Arduino Based Semi-Autonomous Vision Biped Robot

R.Prema, K. Anuradha, Sakthi Sabreesh K, Sree Valsan R

Abstract: ***Robots are extensively used in Research and Development. Agriculture and Home automation systems play a vital role in this autonomous world. By interfacing image and voice sensor a semi – autonomous biped robot using MATLAB and ARDUINO is developed. The main objective of this robotic system is to harvest the vegetables from the farm using image sensor. This is done by detecting and comparing predefined images with live video snap shot with in limited time. Another feature of this robot is to pick and place the objects in home. This robot can be used for various domestic purposes.***

Keywords: Semi – autonomous biped robot, MatLab, Arduino, Detection and recognition.

I. INTRODUCTION

In the last few years, Artificial Intelligence has a rapid growth and turned on a new platform for innovation. In this paper, we have focussed on the automation of biped robot. This is not like conventional robot which are wheeled, stem. This robot looks like human structure and make movements called as Humanoid Robot. The proposed system has a framework for parsing images into regions and objects. In this framework, the detection and recognition of object is simultaneous with image segmentation [1]. This approach illustrates natural images where the primary interest are objects and faces. This system illustrates the advances and importance of combining bottom-up and top-down models of performing segmentation and object detection or recognition simultaneously.

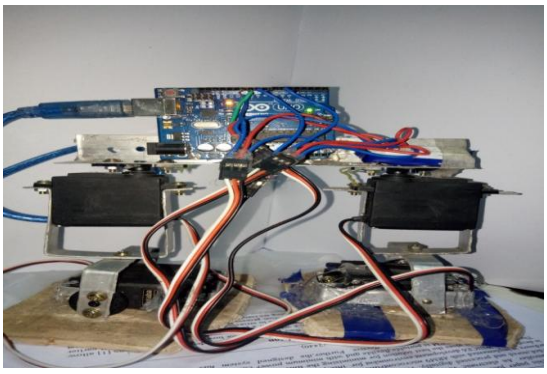

Fig. 1 Biped Robot

Overall, a low cost, biped robot (Fig. 1) with underlying objectives with enhanced algorithms and movement controllers is developed.

II. EXPERIMENTAL SETUP

The setup of the robot is carried at Karpagam Academy of Higher Education, Coimbatore. The robot has two legs and one arm. The camera is placed between the two gripers at the end of the arm so that it can detect image clearly and find distance accurately. It can be programmed manually. Its action can be set by rotating or adjusting its arm continuously. The robot works according to our voice commands.

III. WORKING LOGIC

This project works by the combination of camera and voice commands. Vision camera has capability to identify, measure, detect, track and classify the objects. It can easily identify the moving objects by using “subtraction method” and “Viola Jones algorithm”. It can detect even the orientation of the images when it changes. After this process, a high pulse is allowed to the Arduino controller[2]. The arduino controller gives the order to the motor which is connected to controller and a feedback is sent to the camera. A clear image is obtained through this. This process is continued till a clear image is obtained.

IV. BLOCK DIAGRAM

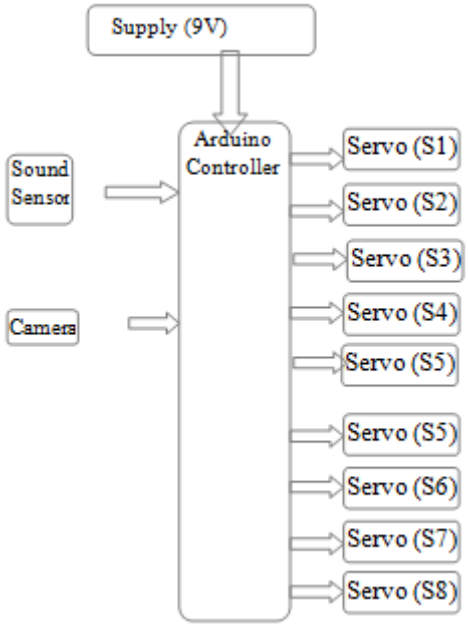

Fig. 2 Block Diagran

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V. FLOW CHART

The flow chart is shown in diagram Fig. 3.

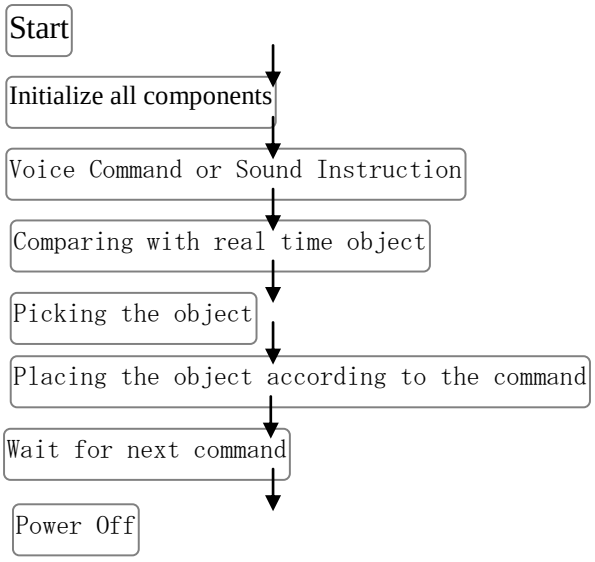

Fig. 3 Flow chart

Working Steps:

Biped's moving Sequence Algorithm[3]:

- Calibrate the robot to ZMP (zero moment point).
- Right foot servo and left foot servo tilt towards right side.
- Right hip servo made to rotate so that, left servo's raised to keep one step forward.
- Left foot servo and right foot servo title towards left side.
- This step is made to keep robot chassis at center without falling down while waking.
- Now, left hip servo made to rotate so that, right servo's raised to keep one step forward.
- This step is continued again to move next step by calibrating itself, vice versa.

Depending on Human action:

Few researchers in biomechanics have observed that humans appear to regulate angular momentum about the center of mass when standing, walking and running. Depending on this mechanism our biped robot partially walks by calibrating itself [4] when it get high pulse from image sensor and voice input

ZERO moment point:

It is a concept used to keep biped robot stable while any two point of the robot made to contact with ground and made its horizontal inertia and gravity force equal to zero (0). It is proposed mainly to walk in uneven surface. This concept is used in Honda's Asimo.

E.g.; angular momentum of the inverted pendulum.

Making the whole body centripetal equal to zero. The resultant force of the inertia and gravity forces acting on the biped robot is expressed by the formula (1):

$Fgi = mg - maG$ ----------(1)

where, m= total mass.

g = acceleration of gravity

aG=acceleration of the center of mass.

Arduino Specification:

Arduino is the most suitable friendly board in the arduino family. This project uses Arduino board. The board consists of several ports. The main controller used in the board is ATmega controller. Arduino consists of 6 analog pins (from A0 to A5) for reading analog inputs from the sensors and convert them into digital signals. It consists for 14 digital IO pins from 0 to 13. Some of the digital pins may also be used for PWM. Other pins present on the board are power supply pins (5 V or 3.3 V), ground pins, Aref pin. Reset button, USB port for connecting the Arduino to IDE and a power supply jack for providing external power supply are also present on the board.

Camera:

Fig. 4 Camera

Here the camera (Fig. 4) is used as the main guidance or input device for the entire robot. This camera will give the robot which way to take and which object to identify. The camera simultaneously take images and send to the software for comparison[5].

The software(matlab) calibrate the distance using Viola Jones algorithm, according to the picture and frames. The size of the images vary when they appear in long distance.

Table. 1 Camera specifications for the CMOS OV7670

Active Array Size		640x480
Power Supply	Digital Core	1.8VDC ±10%
	Analog	2.45V to 3.0V
	I/O	1.7V to 3.0V
Power Requirements	Active	60mW typical (15fps VGA YUV format)
	Standby	<20µA
Temperature Range	Operation	-30^0C to 70^0C
	Stable Image	0^0C to 50^0C
Output formats (8-bit)		• YUV/YcbCr 4:2:2 • RGB565/555/444 • GRB 4:2:2 • Raw RGB Data
Lens Size		1/6"
Chief Ray Angle		25"
Maximum Image Transfer Rate		30fps for VGA
Sensitivity		1.3V/(Lux. Sec)

S/N Ratio	46 dB
Dynamic Range	52dB
Scan Mode	Progressive
Electronics Exposure	Up to 510:1(for selected fps)
Pixel Size	3.6µm x 3.6µm
Dark Current	12mV/s at 60^0C
Well Capacity	17Ke
Image Area	2.36mm x 1.76mm
Package Dimensions	3785µm x 4235µm

Dynamixel AX-12 servo motor:

It can produce (Fig 5) high torque and is made with high quality materials to provide the necessary strength and structural resilience to withstand large external forces. It also has the ability to detect and act upon internal conditions such as changes in internal temperature or supply voltage and can also handle the problem automatically.

Fig. 5 Dynamixel servo motor

Precision Control Position and speed can be controlled with a resolution of 1024 steps. Compliance driving the degree of compliance can be adjusted and specified in controlling position. Feedback for angular position, angular velocity, and load torque are available.

Communication Wiring is easy with daisy chain connection, and it support communication speeds up to 1Mps.

Axis Bearing is used at the final axis to ensure no efficiency degradation with high external loads. LED can indicate the error status to the user.

Motor Specification:

Weight (g) of motor 55,Gear Reduction Ratio 1/254 ,Input Voltage (V) at 7V at 10V
Final Max Holding Torque(kgf.cm) 12 16.5
Sec/60degree 0.269 0.196, Operating Angle 300°, Endless Turn, Max. Current 900mA Protocol Type half duplex Asynchronous Serial Communication (8bit, 1stop, No Parity).

HC-05 Technical Specifications:

Serial Bluetooth (Fig 6.) module for Arduino and other microcontrollers, Operating Voltage: 4V to 6V (Typically +5V), Operating Current: 30mA, Range: <100m, Works with Serial communication (USART) and TTL compatible, Follows IEEE 802.15.1 standardized protocol, Uses Frequency-Hopping Spread spectrum (FHSS), Can operate in Master, Slave or Master/Slave mode, Can be easily interfaced with Laptop or Mobile phones with Bluetooth Supported

Fig. 6 HC-05 baud rate: 9600, 19200, 38400, 57600, 115200, 230400, 460800

Further developments:

This project can further be used in any aspect. Biometric system can be introduced such that only authorized persons can use the robot. We can adapt to real world by auto updating of program as per the authentic person desires. Even the robot can speak according to the further development needs. We can do 3D image processing using the concept of point cloud processing. This idea involves in capturing the individual points and spaces from the 3D images. This is used in the autonomous robot and self driving cars, which are under research.

VI. CONCLUSION

Many advantages are viewed in this project. Even though each and every robot have some drawbacks, overcoming those drawbacks in this project might be the one of the auto programmable.

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