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A comparisonal study on robot arm in terms of light weight handling

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Abstract- *In case of light weight handle able miniature robot arm, end effector combinational method is far better than U-arm method used for connecting every moving part. In case of u-arm method, ground base acceleration is made with complex mechanics and a huge friction loss occurs and it also has limited degree of freedom. But, while using robot arm for miniature spy robot or light weight holding capability, minimum 4 degrees of freedom are required and accuracy is just in case of spy robot or a detective one. In this case, u-arm performs poorly where combinational end effector works perfectly with higher efficiency and accuracy rate.*

Keywords: Friction, Miniature, Four degrees of freedom**.**

1. INTRODUCTION

Robotics is now the most buzzing word. Industrial automation in terms of robotics is now a part and parcel of both industrial and human advancement. In case of robotic arm, the arm is linked with some separate parts. The links of such a manipulator are connected by joints allowing either rotational motion such as in an articulated robot or translational (linear) displacement [1]. But incase of more accuracy like detective robot arm,medical use,for laboratory workplace the positioning of end effector of a robotic arm is the most important factor.For this case using servo motor at every joints of a robot can performe more accurate than traditional uArm mechanism with using third hand. For more accurate work or working with critical systematic environment that has high sensitivity, need accurate positioning of end effector of the robotic arm [2]. Incase of uArm, it's difficult to perform accurately for it's functioning with friction. While joint motorization and using third hand can solve the problem in terms of light weight paper.

2. Background

At first robot was developed by Leonardo da Vinci. Now a Japanese robotic company KAKU manufacturing robotic arm which are so costly and very complex in work field to control [3]. In 2007 the world market grew by 3% with approximately 114,000 newly installed industrial robots . At the end of 2007 there were around one million industrial robots in use, compared with an estimated 50,000 service robots for industrial use [4]. Due to increase using of industrial robot arms, an evolution to that topic began trying to imitate human movements in a detail mode. For example a group of students in Korea made a design of innovations that robotic arm take account of dancing hand, weight lifting, Chinese calligraphy writing and color classification [5]. Another group of engineers at USA developed robot arm with eight degrees of freedom. This robot is able to grasp many objects with a lot of shapes from a pen to a ball and simulating also the hand of human being [6].In space, the Space Shuttle Remote Manipulator System, known as SSRMS or Canadarm, and its successor are examples of multi degree of freedom robot arms those have been used to perform a variety of tasks such as inspections of the space shuttle [7]. But for detective purpose, there are some problems with grabbing any object. Most of the time it would not have backup, a third hand can minimize the risk [8].
Using a specially deployed boom with cameras and sensors attached at the end effector and satellite deployment, indeed.

3.0 System component

The whole system is based on two parts, mechanical part with functioned arm and signal processing part. Signal processing part will process the computing language uploaded to the microcontroller and mechanical part is the design concept using mechanics. Signal processing part is given below:

3.1 Raspberry Pi

It is one of the smallest computers available in locality. Raspberry Pi is somewhat equivalent to the chip used in first modern generation smartphones [9].
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Fig.1: Raspberry Pi microprocessor

3.2 Servo motor

A servomotor consumes power as it rotates to the commanded position but then the servomotor rests. In case of this prototype robotic arm "Tower pro" MG 996R, 14kg/cm is used [10].

Fig.2: Servo motor

3.3 Stepper motor

The stepper motor is known by its property to convert a train of input pulses into a precisely defined increment in the shaft position. Each pulse moves the shaft through a fixed angle.

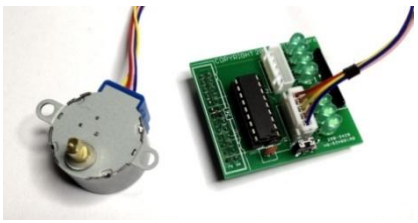


Fig.3: Stepper motor and motor driver

3.4 stepper motor driver

It controls the motor with the given algorithms through microcontroller.

3.5 Robotic claw

Claw can reach objects up to 108mm away and trap highest 55mm wide objects securely in its clutches.

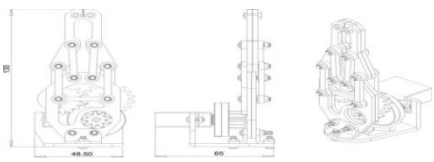


Fig.4: Robotic claw

3.5 10 k Ohm potentiometer

Potentiometer is a variable resistance, by which resistance can be change from zero to 10k ohm

3.6 220 Ohm Resistor

Locally available 220 Ohm resistance using which excess current can be controlled while supplying to the servos

3.7 Breadboard (full)

Normally PCB (printed circuit board) is not available, so breadboard is used where points are connected in a sequential manner.

3.8 Jumper wire

For connecting the points of the breadboard (when necessary) jumper wire was used. There were three kinds of wire were used male to male, female top female & male to female jumper which are locally available and current rate 1800mAm.

3.9 9V DC power supply

In case of power supply initially variable supply was used but after facing load difficulty and heavy current drain it causes a result of using Lithium polymer battery. Which can supply 11.5 volt but in case of limitation the whole circuit can withstand with 6 volts maximum. So, special diode and resistance are used for keeping the voltage down.

4.0 Methodology

In case of light weight handling, specific grabbing point to grab any kind of object is much important than a heavy weight handling. In this case articulated robotic arm is used. But while using articulated robotic arm vibration of the whole body due to servo can make the arm possibly fail in case of accuracy. For centralization or having the grabbing object on a specific point and making the object at a fix point can make the arm easier to grab the object. For this case a third hand is introduced. A third hand that gains its movement up to 90^0 each linked with two separate servos and the servo was fixed with the main base. While any object detected with the VGA camera [11] connected with Raspberry Pi then the third arm will be activated, thus the third arm will make the object pointed at a fixed co-ordinate which makes the arm easier to grab the object. As, the third arm is activated until the object was successfully grabbed so, it will ensure the probability to grab the object. The following controlling method will be used; In this case computerized scanning and figuring the required shape or simply functioning it with programming can make the work easier. The computer language uploaded to a microprocessor system will convert binary information to voltage variation which will function the joint of the arm by using mechanical component with calculated mechanics. For controlling the servo motor there will be three point of wire coming from the motor, two of them are ground and supply voltage and last one is for signal. In case of servo motor, it can rotate according to the programme and its range is 180 degree to 0 degree. This kind of servo loaded with the pin number 3,4,5,6 from the Raspberry Pi microprocessor board. And both ground and supply voltage is given by the provided pin from Raspberry Pi microprocessor called 5V and GND 4 servo work for joint movement and the movement is specified by objects position. A stepper motor which rotate 360

degree in 120steps is used controlled by a stepper motor driver L298D.5v supply and ground voltage is given by Raspberry Pi microprocessor supply pin and the main four signal pins from stepper motor driver are connected with the pin number 7,8,9 and10 of Raspberry Pi microprocessor.

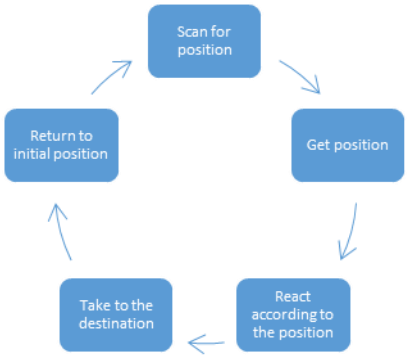
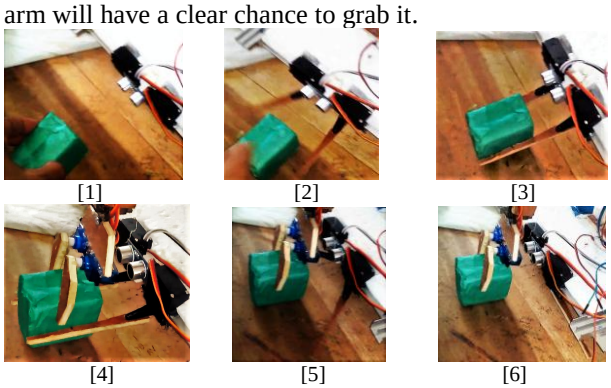


Fig.5: Working cycle

In case of vibration, if the grabbing process failed, the third arm will remain in its position and then the main arm will have a clear chance to grab it.



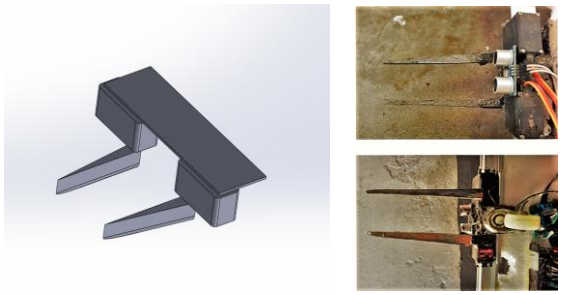
[1] [2] [3] [4] [5] [6]

Fig 6: [1] Initial position; [2]Grabbing the object ; [3] 3rd hand making fixed;[4]Grabbing by claw;[5]Releasing for third hand;[6]successful picking operation

If the process made to have the object then, the third arm will return to its initial position.

5.0 Designing & construction

In designing, simple wooden and stainless aluminum is used .For accuracy third hand has a long length. For its long length, it has a range of 180^0 rotational rang with its radius. For which, it can work with good area condition. Mechanical strength is calculated according to its using purpose. As, it was functioned with light handling, it is perfect to use aluminum even wood.



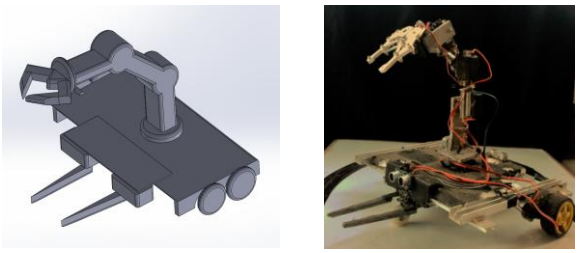
[1] [2]

Fig.7: Third Hand [1] in design [2]in experiment (top & back view)

This third hand is attached with the base of the chassis. But in case of movement two metal servos with wooden claw is used and the servo and wooden claw was attached using glue gun heated polymer. And the whole set of arm was attached with the chases using screw.

The designed joint has following freedom:

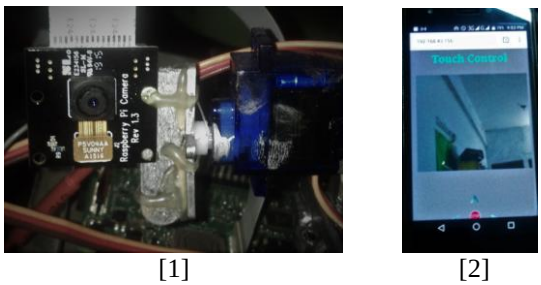
Angle	Range(degree)
Elbow	0-120
Wrist	0-40
Third hand	0-90



[1] [2]

Fig.8: Total body and perspective position of third hand [1] Conceptual design [2] construction

The robotic arm at first the loop starts by scanning its surroundings by rotating 360 degree. As a sonar sensor is used for determining the co-ordinate of any object. While the sonar find any object it will send a signal to the processing unit (Micro controller) then the output signal will stop the rotating stepper motor and start functioning the grabbing part.



[1] [2]

Fig 9: Camera of Raspberry Pi microprocessor [1]; mobile view of camera output[2]

In case of grabbing a object the processor provided with raspberry pi r3 gives voltage signal from binary coded information. In this case the moving arm will move by its servo motor according to object's co-ordinate. As this is a three dimensional co-ordinate system, this can be displayed in mat lab with graphical representation. But in case of grabbing the object, some displacement can be happened, that's why it has great mechanical advantage.

6.0 Result:

The following results are found:
Current consumption and weight analysis:

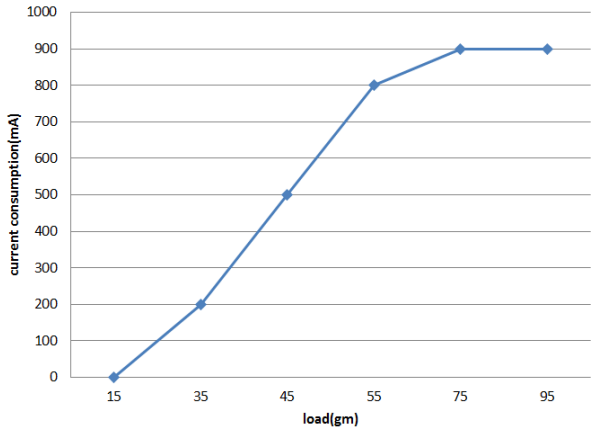


Fig 10: Load VS current consumption

From the Fig 8, the consumption of power can easily be measured. It shows that the more the load greater the current consumption. As the experiment was carried out with a prototype, in this case, for initial it will consume zero energy, but when increase in load from 15 gm. to 55gm it will gradually increase the current consumption. While using third hand, it will help with initial lifting but not in long run.

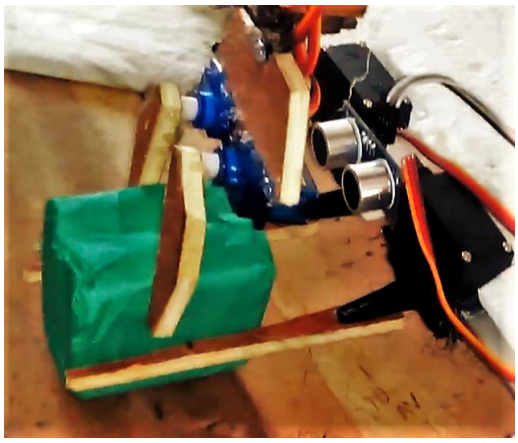


Fig 11**:** Position for zero loads on current

In case of movement of the servo, following results were found
Table 1: Cyclic position of servo

Activity step	Servo 1	Servo 2	Servo 3	Stepper motor (degree)
1st step (scan 360 degree)	0	0	0	60 step
2nd step (if object detected)	0-120	0-40	0-80	Located position
3rd step (grab the object	120	40	80-0	stable
4th step (take to a position)	120-0	40-0	0	removing
5th step (scan again)	0	0	0	Initial position

From the table, the output and programmatic schedule of every servo and its comparative timing for third hand can be found out. In step 2nd from "Table 1" the object was found with the scanner and at this point in step 3rd and before step 4th the third hand was activated by the timing algorithm then the taking operation was done by the claw was successful.

Table 2: Load capacity with accuracy

Load	Current consumption(mA)
15gm	Low (0-200)
35gm	Normal(200-500)
45gm	Normal(500-800)
55gm	High(800-900)
75gm	Overloaded(above 900)
95gm	Overloaded(above 900)

Form table 2, algebraically data of fig 8 can be found. It indicates the current consumption of the total load, where the total consumption was zero while it maintain 15 gram of load initially.

7.0 Discussion

Throughout the construction, some designing concept was changed because of un availability of proper materials. On the other hand, some advantages and also some disadvantages were found while using new concept of third hand in case of light weight handling. Instead of metal construction, wooden frame was used for the arm and also for the third hand .the percentage rate of grabbing any object with third hand is 70% where without the third hand its very low in rate, about 40%.Some problem was found while handling prospectively heavy weight. According to the graph shown in Fig 10, more than 95 gm. load can cause error in grabbing the objects. As this experimental data were collected from a prototype, it shows perspective results.

Weight greater than 95 gm. can cause failure and drug forced while centering the object will make it damage. In case of sensitive object it's not wise to use third hand but a high regulation camera for accuracy. Otherwise, it's better to use third hand while handling light weight.

8.0 Conclusion

This paper represents the design, development and implementation of robot arm in terms of light weight handling. For which a new technique is introduced for avoiding in grabbing object and accurate robot arm's performance. It has been observed that, it can be implemented in detective robot or rescue robot for maintaining its accuracy. For taking care of patient and house hold helping robot third hand can be used. More over in case of industrial automation, when it demands for grabbing any object, third hand can be used. It has some problems like heavy weight handling or not taking much care about the object that has to be picked. But above all, end effector third hand can perform a good output in practical field in some specified working class, indeed.

9.0 REFERENCES

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