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The small eye and tongue module for an android robot head

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Abstract: In this paper, the small size eye and tongue module for an android robot head are presented. There are narrow spaces inside the android robot head by its human like shape and size, so to use small size parts is very important to design an android robot head. We tried to design an android robot head with 33 D.O.F and human like shape, but as the large numbers of D.O.F and human like shape, it was needed to make small size of each module to achieve our goal. The eye module presented has 2 D.O.F for eyeball and 1 D.O.F for eyelid, so there are roll, pitch motion for eyeball and pitch motion for eyelid like human eye. A gimbal was generally used in robotic eye, but a spherical joint was selected to reduce space occupying by its simple structure. The spherical joint is very simple and can manufacture small one, but it has 3 D.O.F even if there are only 2 D.O.F in eyes, so rotation motion of eye can be occurred. To avoid rotation of eyeball by using spherical joint, spring column was installed in center of eyeball. There has been no active tongue for an android robot or humanoid robot until now. The tongue is very important factor to design human like robot because it can be shown when the robot speaks, so an active tongue give more reality to an android robot when it speaks. Additionally, there are many emotional expressions to use tongue like ridicule, so tongue can help to make more various emotional expressions in android robot research. The tongue module has a flexible silicon complex skin for natural motion and human like looks. It has 2 D.O.F for stick out-put in and bending. The wire and rack gear were used to make that motions. With this small eye and tongue module, an android robot head which is highly sophisticated and more similar to human head can be designed.

Keywords: Android, robot, robot eye, robot tongue

I. INTRODUCTION

As researches in robotics have been developed, the researches of a humanoid robot and an android robot have been increased. An android robot is one of humanoid robots, but it has human likely appearance than one of humanoid robot. Because an android robot has human likely appearance, it can be used generally like a secretary, an announcer, an actor, etc. [1]. The appearance and size of android robots are similar to human, so the inner spaces of them are very narrow and this is one of the hardest things to design an android robot. Especially, in case of a head, there are many actuators to make facial expressions, so securing spaces is the most important to make a face with large numbers of D.O.F. The best method to secure spaces inside head is to reduce the size of each part, but most of parts like actuators, bolts are standardized, so it is not easy to reduce their size. For this reason, to downsize structures by simplification can be one of the best solutions. The eye parts are usually a gimbal which has yaw, pitch joint and they are most complicate and large sized parts in a head. The eye used a gimbal has 2 D.O.F in each eye and it is very common structure as a robotic eye, but it has frame in outside of eye ball and it is not good to downsize [2] [3]. Downsizing an eye means increasing of the number of D.O.F to the android head. Takuya Hashimoto made a female android robot SAYA and its eyes are gimbal type, so it has only 19 D.O.F in head, because eyes take so many spaces [4]. Minoru Hashimoto used artificial muscles to make an android robot face. This face is based on anatomy, so it is very good trial to make an android robot, but it is hard to make and maintain [5]. Jong Won Kwak used polymer artificial muscles to make eyes. These eyes are very small and simple, but it needs separate controller and DC-DC converters, so it is not suitable to our robot [6]. Our android robot has been used in commercial areas, so it is very important factors like maintenance, cost and parts supply, so we tried to develop small but simple structure [7]. To make small and simple eyes, spherical joint and spring column was used. Lorenzo Jamone used spring as a neck joint and bone to make their humanoid robot [8]. From this spring joint, the idea of spring column which prevent a rotation of the spherical joint can be drawn. The spherical joint is the simplest structure to make 2 axis motions, but there is a rotation of axis and using a spring column can hold this rotation. The main role of a tongue to an organism is degustation, but robots don't need to taste, so it is not exist or generally used as a decoration. The android robot has human like appearance, so the tongue is necessary, but it is just a dummy generally. In case of humans, the tongue

is used when they are speaking, express emotions, so we focused its role to emphasize emotional expression. This is the first trial for android and humanoid robots. Toshiya Kawamura made a robotic tongue to research flexibility and soft motions of robots, but it was made for researches, so its size is too big and appearance is not matched to one of humans [9]. The robotic tongue presented has 2 D.O.F (stick out – put in, bending) and it was made by silicon complex, so it has human like appearance. To make natural bending motions, wires were used and a rack-pinion gear was used to make stick-out and put in motions. This tongue module was designed small size enough to install in a jaw, because there are no actuators for skin in a jaw even if its space is narrow.

II. Hardware design

1. Design of the eye module

The purpose of a presented robotic eye is to make small size, simple structures and easy to maintain. In addition, the size and appearance must be exactly same to human eyes. There are pitch and yaw motions in human eyes and in case of both eyes, the yaw motion is separated but the pitch motion is constrained, so both eyes have 3 D.O.F. In case of the android robot, it has eyelids and they move independently, so the eyes of android robot need 5 D.O.F totally. The gimbal is used generally to make pitch, yaw motions of eyes, but this structure has frame outside of eyes and this is not good structure to miniaturize. In addition, this structure needs standard parts like bearings, bolts, etc. and there is limit to find small parts among them. The simplest structure to make 2 D.O.F is a spherical joint. The spherical joint is consist of only 2 parts, cup and ball joint, so it is very easy to downsize and manufacture, but there is a problem to use for eyes. The joint of spherical joint is not fixed to rotate motion unlike a gimbal or universal joint, so the eyes can rotate. The spring column is used to prevent rotation of eyes. The spring can be used as a joint because it can be bent to any directions. The presented eye ball consists of a cup joint, hollow ball joint and spring column. The spring column is connected with ball and cup joint, and it is located in hollow of ball joint, so the eyeball has only 3 parts but it has 2 D.O.F, small size and the simplest structure (Fig.1). 3 RC servo motors (Dymond D47, HiTec Hs5085mg) are used as actuators to move an eyeball and an eyelid, because RC servo is easy to use and small. The eyelid are designed similar to human eyelid and manufactured by CNC not bending, because the gap between an eyeball and an eyelid is very important to looking, so the gap is just 0.5mm. The eye ball and eyelid is connected to servo motors by ball joints. These parts are assembled as a module, so it is easy to maintain. The module structure is easy to maintain and attach to other face. The size of a presented 3 D.O.F eye module is very small as 64x40x40mm (Fig.2). Because of using small eye modules, more spaces inside of head can be occupied, so 33 D.O.F head can be developed.

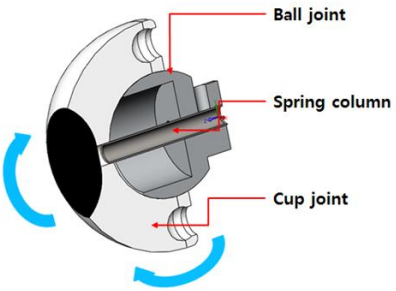

Fig 1 Structure of eyeball

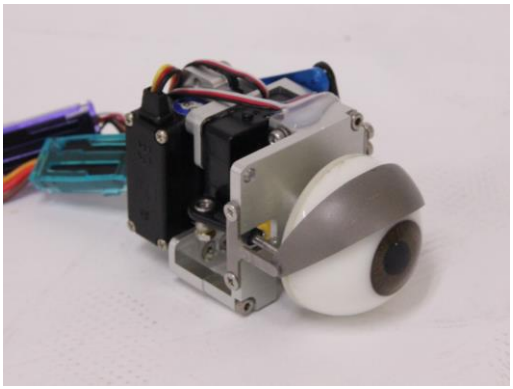

Fig. 2 3 D.O.F eye module

2. Design of the tongue module

A tongue is one of the most complicate parts in human body, so it is very difficult to make human like tongue. The motions of a tongue are divided outside of mouth motions and inside of mouth motions. In case of an android robot, the role of a tongue is only for expressions or as a decoration, so inside of mouth motions are not needed. The outside of mouth motions can be simplified as stick out-put in, bending up-down, bending left-right, so there are 3 D.O.F. The tongue is located in a jaw and the space inside a jaw is very narrow, so 2 D.O.F (stick out-put in, bending

up-down) is selected for downsizing. The silicon complex is used to make human like appearance and elasticity. There is a plastic bone inside the silicon tong and wires are used to make motions. Three wire holders are attached the bone and by changing of the location of these holders, the bending shape can be adjusted. A rack- pinion gear is used for stick out-put in motion, because it is very simple and cheap. The actuators for tongue are RC servo motors (Dymond D47, Dymond D 60). This robotic tongue is also designed as a module, so it is easy to maintain and apply to other head. The size of this tongue module is small as 100x60x60mm and the range of stick out-put in is 40mm. Fig. 3 shows mechanism of tongue module. These small sized eye modules and tongue module can supply spaces enough to make 33 D.O.F inside an android robot head (Fig.4).

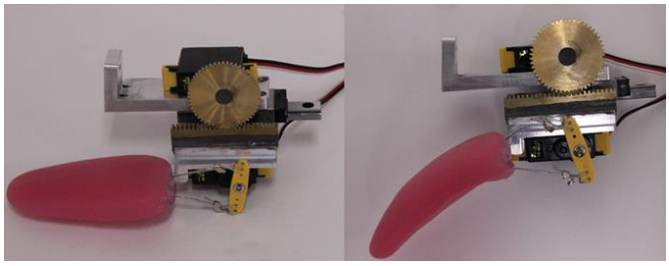

Fig. 3 Tongue module and its mechanism

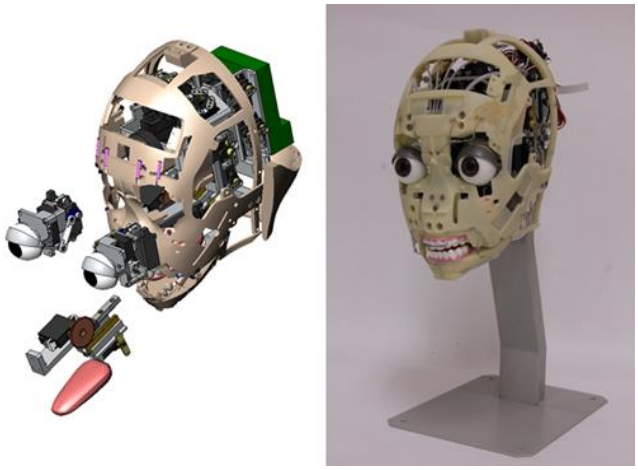

Fig. 4 Assembly of each module and 33 D.O.F head

III. Experiment and result

Experiments were taken to check whether the eye module, tongue module work or not when it is attached to skin and in that time, how the appearance is similar to one of human. There are no cameras in eye module, so accuracy doesn't matter in this device and the RC servo motors used are subminiature analog types, so it is hard to receive data from devices. The most important factor to the android robot is how the android robot is similar to human, so we focused to check its shape when it operated. We attached new eye and tongue modules to our hardware, android robot EveR-3, with new head which has 33 D.O.F and test. Fig. 5 shows yaw and pitch motions of eyeballs and a pitch motion of eyelids. The stick out-put in, bending up-down motions are also checked (Fig.6). All motions with eye, tongue modules are operated without trouble and similar to one of human. The presented eye, tongue modules have small size and simple structure, so the 33 D.O.F android robot head with higher expressions and easy maintenance can be developed.

Fig. 5 Eye motions (default, left, up, down gaze)

Fig. 6 Tongue motion (stick out, bending down)

IV. CONCLUSION

The small and simple eye, tongue modules for new 33 D.O.F android robot head are presented. The android robot needs many actuators to make human like facial expressions, so inside spaces of head are very narrow. In this reason, downsizing of each part is very important to decide its D.O.F. In addition, our android robot has been used in commercial area, so easy maintenance and reliability is very important. To satisfy these needs, small

and simple eye, tongue modules are developed. The eyes used a spherical joint and spring column and these can make small, simple structure and it is made as a module, so it is easy to maintain. The tongue consists of the silicon complex tong, plastic bone and rack-pinion gear. This tongue is also made as a module and small sized. The small sized RC servo motors are used as actuators. By this eye, tongue modules which are downsized, the android robot head with 33 D.O.F can be developed.

Acknowledgement

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