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Design and Implementation of a Novel Modular Armed Advanced Robotic System (MAARS)

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ABSTRACT- A Modular Armed Advanced Robotic System based on face recognition is intended for military applications identifies the unidentified individuals in border area or conflict zones or in any comparable location, and conducts obstacle detection, bomb detection and implements gun aiming system. Wi-Fi connection is carried to send the message to the receiving system. This function is done by algorithm or manually with the assistance of Lab view or SSH (Secured Shell) software installed in recipient system. This method is done out utilizing Raspberry Pi board with ARM cortex A53 CPU and Arduino Uno microcontroller (AtMega328P). The hardware comprises the ultrasonic sensor, Bluetooth device, wireless camera, DC (Direct Current) servo motor, and mechanical gripper. Unique single ultrasonic sensor is automated to pursue the article, and complete the article localization. A human-machine interface is manufactured to remotely operate the transportable robot. Through wireless connection and camera, the investigation of a minute and punishing environment may be carried out. Hardware explanation language is utilized in the controller enterprise and the fringe I/O (input/output) circuit. Human-machine interface is done via C language which can be useful in various future studies.

KEYWORDS- Military Applications, Raspberry Pi, Robotic System, Wi-Fi Network.

I. INTRODUCTION

In current day, the characteristic of warfare is extremely different from what it used to be, and function of technology is deep in molding warfare tactics. The danger faced by armies are unexpected, with crowded area frequently being the battlefield, and enemies technically progress, increased reach, and clever. This trumps the effectiveness an army has for conventional confrontation. Tactical innovation, however, has given countries the capacity to confront fiend assaults in an effective and responsive way. Such an accomplishment is in the area of military robots. Modular robot is a robot that can be fitted with additional equipment/sensor or it can be removed according to the needs. The first Modular Armed Advanced Robotic System (MAARS) robot was presented by QinetiQ to the military on 5th June 2008, under a contract by Explosive Ordnance Disposal/Low-Intensity Conflict (EOD/LIC) program [1][2].

In the suggested system, the military robot is created to locate the unidentified individuals in border area or conflict zones or in any location, obstacle detection, bomb detection and gun aiming system based on face recognition. The control is placed in the microcontroller. Moreover, bomb detection, face recognition and gun trigger controlling are intrinsic. The robot travels over the rough terrain. The control of the robot from isolated location may be accomplished using a computer or any other smart computer-based devices. This project is built using Raspberry Pi board with ARM cortex A53 CPU and Arduino Uno microcontroller (AtMega328P). Here Raspberry pi module include of camera, IR sensor, and metal detector, relay control for gun trigger and motor driver for motor control. The OS (operating system) of Raspberry Pi device is installed in SD (standard definition) Card is placed in its memory slot. The Arduino module is utilized in land drone controlling system where it comprises of motor driver to control two motors using the GPIO (general-purpose input/output) pins and also a wireless transmitter for controlling the motors from an external device [3][4].

II. LITERATURE REVIEW

Modular robots are robots that can be fitted with additional equipment/sensor or it may be removed according to the needs. This part examines some of the previous work that were carried out with regard to MAARS and other few comparable investigations. Robot Control Technology Department, Industrial Technology Research Institute, Taiwan has developed on a submerged erection robot for debris smoothing on the seabed for port building. The study developed a submerged erection robot to level rubbles on the seabed for port building. The rubble smoothing is assisted by a submerged robot equipped with submerged cameras and imaging sonars, gyroscope sensors and Long Baseline (LBL) [5][6].

A virtual reality system is manufactured to envision the robot's character and the topography over the working environment; thereafter, the robot is effectively tele-operated by an operator. The article describes the robot's system and control, and it specifies the working process of the rubble smoothing assisted by the robot. Moreover, the presentation of the robot is established via the investigative results in subsea. The working swiftness of the robot is faster than that of an anthropological aquanaut, and the robot can operate longer than the aquanaut who can perform for a limited time to avoid undersea sickness. The robot is expected to have considerably better effectiveness in deep water where an anthropological aquanaut is unfit to operate [7][8].

Shu-Yin Chiang et al. proposed the strategy of smart supply robot. The research aims to develop the smart communicative multi-functional robot to provide buddy and enjoyable. To collect the conservational data, we utilize Kinect depth image as the pictorial system platform and to complete the image distribution procedures. Then, the image

dispensation results are useful to the robot performance planning, coupled with omni-directional wheels, high power motors, FPGA and ARM-based advance board as motion system. The bottom body of the robot is constructed by four omni-directional wheels, and the top body is in anthropological enterprise. In the research, we practice the material mined from depth picture stream of Kinect and integrate the robot localization system to construct the real-time environment chart and complete the hindrance evasion. In addition, we utilize Kinect skeleton recognition and anthropological face appearance recognition to accomplish the task of the smart communication [9][10].

The characteristics of combat today are vastly different from those of the past, and technology plays a significant role in shaping battle tactics. Armies encounter unanticipated dangers, with congested areas regularly serving as battlegrounds and foes that are technologically advanced, have extended reach, and are cunning. This takes precedence over an army's ability to engage in traditional combat. Tactical innovation, on the other hand, has provided governments the ability to respond to fiendish attacks in an effective and timely manner. This achievement is in the field of military robotics. A modular robot is one that can be equipped with extra equipment/sensors or removed depending on the situation [11][12].

The proposed system includes a military robot that can find unidentified persons in border areas, combat zones, or any other site, as well as obstacle detection, bomb detection, and a facial recognition-based gun aiming system. The microcontroller is where the control is kept. Furthermore, bomb detection, facial recognition, and gun trigger control are all included into the system. Over the rugged terrain, the robot goes. A computer or other smart computer-based devices may be used to operate the robot from an isolated place. The Raspberry Pi board with ARM cortex A53 CPU and Arduino Uno microcontroller were used to create this project (AtMega328P). Camera, IR sensor, metal detector, relay control for gun trigger, and motor driver for motor control are all included in this Raspberry Pi module. The Raspberry Pi device's OS is loaded on an SD Card that is inserted into its memory slot. The Arduino module is used in a land drone control system that includes a motor driver that uses GPIO pins to operate two motors and a wireless transmitter to control the motors from an external device [13][14]. Modular robots are robots that can be equipped with extra equipment/sensors or have them removed depending on the situation. This section looks at some of the prior research on MAARS as well as a few other studies that are similar. The Taiwanese Industrial Technology Research Institute's Robot Control Technology Department has created a submerged erection robot for trash smoothing on the seabed for port construction. The research team created a submerged erection robot to level rubbles on the seabed in preparation for port construction. A underwater robot with submerged cameras and imaging sonars, gyroscope sensors, and Long Baseline sensors aids in the rubble smoothing [15][16].

The robot's character and topography over the working area are seen using a virtual reality system, and the robot is then effectively tele-operated by an operator. The article discusses the robot's technology and control, as well as the rubble smoothing process with the help of the robot. Furthermore, the robot's appearance is determined by subsea investigation outcomes. The robot's operating speed is quicker than that of an anthropological aquanaut, and the robot can operate for longer periods of time than the aquanaut, who can only perform for a certain amount of time to prevent being seasick. In deep water, where a human aquanaut is unsuited to work, the robot is predicted to be much more effective [17][18].

A martial robot is built in the proposed system to perceive unidentified people in border zones, war zones, or any other location, as well as obstacle detection, bomb detection, and GUN targeting systems based on facial recognition. The information is wirelessly sent to the host system via a Wi-Fi network. These tasks are performed entirely mechanically or physically using Lab view or the ssh application, which must be installed on the host machine [19][20].

A. System Design

In the suggested system, a martial robot is designed to perceive the unidentified person in border zone or conflict zones or in any area, obstacle detection, bomb detection and GUN targeting system based on face recognition. Wi-Fi network is used to route the information's to the host system wirelessly. Entirely these things are done mechanically or physically with the aid of Lab view or ssh program which is to be mounted on host system [21].

The hardware comprises the ultrasonic sensor, Bluetooth device, wireless camera, DC servo motor, and mechanical gripper. Unique single ultrasonic sensor is automated to pursue the article, and complete the article localization. A human-machine interface is manufactured to remotely operate the transportable robot. Through wireless connection and camera, the investigation of a minute and punishing environment may be carried out. Hardware explanation language is utilized in the controller enterprise and the fringe I/O circuit. Human-machine interface is done via C language [22].

The full control is existent in with the microcontroller. In addition to this, bomb detection, face recognition and gun trigger controlling are included. In this, the robot can transit across the tough terrain. The control of the robot from inaccessible place may be done using a computer or any other smart computer-based devices [23].

The Raspberry module is linked with USB Wi-Fi module so that it is connected to the network to transmit programmed SMS (short message service) on the activities of sensors and face recognition when an unfamiliar individual is detected. It is also linked to a network so that an external device may connect to the Raspberry Pi system through ssh (Secured Shell) using a Putty program from any device with the assistance of its IP addresses to launch the VNC server application for screen mirroring [24].

Here all the accessories are linked and the typical devices to manage and retrieve data from these are laptops/desktop computers/Android mobile phone/tablets. Both the host and the client device is equipped with VNC (Virtual Network Computing) server and client correspondingly. To reach the host the client system must use the IP address to connect. Before that ssh and VNC server must be installed and configured on the Raspberry pi board (Figure 1). The Baud rate for transmission of signals for operating the motors in Arduino is set to 9600 [25].

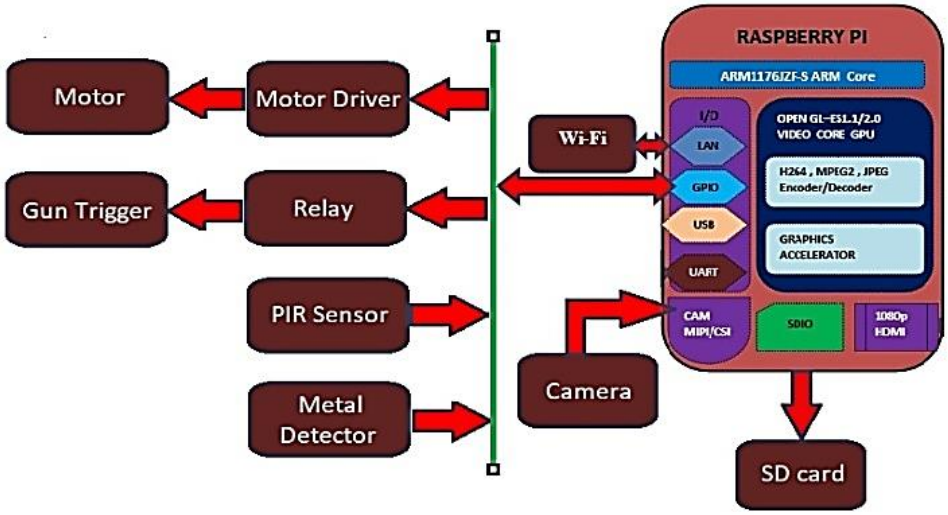

Figure 1: Illustrating the Raspberry pi module

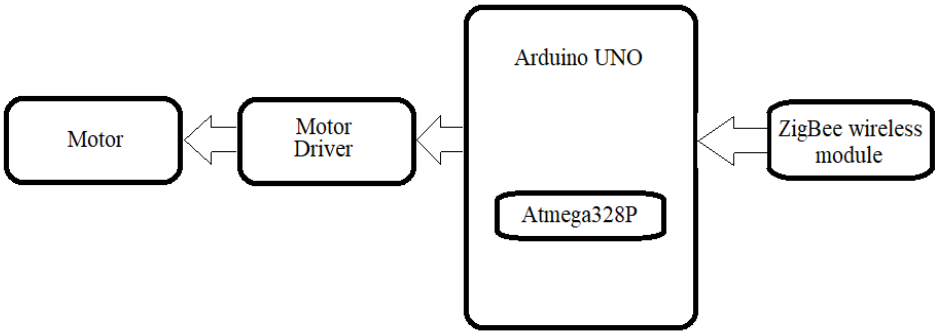

Figure 2: Illustrating the Arduino module

The suggested system may be utilized for military applications i.e. on the front lines of the war zone, rescues missions, bomb detection and dispersal. This design comprises of two modules: Raspberry pi module and Arduino module (Figure 2). Each module has its own purpose raspberry pi module comprises of gun trigger control, motor driver control, PIR sensor and metal detector while the Arduino module consist motor driver for managing the motion of the land drone.

B. System Implementation:

a. Facial recognition

Facial recognition is the main function of the suggested system. This is done out in three steps:

Record construction

- Set the camera and created an alert message to grab the consideration of the students.
- Get user id as input
- Convert the picture into grey scale, identify the look and
- Stock it in record by utilizing provided input as label up to 20 frames.

Training

- Set LBPH appearance recognizer.
- Get faces and Id's from record file to train the LBPH appearance recognizer.
- Save the completed information as xml or yml file.

a) Testing

Load Haar classifier, LBPH face recognizer and training data from xml or yml file.

- Capture the picture from camera,
- Convert it into grey scale,
- Detect the face in it and
- Predict the face using the aforementioned recognizer.

b. Haar Cascades

Each characteristic of the recorded image is defined as a single value obtained from the variance of the number of pixels in the white rectangle relative to the amount of all pixels in the lack rectangle. All the different sizes and probable positions of the classifier are used to process a sufficient number of features. As the number of classifiers increases arithmetic operations seem to take longer. To avoid

this we use the full image concept. In image processing an integral image is a data structure that is a tale of extents and is a method to quickly and competently generate an amount of values in a rectangular grid section. The full image is obtained using the formula.

- ***Integral image:***

To deal with the complexity of the number of classifiers used for the computation we use the Ad boost learning method which is available in the Open CV public library which is a cascade classifier to eliminate the redundancy of the classifiers. Any classifier with a detection probability of 50% or more is considered a low classifier. The sheer number of weak classifiers provides a strong classifier that makes judgments regarding search results. Although classification with a single strong classifier is extremely imprecise we use a classifier cascade. The classification is done in stages if the specified part fails in the first stage we reject it. We do not use classifiers on this disapproved section. The part that passes all the stages i.e. the classifier that is completely roust is considered to be spotty. Mottled appearance is accepted at the appearance recognition stage.

c. Image processing module

- Imagining- Perceive the things that are not visible.
- Image sharpening and restoration- To produce a better image.
- Picture recovery- Pursue for the image of interest.
- Measurement of design– Measures many elements in a picture.
- Picture Recognition– Differentiate the things in an image.

d. Haar Classifier:

The characteristics of Viola–Jones algorithm which make it a good recognition algorithm are:

- Vigorous – Very high recognition rate (true-positive rate) & very low false-positive rate always.
- Actual period – For real-world submissions.
- This method incorporates Haar feature selection process.

Altogether anthropological looks have some similar possessions, these consistencies could be coordinated utilizing Haar Features.

Histogram of oriented gradients (HOG): Execution of the HOG descriptor algorithm is as follows:

- Split the picture into simple connected pieces called cells, and for each cell compute a histogram of ramp directions or edge alignments for the pixels inside the cell (Figure 3 and Figure 4).
- Discretise each cell into angular bins corresponding to the ramp alignment.
- Each cell's pixel provides weighted ramp to its corresponding angular bin.
- Sets of neighbouring cells are regarded as spatial portions called blocks. The group of cells into a block is the basis for group and standardization of histograms.
- Standardized assembly of histograms indicates the block histogram. The collection of these block histograms indicates the descriptor.

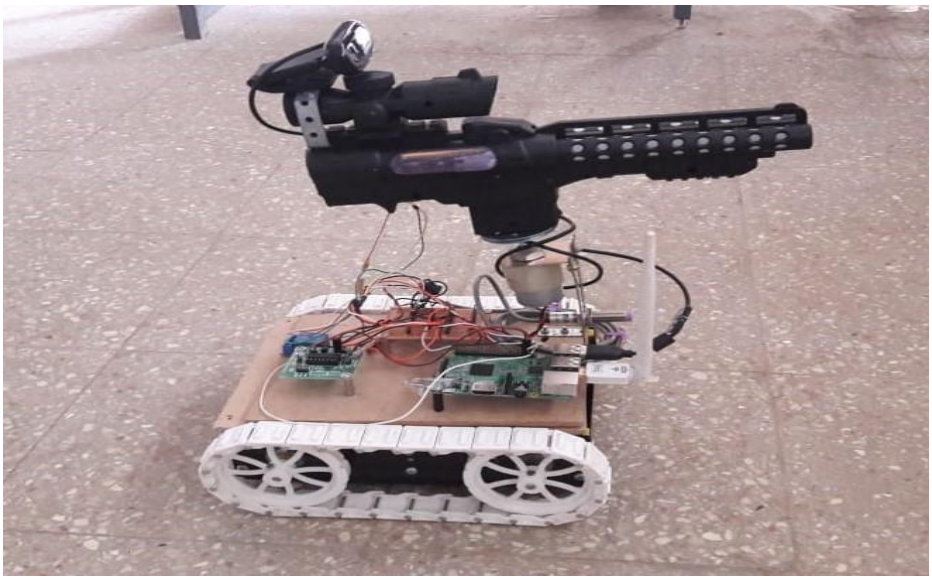

Figure 3: Complete MAARS Project with Raspberry and Arduino combined

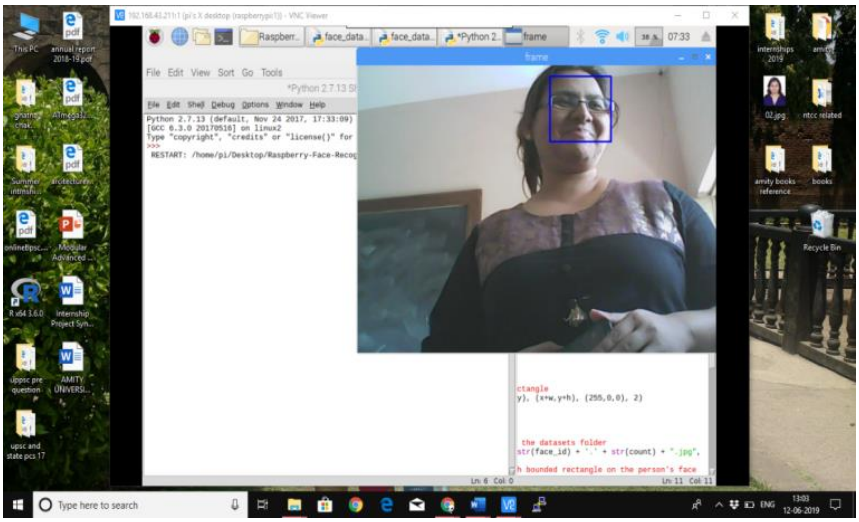

Figure 4: Image shows process of adding facial data of person to facial dataset

III. DISCUSSION

A new MAARS robot was developed and implemented. The uniqueness stems from the fact that it uses the capabilities of both Arduino and Raspberry pi. The prototype created was successfully tested to identify unauthorized person in a typical setting. The same may be tested to identify and hold illegal entrance either in conflict zones or in hostage rescue scenarios, and to find land mines or any metal-based explosives in order prevent fatalities. The project may further be developed in future to offer additional features as stated below:

- Water tank may be installed so as be utilized as fire extinguisher.\s• Normal camera can be changed with night vision camera.
- Zigbee technology may be changed with other technology operate robot from great distance.
- RF sensor may be positioned so that it does not crash the obstacles when not operated manually.

IV. CONCLUSION

A Modular Armed Advanced Robotic System based on face recognition is intended for military applications identifies the unidentified individuals in border area or conflict zones or in any location, obstacle detection, explosive detection and GUN aiming system. Wi-Fi connection is carried to send the message to the receiving system. This function is done by algorithm or manually with the help of Lab view or ssh software installed in recipient machine. This implementation is done out utilizing Raspberry Pi board with ARM cortex A53 CPU and Arduino UNO microcontroller (AtMega328P). A new MAARS robot was developed and implemented. The uniqueness stems from the fact that it uses the capabilities of both Arduino and Raspberry pi. The prototype created was successfully tested to identify unauthorized person in a typical setting. The same may be tested to identify and hold illegal entrance either in conflict zones or in hostage rescue scenarios, and to find land mines or any metal-based explosives in order prevent fatalities.

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