WIRELESS ROBOTIC ARM WITH CAMERA BASED MONITORING SYSTEM

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ABSTRACT

Robotic arm has become popular in the world of robotics. Intelligent Control is the discipline that implements Intelligent Machines (IMs) to perform anthropomorphic tasks with minimum supervision and interaction with a human operator. In today's world there is an increasing need to create artificial arms for different situations where human interaction is difficult or impossible.

The essential part of the robotic arm is a programmable microcontroller capable of driving dc motors. Pick and place is one of the most useful technologies used in our industries. This robotic arm can also be used to reach places where humans cannot reach such as nuclear environment, plant hidden places and small tunnels. It can be helpful for physically challenged people for accessing the objects.

The development of this robot is based on Microcontroller platform that will be interfaced with the wireless controller to the mobile robotic arm. It can move forward, backward, turn right and left for a specific distance according to the controller specification. It has five dc motors attached to it. Bluetooth module is used for communicating between user and robotic arm. Since our paper contains the concept of video streaming this robotic arm can also be used in home monitoring system. It has a camera placed for video streaming which can rotate in clockwise and anticlockwise direction

I. INTRODUCTION

International Federation of Robotics (IFR) defines a service robot as a robot which operates semi or fully autonomous to perform services useful to the well-being of humans and equipment, excluding manufacturing operations. Robotic arm is a mechanical arm to perform the desired task. Humans pick things up without thinking about the steps involved, so the robotic arm is controlled manually through wired and wireless system. These mobile robots are currently used in many fields of applications including office, military tasks, hospital operations, dangerous environment and agriculture. The main aim of the paper is to build a robotic arm that is capable to pick an object and place the object to the required places. The system that is built has two circuits namely microcontroller circuit with Bluetooth module and the motor driver circuit. This system will be powered by a 12v supply. To create a systematic, faster and efficient operation, microcontroller [1-3] will be used. This microcontroller will process the input received from the Bluetooth module

II. LITERATURE REVIEW

Taking a look back at the history of robot development, a special kind of human-size industrial robotic arm called Programmable Universal Machine for Assembly (PUMA) came into existence. This type of robot is often termed anthropomorphic because of the similarities between its structure and the human arm.

A. Leap Motion Controlled robotic arm:

Leap motion control robotic arm allows an optimum mapping between the user hand movement and robotic arm [4]. It uses human-machine communication interface between the Leap Motion controller and the 6-DOF robotic arm. The disadvantage of this system is prolonged use of user's hand for motion control may cause numbness or pain in the hands and can be uncomfortable for the user to use.

B. Gesture controlled robotic arm:

Gesture controlled robotic arm responds to the gestures of the user as well as can be programmed to go along a definite path and task [5]. The system feels the movement of user's arm and robotic arm replicates the given input gesture. The gesture is sensed by a number of potentiometers which are embedded onto a glove. The movement in potentiometer regulate the position for the servo motors driving the parts of the arm. The disadvantage is that the paralyzed person cannot operate efficiently.

C. Accelerometer based system to control an industrial robot:

An accelerometer-based system to control an industrial robot consists of accelerometers that are attached to the human arm for capturing user's gestures and postures [6]. An Artificial Neural Network (ANN) schooled with a back-propagation algorithm was used to recognize arm gestures and postures. The robot starts the movement almost at the same time as the user starts to perform a gesture or posture (low response time). The system is more complex.

D. Wireless robotic arm:

Wireless robotic arm uses Arduino programmer to pick and place objects. It uses android application (Blue control app) for motion control [7]. It has Bluetooth module for connecting between user and robotic arm. Bluetooth module is interfaced to the microcontroller for taking appropriate actions. This robotic pick and place arm don't have the option of vision hence they are not useful in many situations.

The above discussed systems are either sophisticated or too complex in operation and are not cost effective. The Robotic arm which were developed earlier were restricted only for the purpose of pick and place of objects.

III. SYSTEM OVERVIEW

This section deals with block diagram of wireless robotic arm with camera based monitoring system and its description. The block diagram is shown in Figure 1. It has two sections: a transmitter section and a receiver section.

- Transmitter section consists android phone for motion control and laptop for video streaming.
- Receiver section consists of microcontroller to process the signals received through Bluetooth module.

The paper is concerned with the implementation of pick and place task using microcontroller board. The camera placed in the robot streams the video to the user, through which the user can monitor/control the robot. Instructions from user are sent from android phone via Bluetooth to the microcontroller. Bluetooth module transmits the data to the microcontroller. The received data is processed and corresponding output is sent to the motor driver circuit which enables the dc motor to rotate in the desired direction (i.e., forward, backward, left, right, stop). Each and every command is displayed on the LCD (Liquid Crystal Display)

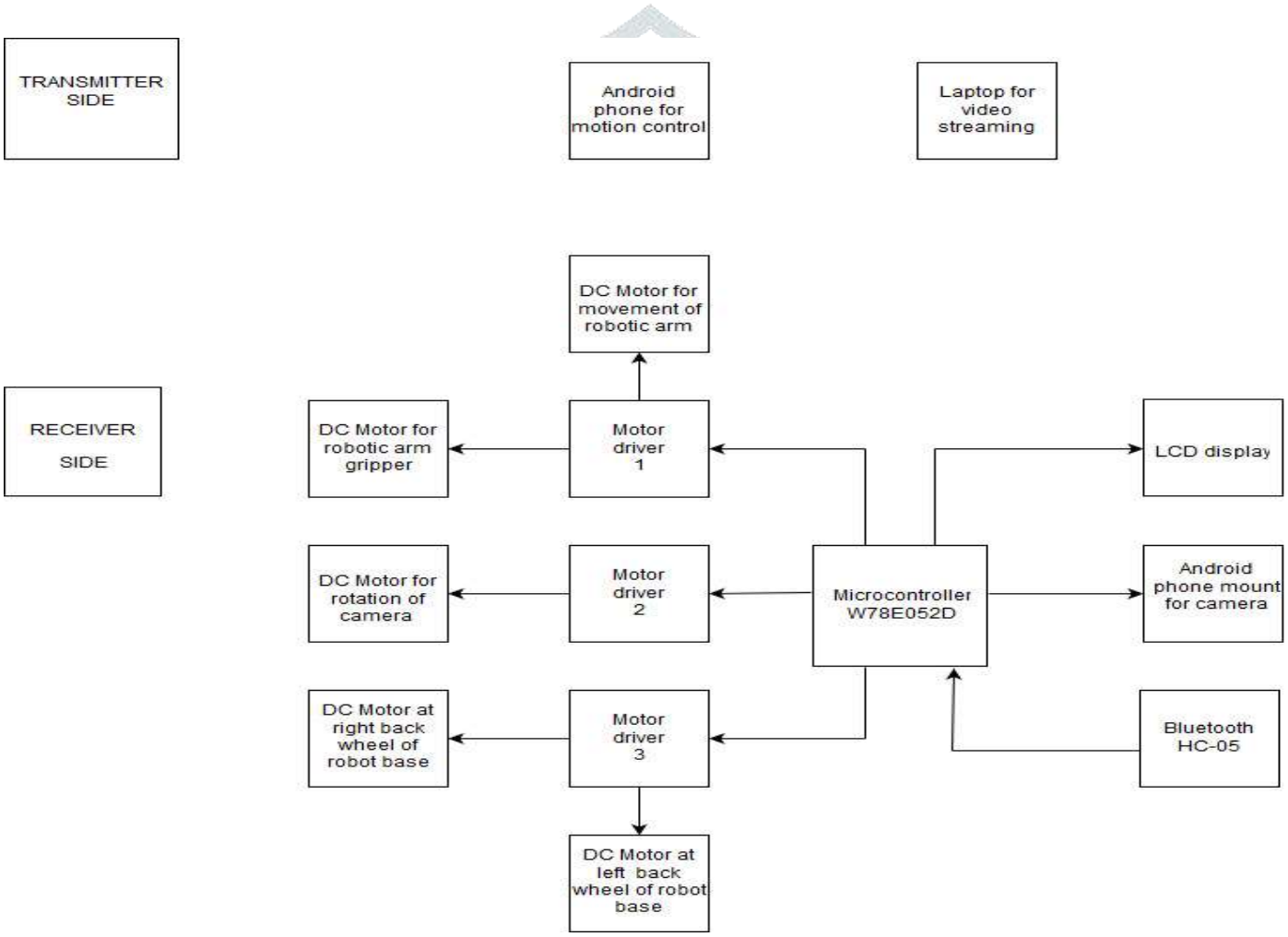


Figure 1: Block diagram of wireless robotic arm with camera based monitoring system

IV. SOFTWARE DESCRIPTION

The software used to control robotic arm model are Blue control application and IP webcam.

A. Blue control application:

Blue Control is a basic universal Remote Control for Blue-Tooth enabled serial devices such as Bluetooth modules connected to a micro-controller. For each button pressed the corresponding ASCII code for the label will be sent. For example, pressing buttons A-H will send the characters "a" - "h". The up, down, left, right,

and center buttons will send "U","D","L","R", and "C" characters. The controls present in blue control app is shown in Figure 2.

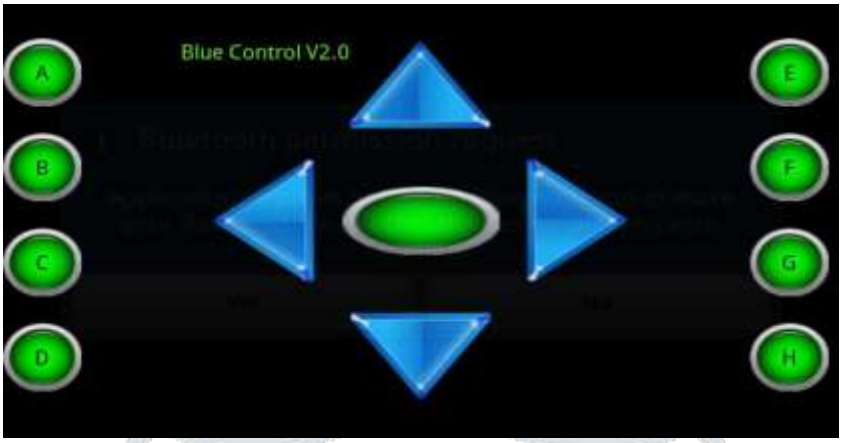


Figure 2: Blue control app

B. IP Webcam:

IP Webcam turns any android phone into a network camera with multiple viewing options. It enables the user to watch live streaming of video on any platform with VLC player or web browser. Streaming of video can be done inside Wi Fi network without internet access. IP web cam application is shown in Figure 6.

V. HARDWARE IMPLEMENTATION

The circuit in Figure 3 shows the connection of 8051 microcontroller to various peripherals which are described as follows:

- Bluetooth Module is configured as transmitter which transmits the signal received from user to 8051 microcontroller i.e., P3.0 is connected to Tx of Bluetooth module.
- Motor drivers are used to drive 5 motors where one motor driver can drive up to two motors. Pins P1.0, P1.1, P1.2, P1.4 are connected to driver 1 which controls the movement of robotic base. Pins P1.4, P1.5, P1.6, P1.7 are connected to driver 2 which drives the mechanical arm and gripper. Pins P3.1 and P3.2 are connected driver 3 which enables us to control movement of camera.
- Port 2 of 8051 microcontroller is completely used for LCD display.

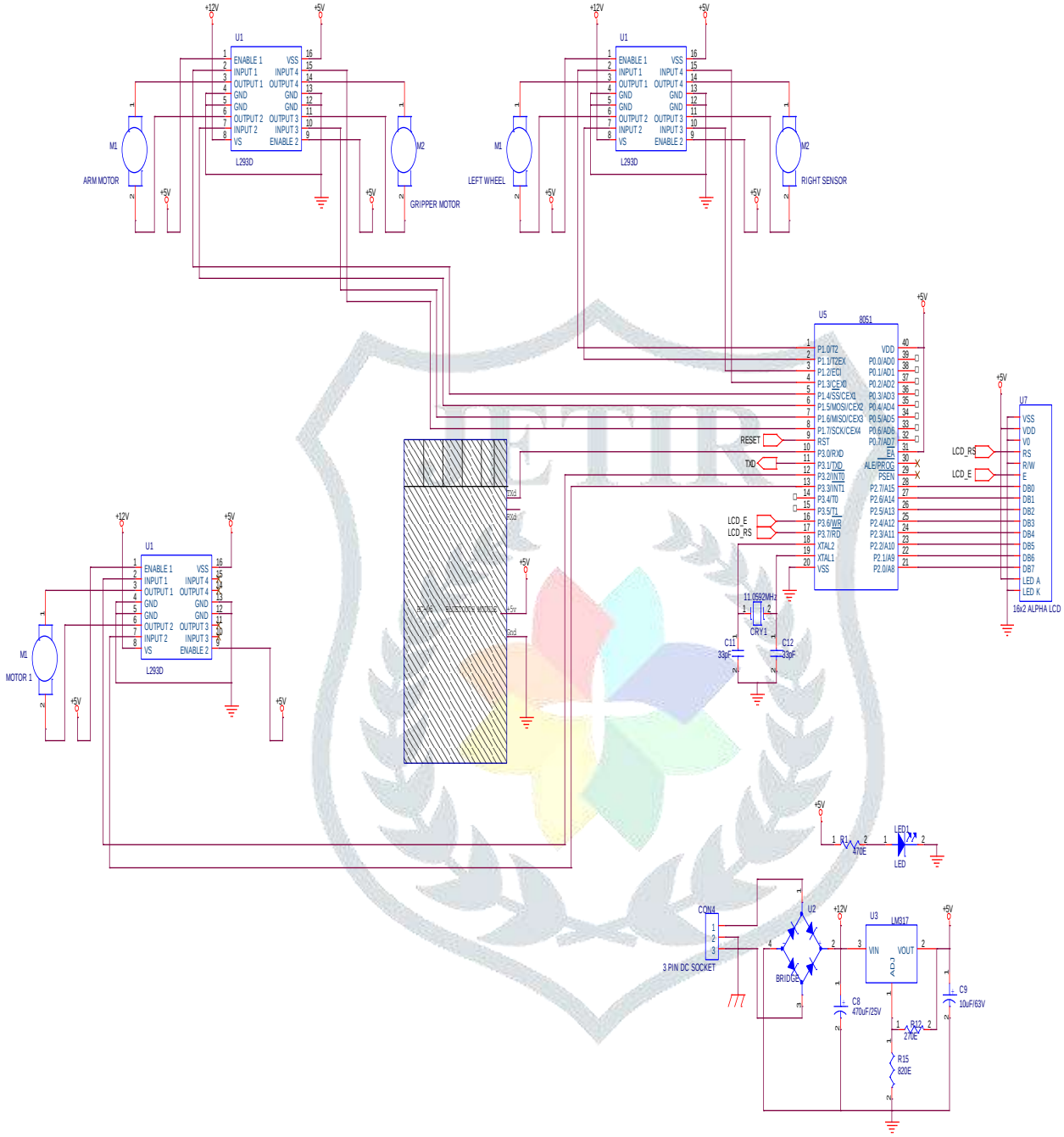


Figure 3: Circuit diagram of the robotic arm model

VI. RESULTS

A high definition camera of 1080 x 720 pixels resolution is used to capture the live video at a frame rate of 30 frames per second. Once the 12 V battery is fully charged, it can drive the robot continuously for 3 hours. The weight of the robotic arm model is 2.5kg with no load. The gripper can handle a maximum weight of 500g. The user input sent to the system corresponds to the movement of the robot in the required direction. The maximum range of this wireless Bluetooth module communication is 5-10m.

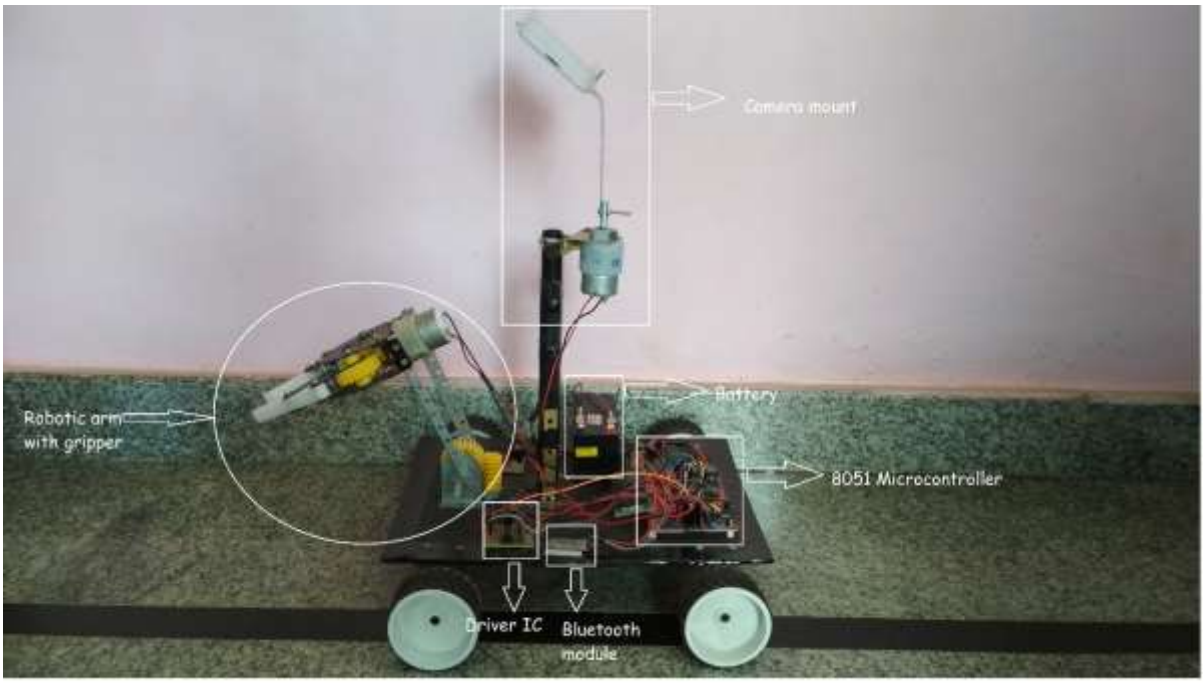


Figure 4: Robotic arm model

The robotic arm model is shown in Figure 4 and it has the following control options- forward, backward, left, right, arm up, arm down, gripper open, gripper close, camera clockwise rotation, camera anticlockwise rotation [Figure 5]. Controlling and movements of the Robotic Arm are detailed in figure 7.

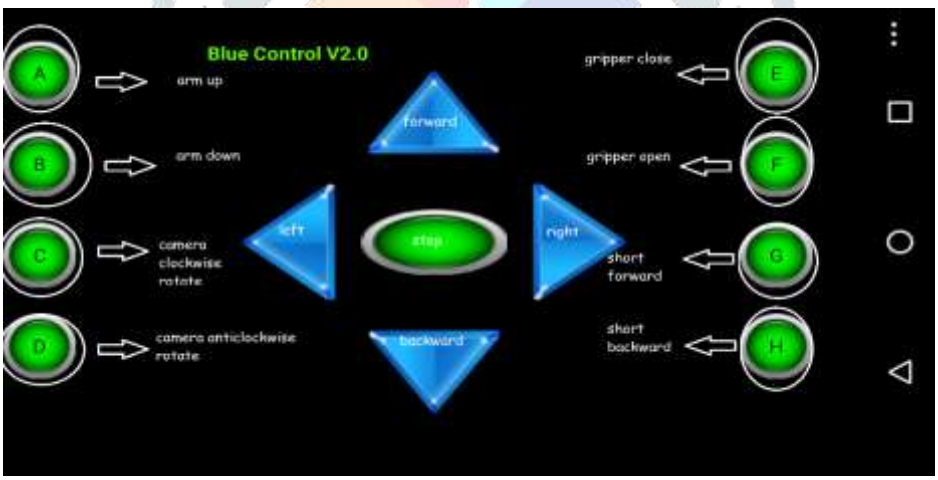


Figure 5: Controls used in blue control app

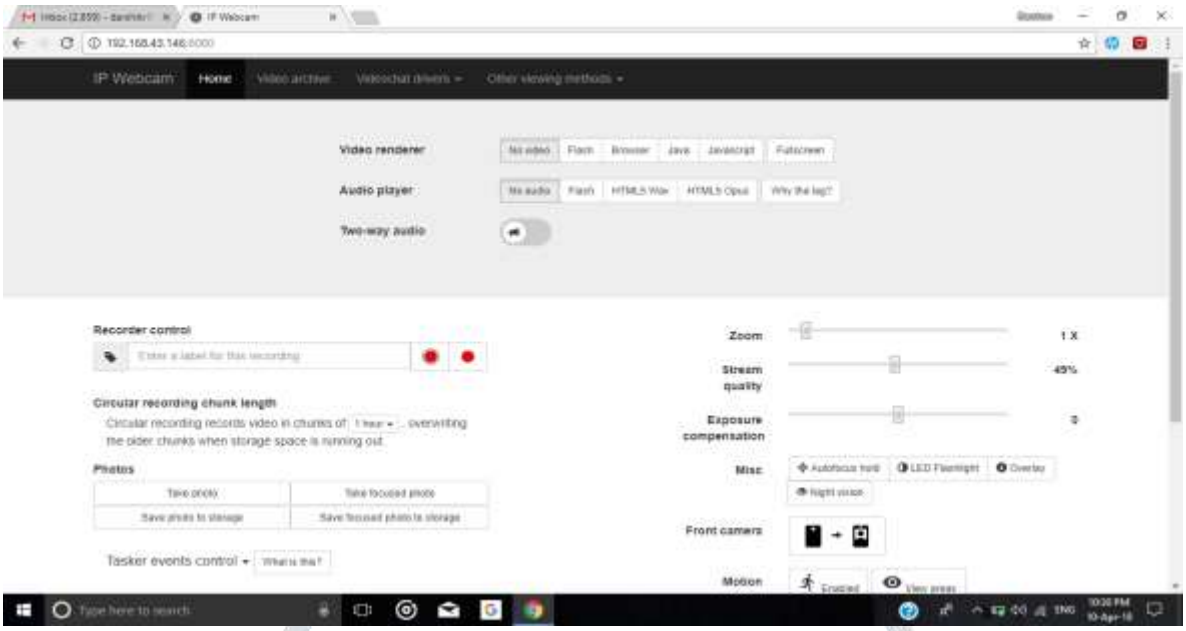


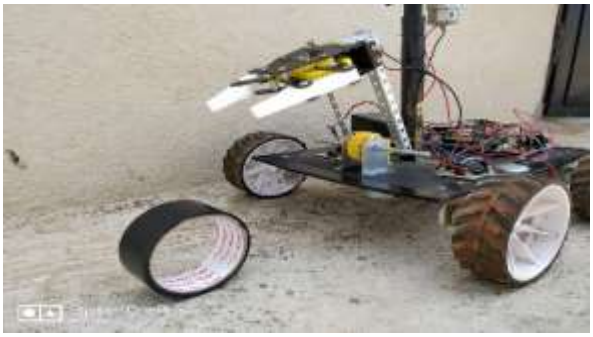
Figure 6: Controls in IP Webcam

The controls used in the blue control app and their corresponding functions are shown in Figure 5. The software used for video streaming is Ip Web Cam as shown in Figure 6. Figure 7(a-d) shows the forward movement. Figure 7(e-f) shows arm down movement. Gripper open action for releasing the object is shown in Figure 7.9(g) and (h). Camera clockwise rotation is shown in Figure 7 (i) and (j) respectively. Similarly, for all other user given inputs corresponding action takes place in robotic arm.

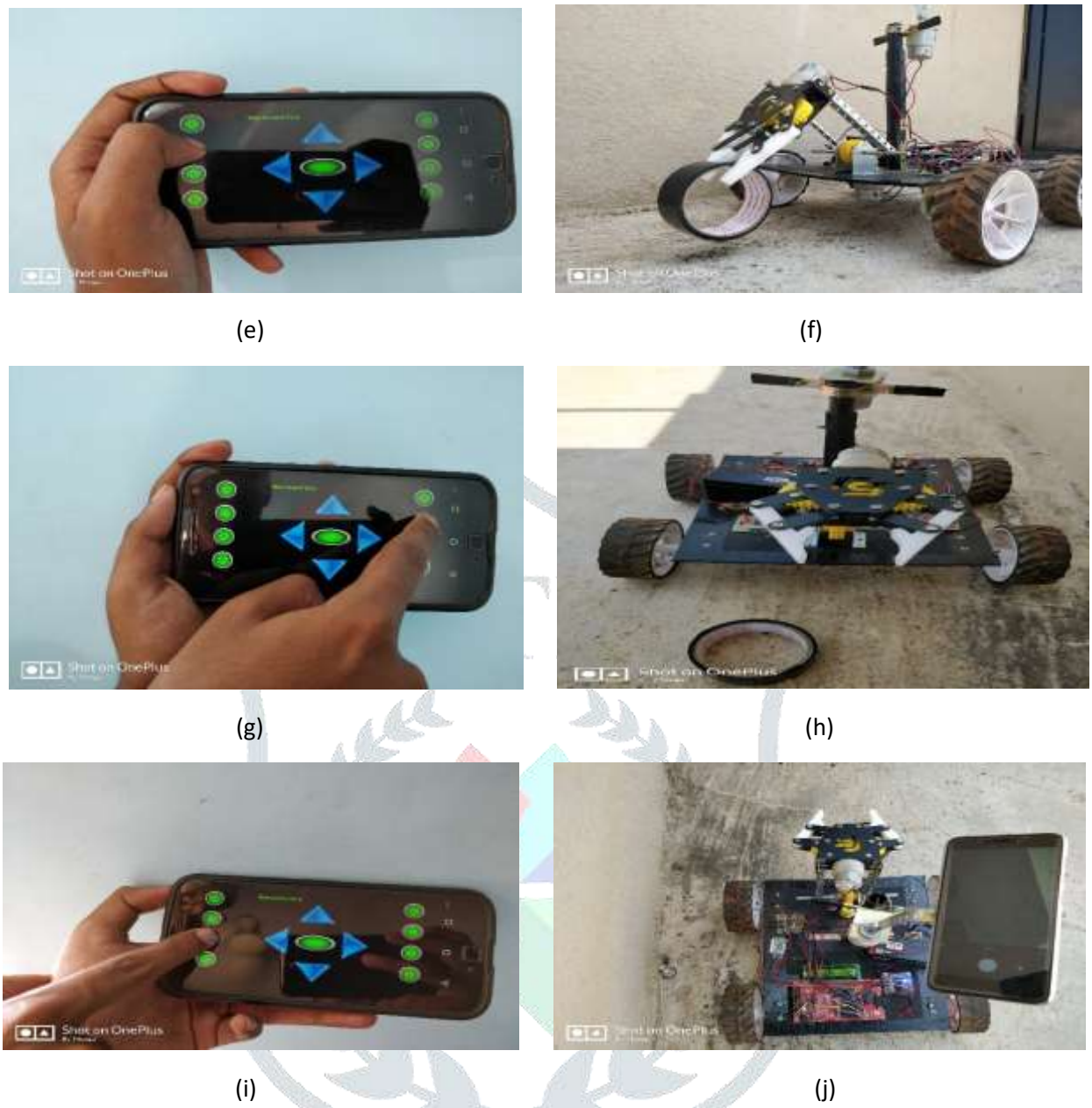
(a)

(b)

(c)



(d)



(e) (f)

(g) (h)

(i) (j)

Figure 7: Movements and controls of Robotic arm

VII. CONCLUSION

The designed robotic arm performs basic pick and place of objects and can move from one place to another place, which is controlled wirelessly and monitored using camera within the range of 5-10m. The paper plays an important role of picking and placing the object, especially for physically disabled people who are in need of doing some basic tasks independently. The system built is precise in its movements, user friendly and cost effective. The software and hardware required for wireless robotic arm with camera based monitoring system has been designed and tested successfully.

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