MQTT Based Unmanned Ground Vehicle (UGV)

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Abstract : Nowadays security is the most important parameter with respect to national and international security without involving human life while providing the same is the main focus of the dissertation. Taking into account the measures for national security multiple ways has been encountered out of which Unmanned Vehicular Bot is one of the option which serves better for defense application and also ensures less causality to the nations defense personnel. The literature survey states the comparative study of different technologies used till date out of which IoT based robotics turns out to be the most effective and efficient way to control robotic action over the internet. In another literature survey HTTP protocol & Bluetooth was used in initial stages which has many drawback as security is our main concern. In this dissertation our main aim is to carry out robotic action over the internet using MQTT protocol which overcomes the drawbacks of HTTP protocol, secondly the robot is able to track target through camera and the same is targeted by the demo gun mounted on robot. Here image processing is used on raspberry pi micro-processor which captures image and processes it with the help of Open-CV algorithm. The frame is scanned for target and the demo laser gun which makes movement using servo motor tracks the target which is identified by the algorithm used for detection and processing of image. This will help the authority to monitor and execute any plan deep inside enemy territory.

IndexTerms **- MQTT, Raspberry Pi, Image-Processing, Open-CV.**

I. INTRODUCTION

Military robots, drones, unmanned vehicles, etc. are used for fighting enemy forces and organizations, intelligence gathering such as taking visual images of enemy infrastructures and strongholds, surveillance and reconnaissance and rescue missions. [2] Customized drones according to requirements can be employed to fulfill necessities in the aspects of military defense and offense applications [3]. These remotely operable robotic systems are immune to the threats posed by environments which, on a contrary basis are actually threatening to Human personnel, whose intervention in the said environments may be of utmost importance. To avoid such issues, the UGV systems prove to be of great help regarding their capability of being deployable to such hostile environments. Here we have a custom-built UGV [4], dubbed as 'Defense bot' with respect to the dissertation title. A key feature proving to be of use here is a stealth gun which fires Ferro-magnetic projectiles and is mounted in a turret which is operated with a customized remote control [5].

The robots embedded system based on Raspberry Pi have more obvious advantages than the traditional robots in system cost, development difficulty, power consumption of equipment and safety coefficient [2]. So we use the Raspberry Pi as embedded CPU, combined with 802.11g protocol [3]. HTTP, TCP/IP, the USB serial port communication protocol, streaming media technology and real-time video transmission RTP/RTCP [3]. Through SSH security protocols we designed a higher security of real-time video monitoring, data monitoring, mobile robot which was controlled by android mobile phone terminal. On Raspberry Pi development we designed embedded driver, servers and application of mobile phone terminal, and realized the function of mobile home-monitoring in real time finally. Communication protocol is also one the issue when applying to the single chip microcomputer or microprocessor, where battery usage and one-to-many communication must be considered[11]. HTTP is one of the protocol that has been used for control over WIFI. However, as HTTP is not an actual bidirectional communication, practical usage when implement into remote control robot can be a cumbersome because managing the connection requires to specify the connection ports (and might also the IP address) for each components in the network. This also leads to another problem when the control must be able to achieve through the internet connection, where controlling from anywhere is necessary. Moreover, HTTP protocol has a large size of packet, which consumes a lot of power, especially for battery powered device[9].

Thus in this dissertation we will implement the MQTT cloud platform for remotely control robot based on "publish/subscribe" concept. Our main aim is to carry out robotic action over the internet using MQTT protocol which overcomes the drawbacks of HTTP protocol, secondly the robot is able to track target through camera and the same is targeted by the demo gun mounted on robot. Here image processing is used on raspberry pi micro-processor which captures image and processes it with the help of Open-CV algorithm. The frame is scanned for target and the demo gun which makes movement using servo motor tracks the target which is identified by the algorithm used for detection and processing of image[6]. This will help the authority to monitor and execute any plan deep inside enemy territory.

II. CIRCUITRY

The interfaces on the Motor side of the circuit is shown belowin Fig 1.The Motors are connected to Motor Driver L298 which controls the direction of Motor with the help of I/O pins which are connected to Processing Unit i.e Node MCU (ESP 8266) . The other operation control provided to Node MCU is Laser Gun triggering .

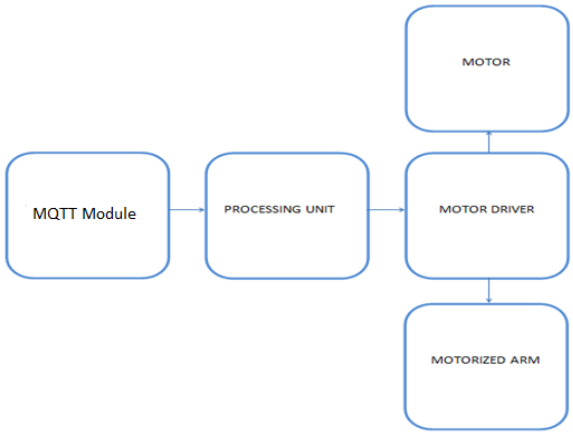

Fig 1. Bot Motor Interface

Another interface shown in Fig 2. below is provided for video processing on Raspberry PI connected to Camera Module (Webcam) which acts as input connection and the GPIO pins on raspberry pi is given as output connection to Motorized arm where laser gun is mounted on it. The motor driver is Powered which 12V battery and 5V enable pin connection.

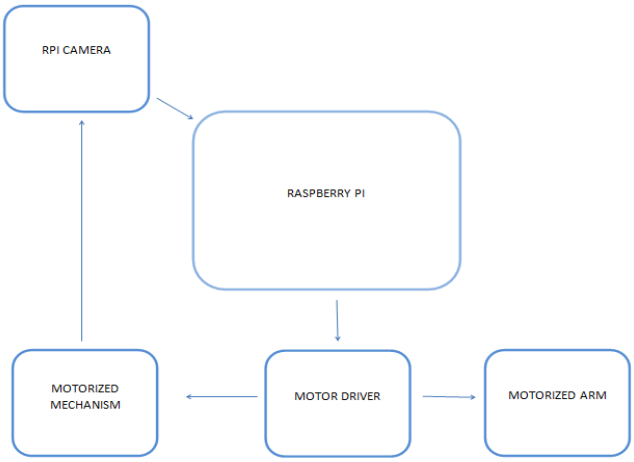

Fig 2. Raspberry PI interface

The list of requirement for dissertation is essential :

A. Node MCU(ESP 8266)
B. Raspberry Pi Zero W
C. 12 V Battery
D. Motor Driver(controller) L298
E. Webcam(Camera Module)
F. Survo Motor (Motorized Arm)

III. METHODOLOGY

The prime working of dissertation rely on image processing where in this work the suitable algorithm used is Haar-Cascade. This haarcascade algorithm is used for detection of human face and also tracing it. The platform used for performing this operation is Simulink (Matlab) in Raspberry Pi Zero W. The tracing part of work is provided with help of survo motor and laser gun, where the calibration for survo motors is also done using GPIO pins in Raspberry pi.

The camera is attached to Pi to provide input to the user and with help of simulink software the face detection algorithm is run through it and tracing begins. The bot movement and control over the triggering of laser or in other word encountering the enemy can be provided using Node MCU. Hence the raspberry pi can only provide the passive interface whereas the superior authority of work can be enabled using Node MCU for the essential purpose. The motor controller is connected to Node MCU which works on digital(logical) signal patterns for the movement of bot.

The following Fig 3. below, shows the working algorithm for the dissertation:

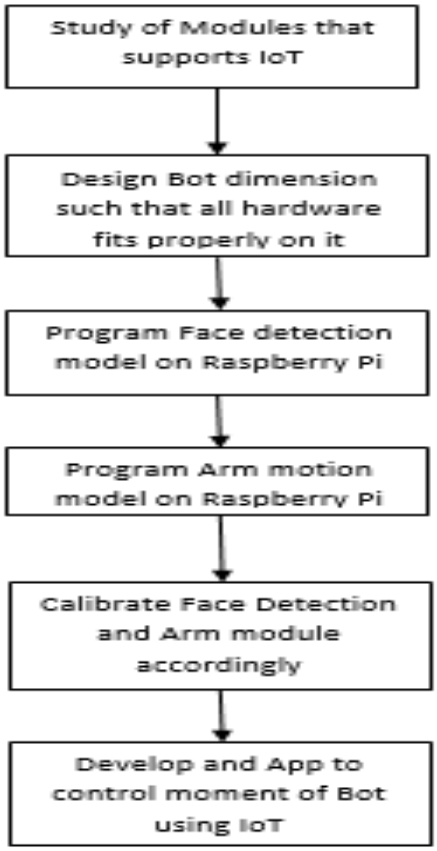

Fig 3. Working Algorithm

The below Fig.4 shows the code for Client server connection for IoT broker. The broker use is AdaFruit.

```
#include <ESP8266WiFi.h>
#include "Adafruit_MQTT.h"
#include "Adafruit_MQTT_Client.h"
#define laser D3
const int motorPin1  = D1;
const int motorPin2  = D2;
//Motor B
const int motorPin3  = D5;
const int motorPin4  = D6;
#define WLAN_SSID       "xyz"             // Your SSID
#define WLAN_PASS       "xyz"         // Your password
/************************ Adafruit.io Setup ***********************************/
#define AIO_SERVER      "io.adafruit.com"
#define AIO_SERVERPORT  1883                   // use 8883 for SSL
#define AIO_USERNAME    "arif_q"            // Replace it with your username
#define AIO_KEY         "fb86979f0a5d4363b8947272f578fe"   // Replace with your Project Auth Key
/************ Global State (you don't need to change this!) ******************/
// Create an ESP8266 WiFiClient class to connect to the MQTT server.
WiFiClient client;
// or... use WiFiFlientSecure for SSL
//WiFiClientSecure client;
// Setup the MQTT client class by passing in the WiFi client and MQTT server and login details.
Adafruit_MQTT_Client mqtt(&client, AIO_SERVER, AIO_SERVERPORT, AIO_USERNAME, AIO_KEY);
```

Fig 4. IoT Adafruit Broker

IV. RESULT

The output of simulation shows the Coordinates for Face pointer, where the pointer the is just mark between the nose and eyes with green colour dot mark. As the movement of face in the frame resolution is found the coordinates changes accordingly. Also with the change in coordinate of face the moment of Servo arms is observed which in phase which human motions. The below image Fig 5. Simulation output, where we can observe the frame and coordinates of human face.

Fig 5. Simulation Output

V. Conclusion

The output observed has overall efficiency of 50%. The efficiency can be overcome with better platform in raspberry pi as the ram is 512mb and picture resolution was limited to 480x280 frame due to same. Also introducing algorithm like deep learning and AI can bring a huge differences in the output and provide better result and performance.

VI. Current application

The current prototype can be used for the following applications:

i. Border Patrolling and enemy territory surveillance
ii. Operation in Bio-hazard area and radioactive hazard area
iii. Operations involving spying, search and destroy

VII. Future Scope

The robot can be improvised to traverse vertical surfaces using amplified Van der Waals force of attraction principle. The mobility on different vertical surfaces can be achieved using claw – gripping effect to climb on porous surfaces such as brick and concrete walls, mud walls etc. and electromagnetic surface attraction to climb on metallic walls. The mobility can be improved on air, land and water for stealth operations. The maximum effective range of the present gun is 10mts and we can extend it up to a range of 50mts. In addition to this, different types of lethal and non-lethal ammunitions such as armor-piercing rounds, anti-material rounds, Taser rounds etc can be implemented on the defense bot.

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