

**Design of an Autonomous Eating Pet Robot**

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**Abstract:** The trends of recent developed a pet robot which interacts with people are increased gradually. There are a few pet robots that are a robot dog, robot cat, and robot fish. The pet robot is featured that it is possible to sympathize and give pleasure to human. The pet robots express delight, sorrow, surprise, and hunger through the artificial intelligence. Previously, the pet robot has to exchange the battery when it is exhausted. Commercialized robots have a self-recharging function, which express hunger. Robot dog AIBO, SONY in Japan, checks the battery for expressing hunger. They find an energy station for recharge. While operation time of AIBO is 1 hour 30 minutes, recharging time is 2 hours. Recharging time is longer than operation time. During the recharge, they don't operate. We obtain a motivation for eating the battery when find the problem. In this paper, introduce an Autonomous Eating Pet Robot and propose a design for realization. The Autonomous Eating Pet Robot has a function that is the most basic instinct that is finding a food and evacuating.

**Keywords:** Entertainment robot, Pet robot, Biomimetic, Eating robot.

**1. INTRODUCTION**

The tendency of the recently developed robots is human friendly robot such as entertainment robot, biomimetic robot and humanoid robot. Entertainment robot is used with commerce as a home and a personal robot. The pet robot is a kind of entertainment robot such as the robot dog (AIBO, I-Robo) and robot cat (BN-1). Biomimetic robot such as snake robot or a cockroach robot that mimics biology of an animal is used as a purpose of study. Humanoid robot is a human friendly robot such as ASIMO of Honda and SDR-4 of Sony. Entertainment robot is a more human friendly than other robots. And it is suitable for a home or personal environment.

A disadvantage of Entertainment robot is the use of Battery. Because it has more charge time than action time. In case of AIBO of Sony, while operation time is 1 hour 30 minutes, recharging time is 2 hours. Recharging time is longer than operation time. During the recharge, they don't operate. We need a robot that doesn't depend on battery

There is the robot that doesn't depend on a battery among conventional robots. It is a Slugbot [1] and Gastrobot [2]. The Slugbot in California Institute of Technology is capable of autonomous action on agricultural land for eating slugs. The Gastrobot in University of South Florida obtains energy to use various foods. Gastrobot is using a sugar. A common point of the robots has an energy converter to use an animal or food in nature and has a fuel cell. The disadvantage of way to use a fuel cell is increased in volume with the weight of a robot with a device to make a food from fuel cell besides the battery. And it is difficult with a prey with the slug which is a food of the Slugbot in a home or a personal environment.

In this paper, we introduce the Autonomous Eating Pet Robot (EPRO), and propose the design and mechanism of EPRO. The feature of EPRO is human friendly robot which eating a battery in home or personal environment The EPRO has functions which are the most basic instinct that is finding a food and evacuating.

The rest of section is as follows. Section 2, we describe about the design requirements of EPRO, which are a

specification of EPRO, a mechanics part, a control part, a sensor part, and food. Section 3, we describe about the design that it was proposed to in order to conform to design concept and a requirement. Section 4, we describe about a current progress situation, advance in EPRO, and future study.



(a) AIBO



(b) BN-1

Fig. 1 Entertainment robot



(a) Slugbot



(b) Gastrobot

Fig. 2 Conventional eating robot

**2. DESIGN REQUIREMENTS**

System requirements of EPRO are size (200×400×250) mm , weight 2 kg , the maximum speed 0.5 m/s. EPRO is composed of a mechanics part, a sensor part, a control part, and a power part. The requirement of each components same with table 1.

Table. 1 Design requirements

Class	Item	Requirement
Mechanics	Head	A mechanism to get into body
	Neck	Sliding structure
	Mouth	A mechanism to easily grip a food
	Stomach	A mechanism to use a internal energy
Contorl	Sensor	640×480 CMOS image sensor
	Microprocessor	The processor to drive 6 motors and to process a image data
Power		Express hunger
Food	Secondary battery	Small size, low cost

**2.1 Part of the mechanics**

A component of a mechanics part consists of a head, a neck, a mouth, and a digestion device. The design of the mechanics is miniaturization and simplification.

**2.1.1 Head**

A head has a mouth and a neck. A weight of head isn't increased with an internal device. We need a mechanism, which eat and put into body for a food. A head includes a pulley to pull the tongue with Wire.

**2.1.2 Neck**

A neck selects a simple sliding mechanism to slide form body in order to move a head toward a food instead of joint mechanism. Rack gear is required for joint of a sliding form.

**2.1.3 Stomach**

The stomach needs a storage device to use a prey as an internal energy, an excretion device to exhaust a food discharge a prey to the body outside.

**2.2 Part of the control**

A control processor to process data to come from 6 motors control and image sensor is required. The 32bit CPU TMS320F2812 in Texas Instrument, clock speed 150 MHz, used

for a part of control. CPU includes 16 PWMs on interior so motor control and image processing is available. A vision sensor uses the CV0A03B0C CMOS image sensor of Pixel Plus which is Master clock of 35 frames per second, 13.5 MHz every a pixel array 640×480.

**2.3 Part of the power**

The power part needs a movement of a robot, a battery remainder checker for a hunger expression, and a circuit for a battery charge. EPRO cannot operate only a battery for a food. Therefore , a part for a movement of EPRO use a 12V 3000 mA Ni-Cd battery.

**2.4 Food**

The food use a second battery of button type Ni-Cd 1.2V 70 mA which is easy to get home and personal environment.

**3. PROPOSED DESIGN OF EPRO**

**3.1 Design concept**

EPRO focus on a mechanism for eating and storage a food. EPRO has simplified a mechanism of a neck and a mouth. A neck selects simple sliding structure for simple control. The mouth used the tongue made from a permanent magnet, and to be able to catch a food in the ground.

An order EPRO eats and to excrete a food is as follows. The first, find a food use a vision sensor and move to a place with a prey. The second, head is brought down from body to the ground and attach the food to tongue in the mouth. The third, EPRO lifts up head from the body, and the tongue pulls in the mouth, and drops a food from the tongue. The last, a dropped food sinks in the body, and the stomach stores a food with an input device.

In this way a food saved in the stomach is used as an internal energy to eat a food. The exhausted food gets out of the body through an evacuation device. The figure of EPRO and the order of eating are as follows.

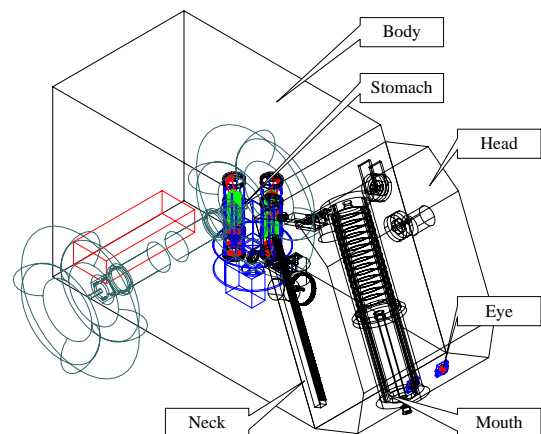


Fig. 3 EPRO (isometric view)

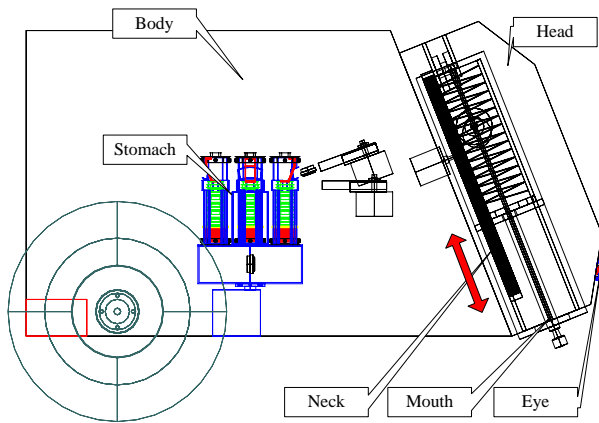


Fig. 4 EPRO (right view)

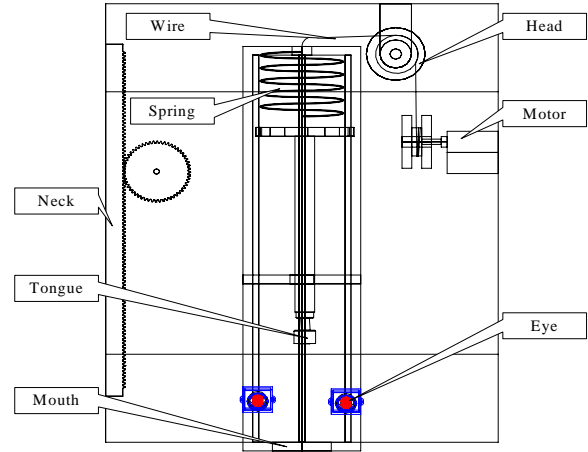


Fig. 6 Head of EPRO

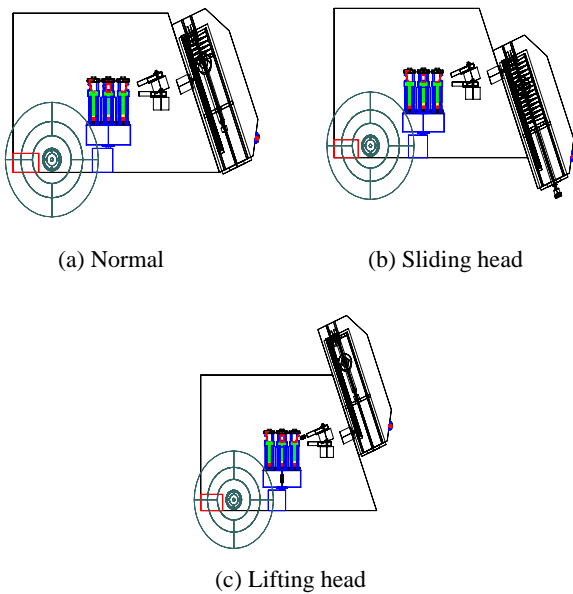


Fig 5 the order of eating sequence

**3.2 Head**

A head has eye and a mouth and is connected with a neck. EPRO uses the eye in order to find food as CMOS image sensor. The structure of mouth is cylindrical structure with piston type, and the mouth has the tongue in the inside. The tongue in the mouth made a permanent magnet is able to catch a food in the ground. Back of the tongue is connected with wire. Motor pulls this wire and pulls a food inside of the head. The attached food to tongue in the body though out the structure which dropping the food from tongue, and the drooped food comes into body. The structure of a neck is structure to use the rack gear which a sliding the head from body.

**3.3 Body**

The elements of body are composed the stomach, insertion device, discharge device. The stomach consists of the battery disk that is a special device to use a food as an internal energy. A battery disk consists of a battery pack. A battery pack is made of structure to connect 6 batteries in a series, and battery pack is consisting of a positive electrode and to the negative electrode. One of the Battery packs is 7.2V 70 mA. Battery pack has an entrance and an outlet. The battery for food is stored through out the entrance and exhausted discharged battery through out the outlet. Battery inserts a Battery pack after confirmation with a polarity.

A Battery disk connects 3 Battery packs in parallel so that the use can make an internal energy of 7.2V 210 mA with batteries for food. If the battery insertion is completed by one battery pack, a battery disk turns right, and it is filled an empty battery pack. Exhausted batteries shove it from a battery pack through a discharge device. An exhausted battery is naturally discharged through the outlet that there is among a battery disk without a physical external force.

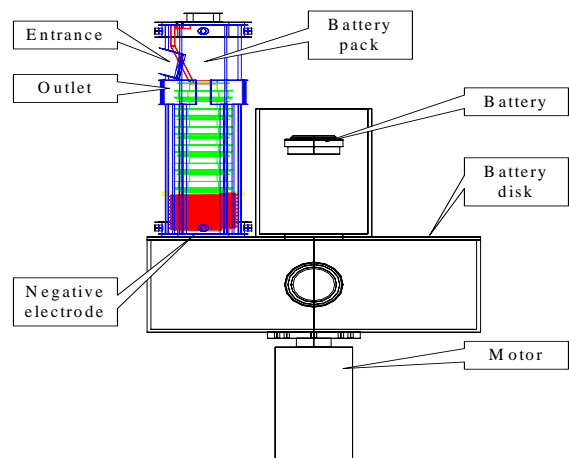


Fig. 7 Stomach of EPRO

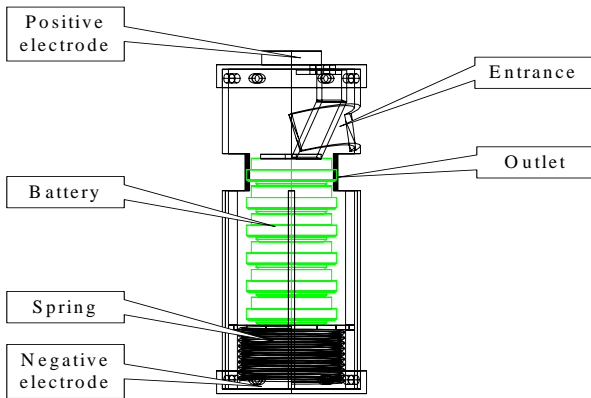


Fig. 8 Battery pack

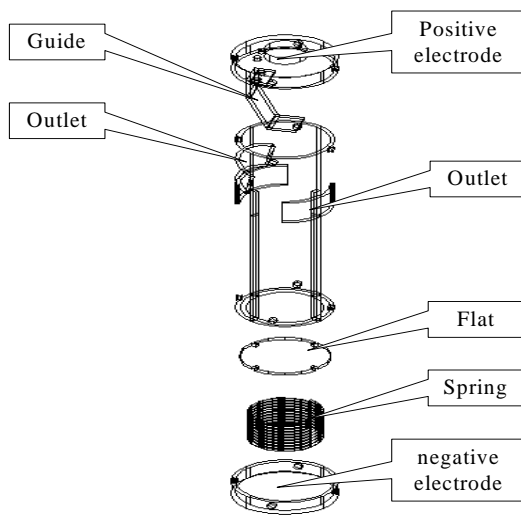


Fig. 9 Battery pack(assembly)

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#### 4. CONCLUSION

EPRO is Entertainment robot of a new form to autonomous move while eating a food. EPRO has settled wait time which Entertainment robot waits for recharging battery. EPRO interacts with people are as if pet owners give a food to pet animal. EPRO is human friendly and to play usability in home and a personal environment. As for the EPRO which proposed it at the above, a design was finished and implementing it. The future study after this paper, we'll develop algorithm to find a food using a vision sensor and mechanism to eat a food.

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