. The process of filling the bowl with water and closing the drain valve begins only when the dog is detected. The pump is then activated for the time it takes to fill the bowl to the 0.5-liter level. The entire process ends one minute after the dog leaves the feeder. Then the servo opens the drain valve allowing the water to drain freely. At this point, the value that determines the amount of drink is always set to 4 so that when switching to summer mode, the dispenser automatically starts the process of water exchange, which in this case is simply filling the bowl with water. In the winter system, the heater placed in the tank is also an important element. Its task is to heat the water when its temperature drops below 1 $^{o}$C. This process continues until it is heated up to 5 $^{o}$C. The condition for activating the heater is also a drop in air temperature to 1 $^{o}$C which eliminates the possible operation of the heater when switching between modes. The process of dispensing food in both the winter and summer programs looks the same. At first, it is necessary to detect the presence of the dog at the food bowl. This is done analogously to the water dispenser - it is necessary for the dog to step on the pressure plate placed next to the food bowl. An additional task that the microcontroller must perform in this process is the proper recognition of dogs.

In the case of water feeding, it is only necessary to check whether the dog has reached the minimum weight. This is done by comparing the weight read at a given time on the pressure plate and the weight of one of the dogs assigned during the setup process. This action will specifically determine which animal is requesting food at any given time. This is followed by a check to see if food can be dispensed to it. This information is determined by comparing the number of feedings specified during setup and the number of "approaches to the bowl," which is counted each time a particular dog attempts to receive food. Another condition that must be met before dosing is to

check the amount of food in the bowl. If the dish is completely empty, the food is dispensed in the amount specified with the configuration. If the bowl is not empty, the weight of the food in it is determined, and then the missing amount is added.

If the bowl is not empty, the weight of the food in it is determined, and then the missing amount is added, so that the value saved in the configuration is reached. A 5 kg strain gauge bar is responsible for monitoring the contents of the bowl. The information on the number of feedings is counted on a daily basis, resetting it every day so that the device maintains its functionality every day. The food to the bowl is transported through a feed tunnel from the tank. Inside is mounted the above-described conveyor. The axis on which it is located has been integrated with the servo orifice.

The level of water and food in the tanks is constantly monitored by ultrasonic HC-SR 04 distance sensors [4], and this information is provided on the display. In addition, also shown is the temperature of the air and water in the bowl, which is controlled by 2 thermistors. These elements facilitate the control of the device.

Refilling of food is possible thanks to a flap mounted on the upper part of the housing, while topping up water is done through a wide channel located in the side of the housing. Thanks to its versatility, it allows the use of both thin hoses like a garden hose and larger vessels such as a bucket. When refilling the tanks, there is no need to turn off the device, which helps to fill them properly. This is especially important in the case of a water tank that is not accessible from the outside of the housing, and its status is indicated only by the display, which receives information from the distance sensor.

### 3.2. 3D model

The 3D design was prepared in Solid Edge. The individual parts are the effects of assemblies in the assembly module. Each part was created separately or downloaded from a publicly available library located at www.gihub.com. The execution of the project was intended to illustrate all the elements of the of the dispenser and to facilitate the actual implementation. When creating the elements their proper dimensions were maintained. All 3D model graphics were generated in the KeyShot program.

Figure 1 shows a pressure plate, the structure of which is based on angle bars 30x30x2 mm steel angles forming the frame. Strain gauge sensors are placed on 15 mm supports made of 30x30x1.5 mm steel profile. The plate on which the dogs stand was made of 4 mm thick corrugated steel sheet. For better visibility, the plate was moved away from the rest of the structure.

**Figure 1.** Pressure plate design

Figure 2 shows the whole device and the arrangement of individual components. To improve visibility, the housing has been hidden.

**Figure 2.** Arrangement of elements in the dispenser

### 3.3. Electronics

The entire control system is housed in a plastic enclosure that protects it both against mechanical damage and adverse effects of atmospheric conditions weather conditions. It can be accessed by removing the upper part of the housing feeder and removing the housing cover. The wires have been led outside housing with holes prepared for this purpose and routed along the frame elements to the corresponding sensors and actuators. In addition, they are attached to the to the frame by means of cable ties, which limits their tangling and protects them from being torn off. breakage. The wires are elements of multicore colour tape with a raster of 1.27 mm which also facilitates such organization and identification. The elements were connected to each other with Goldpin connectors.

### 3.4. Software

Programming on the platform is based on the C language suitably modified to its requirements. The dedicated Arduino environment (IDE) allows both to compile the the code itself as well as transferring it to the microcontroller [5]. The program provides a built-in code editor with the possibility of verifying it for finding errors. The process processing is carried out by checking for correctness, converting the sketch into a C++ program and compiling it into a form in which it will be readable by the processor of the Arduino. During this cycle, the file is combined with Arduino libraries. The program that controls the feeder begins with the inclusion of the necessary libraries used by the components in use, defining the pins and constant values occurring in the program.

Winter mode differs from summer mode in terms of water management. The program in it has the ability to turn on the heater when the temperature of the water in the tank drops below a certain value and turn it off when it has warmed up sufficiently.

When switching to winter mode, the water does not stay in the bowl, which prevents it from freezing. The valve remains open until a dog is detected. This occurs when the minimum weight assigned to one of the dogs is reached. At the same time time, the pump that fills the bowl to the specified level is also activated. The process of drinking, i.e. opening the drain valve, ends when the weight on the plate drops pressure plate below the value that determines the lightest of the dogs. Counting the number of drinks in this mode mode is for statistical purposes only.

## 4. The execution of the actual dispenser

The entire dispenser was physically made. The components were cut with an angle grinder. A welder using the TIG method was used to create welds. Riveted and screwed connections were used to connect the other components bolted joints. The housing was made of 2 mm aluminum sheet. It consists of 5 removable segments. The pressure plates are not an integral part of the whole structure which makes it possible to adjust their spacing to the size of the dogs. (Figure 3).

**Figure 3.** External appearance of the dispenser

## 5. Comments and conclusions

The food dispenser made in the project is a fully functional device fulfilling the assumed functions. It is characterized by high versatility due to its configuration possibilities. Among the food and water dispensers for dogs available on the market, it is distinguished primarily by its size and ability to be used outdoors.

Tests showed the correct operation of the device. All components performed their assigned functions. A modification that could improve the dispenser's operation would be to use the EPROM offered by the microcontroller. This would give the dispenser the ability to operate after a restart without having to re-enter animal data.

The design of the dispenser, both on the side of its construction and the control system, allows for further development. It is possible to attach new components that will improve its operation. An example is the RFID reader giving the possibility of higher quality control of dogs using the device. There are also many replacements available on the market for the components used. Such parts include ultrasonic distance sensors, which could be replaced with laser ones. This would give a much higher accuracy of the readings. Often, however, solutions of this type make the cost of the project very big, which calls into question the profitability of its creation. The device could also be used on a wider scale. The possibility animal recognition allows it to be used, for example, in shelters or large dog kennels. Other animals, especially cats, can also benefit from it. The only limitation is the accuracy of the sensors detecting their presence and the size of the structure.

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