Robotic Arm Movement using Image Processing

Mayank J. Patel, Brijesh N. Shah

Abstract— Nowadays there is an increasing need to create artificial arms for different in human situations where human interaction is difficult or impossible.. Here I propose to build a robotic arm controlled by MATLAB. A human hand can handle various objects by his hand, with better capacity and precision. In some hostile conditions, a need arises to replicate the human arm movements by some sophisticated manipulator. This report illustrates the controlling of the movements of robotic arm, in accordance with the movements of RGB color strip (attached to human arm) using real time image processing.

Keywords—Matlab, Image Processing, Atmega16, Servo Motor

I. INTRODUCTION

Nowadays, robots are increasingly being integrated into working tasks to replace humans especially to perform the repetitive task. In general, robotics can be divided into two areas, industrial and service robotics. International Federation of Robotics (IFR) defines a service robot as a robot which operates semi- or fully autonomously to perform services useful to the wellbeing of humans and equipment, excluding manufacturing operations. These robots are currently used in many fields of applications including office, military tasks, hospital operations, dangerous environment and agriculture. Besides, it might be difficult or dangerous for humans to do some specific tasks like picking up explosive chemicals, defusing bombs or in worst case scenario to pick and place the bomb somewhere for containment and for repeated pick and place action in industries. Therefore a robot can be replaced human to do work [1] [2]. Robotics is a rapidly enhancing field. This is an important time in the development of the field, when the technical community and the beneficiary populations are working together to shape the field towards its intended impact on improved human quality of life and more and more versatile and smart robots are being developed. Recent development in the robotics motivated us to do our project. The new trends in robotics research have been denominated service robotics because of their general goal of getting robots closer to human social needs, and this article explains the key role of the robotic arm for the safety of human being in inimical conditions such as working in space, military environment etc.

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The human arm is very versatile; however it cannot work under hostile condition. This inspired us to make a articulated robot which will play the role (limited to physical moments of the human arm) of the human arm in hostile conditions without being actually present in that environment [1][2].

ROBOTIC ARM DEFINITION -A robotic arm is a robot manipulator, usually programmable, with similar functions to a human arm. The links of such a manipulator are connected by joints allowing either rotational motion (such as in an articulated robot) or translational (linear) displacement. The links of the manipulator can be considered to form a kinematic chain. The business end of the kinematic chain of the manipulator is called the end effectors and it is analogous to the human hand. The end effectors can be designed to perform any desired task such as welding, gripping, spinning etc., depending on the application. The robot arms can be autonomous or controlled manually and can be used to perform a variety of tasks with great accuracy. The robotic arm can be fixed or mobile (i.e. wheeled) and can be designed for industrial or home applications.

II. PROPOSED SOLUTION

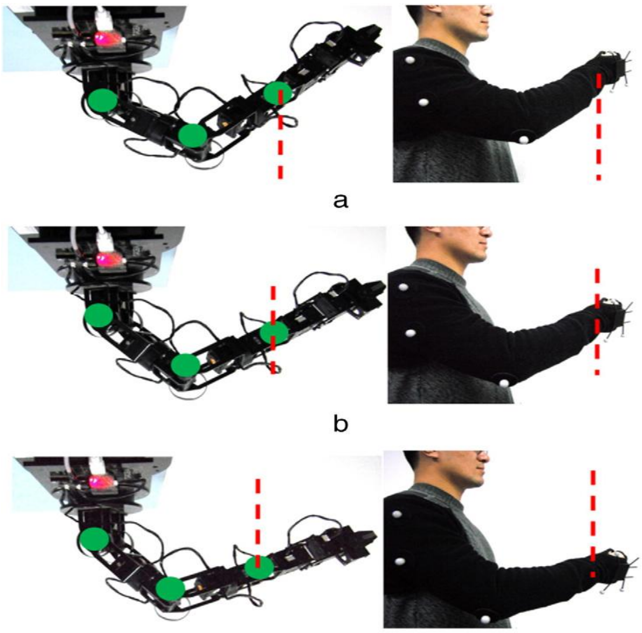

Fig. 1: Robotic Arm Movement

Conventional methods for detecting human arm movements make use of mechanical sensors, such as accelerometer, proximity sensors, which increases the cost and it is dedicated to one person only but my project uses camera and there are no such sensors used.

Any human can arm movements can be replicated, there are no restrictions too. Due to the use of high signal processing, my project establishes synchronization between human arm movements and robotic arm movements. This project can be further improved by increasing the number of axis to get more human arm movements; also there is a vast scope for controlling each joint motion. The basic block diagram shows the concept of project. As shown in the diagram camera will capture the movement of hand and it will send to Microcontroller by P.C via USB. After processing the image it will detect the RGB color label and measure the centroid of RGB color strip. According to the measurement, microcontroller send the signal to the servo motor and it will move the robot as RGB color strip move with movement of hand.

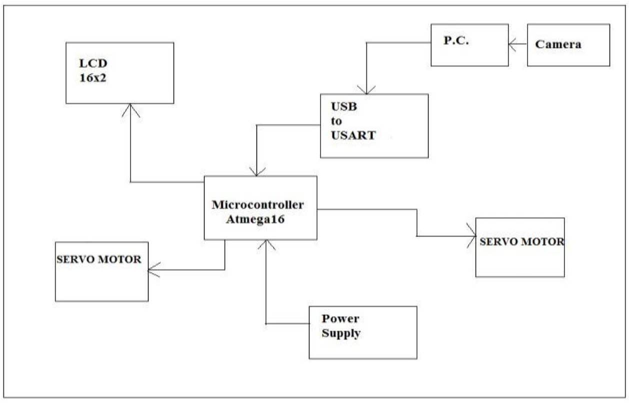

Fig. 2: Block Diagram

I choose to implement the task using image processing and by using RGB color strip and without any mechanical sensors. The inputs to the system are the movements of the Strip(attached to human arm), which will be processed by the processor. It detect the RGB color strip and measure the cetroid of RGB color strip and generates binary pattern which is transmitted to the Controller, and which will control the movement of Robotic Arm .

III. Hardware Requirement

ATMEGA16

The ATmega16 is a low-power CMOS 16-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed[7].

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers. The ATmega16 provides the following features: 16 Kbytes of In-System Programmable Flash Program memory with Read-While-Write capabilities, 512 bytes EEPROM, 1 Kbyte SRAM, 32 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary scan, On-chip Debugging support and programming, three flexible Timer/Counters with compare modes, Internal and External Interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain (TQFP package only), a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and six software selectable power saving modes[7].

SERVO MOTOR

A servo is a mechanical motorized device that can be instructed to move the output shaft attached to a servo wheel or arm to a specified position. Inside the servo box is a DC motor mechanically linked to a position feedback potentiometer, gearbox, electronic feedback control loop circuitry and motor drive electronic circuit[15].

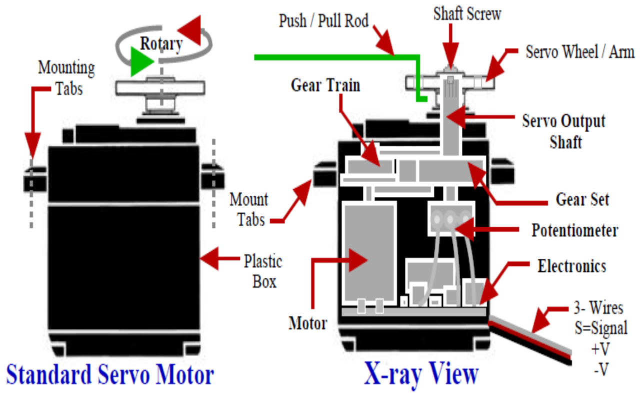

Fig. 3: Servo Motor

A typical R/C servo looks like a plastic rectangular box with a rotary shaft coming up and out the top of the box and three electrical wires out of the servo side to a plastic 3 pin connector. Attached to the output shaft out the top of the box is a servo wheel or Arm. These wheels or arms are usually a plastic part with holes in it for attaching push / pull rods, ball joints or other mechanical linkage devices to the servo. The three electrical connection wires out of the side are V- (Ground), V+ (Plus voltage) and S Control (Signal). The control S (Signal) wire receives Pulse Width Modulation (PWM) signals sent from an external controller and is converted by the servo on board circuitry to operate the servo [15].

IV. Software Implementation

An image is an array, or a matrix, of square pixels (picture elements) arranged in columns and rows. Image Processing Toolbox provides a comprehensive set of reference-standard algorithms, functions, and apps for image processing, analysis, visualization, and algorithm development. You can perform image analysis, image segmentation, image enhancement, noise reduction, geometric transformations, and image registration. Many toolbox functions support multicore processors, GPUs, and C-code generation[6]. Image Processing Toolbox of MATLAB supports a diverse set of image types, including high dynamic range, gig pixel resolution, embedded ICC profile, and tomographic. Visualization functions and apps let you explore images and videos, examine a region of pixels, adjust color and contrast, create contours or histograms, and manipulate regions of interest (ROIs).

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The toolbox supports workflows for processing, displaying, and navigating large images[6].

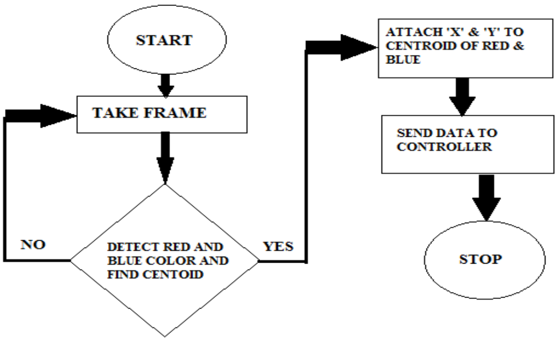

Fig. 4: Flowchart

As shown in the flowchart, here by using camera one frame is taken. After that from that frame red and blue color detected and converted it into binary image. If color is not detected than it takes another frame. On next step it finds centroid of red and blue color. For red color it attaches ‘X’ and for blue it attaches ‘Y’. This data is send to controller by using the USART.

V. RESULTS

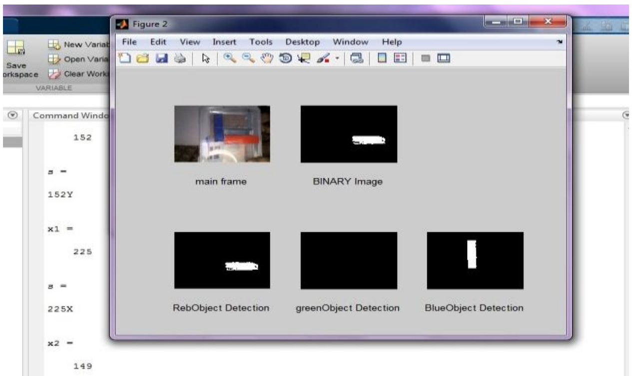

Fig. 5: Result of MATLAB

Here from figure5 we can see that red and blue color detected by MATLAB and attaching ‘X’ and ‘Y’ to centroid of respective color. After that as shown in the figure6 data are sent to ATMEGA16 using USART.

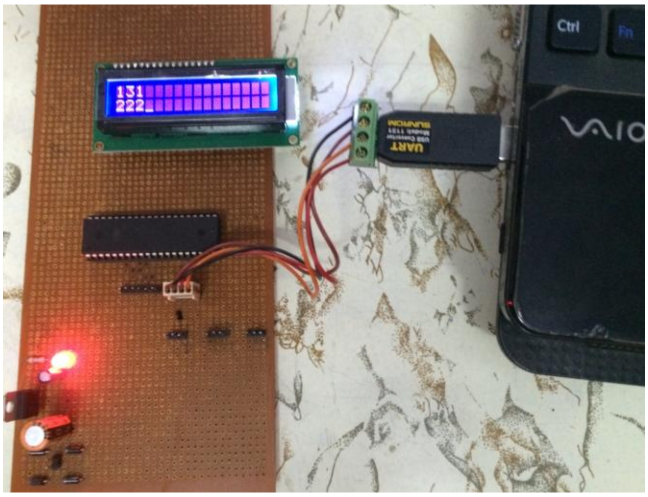

Fig. 6: Sending Data to ATMEGA16

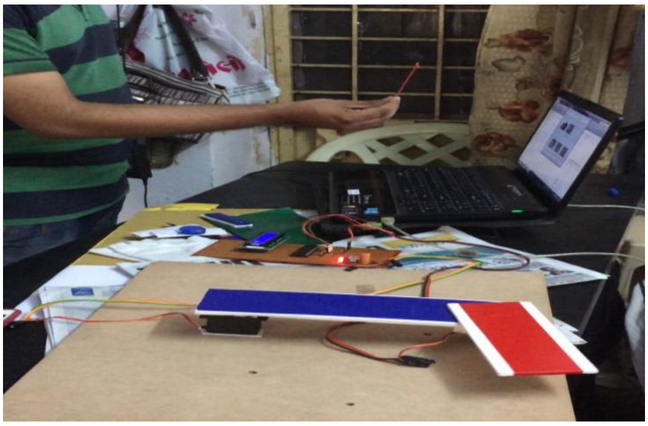

Fig. 7: Movement of Robotic Arm

Here from figure7 we can see the movement of Robotic arm using red color strip.

VI. CONCLUSION

The main goal of the project is to wirelessly synchronize the movements of robotic arm with the human arm movements which were successfully achieved using real time image processing. The conclusions are drawn from this project are that the Video frame captured by the webcam was used as input to the computer for performing task.

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