Developing Wireless Video Surveillance Robot using Facial Detection Technique

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Abstract

Solutions pertaining to surveillance of residential buildings and commercial properties have witnessed various developments over the last few years. However, for high threat level areas and discreet military operations, there are fewer systems available in the market. In those systems, even fewer contain a combined package of agility, stealth, movability, remote access, and recognition systems to track the enemy. This work aims to craft a comprehensive approach that would integrate all of the abilities, plus include additional screen, web, and DTMF control capability.

Keywords: - *DTMF, Video Surveillance, Robot, Facial Detection, Wireless Communication, Arduino, ESP32*

1. Introduction: Long after the invention of the telephone, even in this age we find areas that are lacking proper communication equipment or facilities. Places so remote that accessing it physically to connect it to a communication device seems implausible, issues so complex that they just cannot be solved using human power and requires technological intervention. As such, improvising technology to suit the needs of mankind is a must. Prominent fields that require technical needs are military, medical, infrastructure, transportation, and security. Solutions to these issues that are available in the market involve having covered only one or two problems. However, a combined solution for multiple fields is rare and often highly priced [1].

In order to counter that, this paper proposes a unique device which would help in covering multiple aspects of issues such as communication, military and security. This device is a movable robot whose function is to provide discreet movement in areas that have limited human access, or are on a high threat level to life [2]. This robot will use guidance from a human, and would have the capability of transmitting and receiving information wirelessly. A camera attached to the robot's chassis will relay video data to the server connected to the robot [3]. The underlying system inside this robot consists of an Arduino Uno microcontroller board, a camera module, ESP32, a DTMF decoder circuit along with an attached cell phone for receiving calls, and batteries [4].

The indoor navigation systems available nowadays depend on wireless short distance technologies such as Ultra Wideband (UWB), Ultrasonic, Infrared, Wi-Fi, Bluetooth or RFID. Everyone has its own specific virtues and detriments and thus no particular approach is still the mandated normative [5]. Wi-Fi-based navigation, nevertheless, can communicate with existing networks, and thus does not necessitate any additional hardware or software to be equipped since Wi-Fi routers are widely available on the market. Performance compared, the accuracy of Wi-Fi is strong enough to do that and goes to prove to be dependable down to a range of 2.5 metres. Usage of Wi-Fi is therefore a popular aspect of this project [6].

The DTMF decoder subsystem integrates an MT8870 DTMF decoder IC with its necessary circuitry connected to the Arduino microcontroller board and a cheap mobile phone to intercept phone calls for further processing and send the audio to the decoder circuit. Whenever a user decides to call the number of the robot using the phone and clicks up a specific button on his track pad, the robot positions itself in a particular building area based on certain predetermined space allocations. In case the web server is unavailable or the device used cannot make complex object-based websites the DTMF framework is offered as a substitute [7].

2. System Design

2.1 DTMF:

- Dual Tone Multi-Frequency or DTMF is a mechanism for assigning a telephone number switching device to be dialed, or for issuing commands to switching systems or associated telephony devices [8].
- The dialing method of DTMF resembles the methodology introduced by AT&T in the 50s. It was called MF (Multi-Frequency) and was implemented inside their telephone network to allow direct calls within switching facilities using in-band signaling [9].

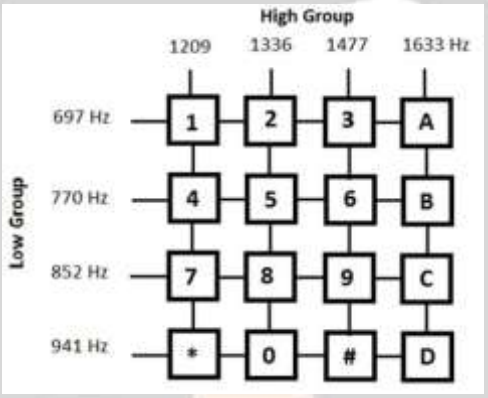

Fig -1: Touch Tone (DTMF) Frequencies

- DTMF utilizes 8 frequency signals transmitted in pairs to represent 16 numbers, symbols and letters, used for communication. This table shows how the frequencies are organized:

- Chosen frequencies help in preventing harmonics from incorrect detection by the receiver. The transmitter of a DTMF signal simultaneously sends one frequency from the high-group and one frequency from the low-group [10].
- This combination of signals is shown at the table above. It indicates the number or letter being transmitted. For instance, transmitting 1209Hz and 770Hz meant that the "4" digit was being sent.
- At the source, the peak signal intensity of a pair of tones ought never surpass + 1 dBm and the minimum intensity shall have to be -10.5 dBm for low-group frequencies and -8.5 dBm for high-group frequencies [11].

2.1.1 Labeling of DTMF numeric digits:

- The DTMF telephone keypad is mounted in a 4×4 button matrix in which each row represents the low frequency portion and each column represents the high frequency part of the DTMF signal. Pressing a key sends a combination of the row and column frequencies [12].
- As such, the key 1 will produce a superimposition of 697 hertz tone and 1209 hertz tone. The original pushbutton prototypes used the levers such that two connections were triggered by each button. Tones are deciphered by the switching core to decide the buttons that the individual pushes.
- Originally, DTMF was decoded by tuned filter banks. Until the turn of the 20th century, optical signal processing was the prevalent encoding technique.
- DTMF decoding algorithms often use the Goertzel algorithm to detect tones [13].

2.2 ESP32 camera module

The ESP32-CAM is a compact camera module with an ESP32-S slot. In addition to the OV2640 camera and many GPIOs for attaching peripherals, there is also a microSD card slot that can be useful for saving photographs taken with a phone or for saving files to serve clients.

Fig -2: ESP 32 CAM Module

This module does not come with a USB connector, so we need an FTDI programmer to upload code by using the U0R and U0T pins (serial pins) available on the board. In this project this module has been used for the purpose of video surveillance and facial detection [14].

2.3 FTDI programmer

This helps you to interface a second computer to a hardware serial port on an Arduino Pro, Pro Mini, or other USB-less board without compromising the ability to boot code from the Arduino IDE. No special coding is necessary to activate programming. In this project we have used FTDI programmer to interface ESP32 CAM with Arduino IDE [15].

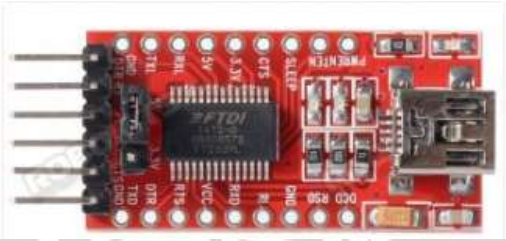

Fig -3: FTDI Programmer

3. Methodology

3.1 Software Development:

3.1.1 AVR Studio:-

AVR studio is an Integrated Development Environment (IDE) developed by ATMEL for developing different embedded applications based on 8-bit AVR microcontroller. In this project we have used it to program DTMF [16].

3.1.2 Arduino IDE:-

The Arduino Integrated Programming Environment (IDE) is a cross-platform framework (for Windows, MacOS, Linux) written in C and C++ functions. It is used to write and install programs to Arduino compliant boards, but also, with the assistance of 3rd party cores, to other manufacturer production boards. In this project we have used it to program ESP32 CAM; which in turn is used for live video surveillance and facial detection [17].

3.2 Platform Development:

- Four wheeled robot can be used both in industry and military purposes.
- Equipped with DTMF for remote sensing so that the robot goes as per our requirement once we make a call.
- For the camera, we have used an Esp 32 camera module which is equipped with camera OV 2640 and wifi module.
- To program the Esp 32 camera module we have used one FTDI programmer.
- After this we will program our Esp 32 and it will send us the streaming of the area.
- After this we will perform facial recognition obtained by Esp 32 camera module with the help of Arduino IDE.
- So our robot can work both on dual tone multiple frequency and wifi within the given range.

3.3 Block Diagram:

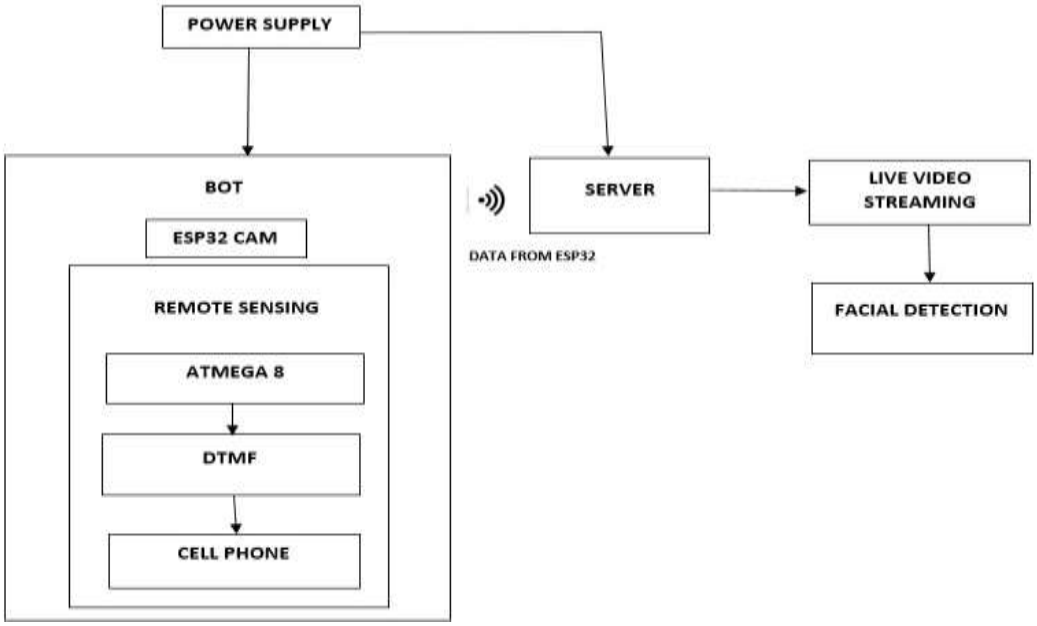

Fig -4: Block Diagram

4. Future Enhancement: Productivity and competitiveness in the manufacturing, workplaces, and shopping centres will rely overwhelmingly on robotics automation in the foreseeable future. For this we have to tweak our user interface so that everything ticks all the boxes of the client. We can do a tactile design for this, rapid movement, reinforced responsiveness, superior quality camera and night vision. Furthermore, for combat reasons, we should fill it with stun weapons. In a plant, we can easily use this robot by attaching a robotic arm [18].

5. Result and Conclusion: The Portable Wireless Video Surveillance Robot is built to hold the military, the police and the security forces in mind. It has various uses, such as manufacturing, warehouses, parking areas, hospitals and hostage cases, and can be found in specific settings and scenarios. For instance at one point it can be used by the military for the areas where involving a human is dangerous and at other points where our robot can move around and give live recording equipped with the facility of facial recognition.

6. References:

1. Kansal, Sachin, Abhijit Makhal, Pavan Chakraborty, and G. C. Nandi. "Tracking of a target person using face recognition by surveillance robot." In *2012 International Conference on Communication, Information & Computing Technology (ICCICT)*, pp. 1-6. IEEE, 2012.
2. M. T. Rashid, P. Chowdhury and M. K. Rhaman, "Espionage: A voice guided surveillance robot with DTMF control and web based control," 2015 18th International Conference on Computer and Information Technology (ICCIT), Dhaka, 2015, pp. 419-422.
3. Cucchiara, Rita, Andrea Prati, Roberto Vezzani, Luca Benini, Elisabetta Farella, and Piero Zappi. "Using a wireless sensor network to enhance video surveillance." *journal of ubiquitous computing and intelligence* 1, no. 2 (2007): 187-196.
4. Cheng, Zhu, Xuezhen Zhang, Shiqi Yu, Yongsheng Ou, Xinyu Wu, and Yangsheng Xu. "A surveillance robot with human recognition based on video and audio." In *2010 IEEE International Conference on Robotics and Biomimetics*, pp. 1256-1261. IEEE, 2010.
5. Durán, Javier, Evaristo J. Abril, Francisco J. Rodríguez, Juan F. García, Vicente Matellán, Juan J. Villacorta, Alberto Izquierdo, Sergio Cerezal, and Miguel Calvo. "VIGICOP: Autonomous surveillance robots with sodar detection and autonomous navigation." In *44th Annual 2010 IEEE International Carnahan Conference on Security Technology*, pp. 165-169. IEEE, 2010.
6. Baniukevic, Artur, Christian S. Jensen, and Hua Lu. "Hybrid indoor positioning with wi-fi and bluetooth: Architecture and performance." In *2013 IEEE 14th International Conference on Mobile Data Management*, vol. 1, pp. 207-216. IEEE, 2013.
7. Tuljappa M Ladwa, Sanjay M Ladwa, R Sudharshan Kaarthik, Alok Ranjan Dhara, Nayan Dalei," Control of Remote Domestic System Using DTMF", in ICICI-BME 2009 Bandung, Indonesia.
8. Dhiraj Sunehra, Ayesha Bano, Shanthipriya Yandrathi," Remote Monitoring and Control of a Mobile Robot System with Obstacle Avoidance Capability", in 2015 International Conference on Advances in Computing, Communications and Informatics (ICACCI).
9. Dhiraj Singh Patel, Dheeraj Mishra, Devendra Pandey, Ankit Sumele, Asst. Prof. Ishwar Rathod," Mobile Operated Spy Robot", in National conference on Machine Intelligence Research and Advancement (NCMIRA, 12), INDIA.
10. Deng, Zhongliang, Yanpei Yu, Xie Yuan, Neng Wan, and Lei Yang. "Situation and development tendency of indoor positioning." *China Communications* 10, no. 3 (2013): 42-55.
11. Hellmers, Hendrik, Abdelmoumen Norrdine, Jörg Blankenbach, and Andreas Eichhorn. "An IMU/magnetometer-based indoor positioning system using Kalman filtering." In *International Conference on Indoor Positioning and Indoor Navigation*, pp. 1-9. IEEE, 2013.
12. Kannan, Prashanth, Saai Krishnan Udayakumar, and K. Ruwaid Ahmed. "Automation using voice recognition with python SL4A script for android devices." In *2014 International Conference on Industrial Automation, Information and Communications Technology*, pp. 1-4. IEEE, 2014.
13. Tushar Maheshwari, Upendra Kumar, Chaitanya Nagpal, Chandrakant Ojha and V. K. Mittal," Capturing the Spied Image-Video Data Using a Flexi Controlled Spy-Robot", in 2015 Third International Conference on Image Information Processing.
14. Espressif, I. "EsP32 data sheet,"." *IotYbased microcontroller* (2017).
15. Das, Swagat, Sonal Patro, Ritika Das, and Antara Mishra. "Arduino based Safety Device for the Visually Challenged." In *2019 International Conference on Communication and Signal Processing (ICCSP)*, pp. 0601-0605. IEEE, 2019.
16. Socher, Guido. "AvrUsb500v2--an open source Atmel AVR Programmer, stk500 V2 compatible, with USB interface." (2012).
17. Dimitrov, Smilen, and Stefania Serafin. "Audio Arduino-an ALSA (Advanced Linux Sound Architecture) Audio Driver for FTDI-based Arduinos." In *NIME*, pp. 211-216. 2011.
18. Humayun Rashid, Iftekhar Uddin Ahmed, Aasim Ullah, MD. Fahim Newaz, Mohammad Sijanur Rahaman Robin, S M Taslim Reza, "Multiple Sensors Based Fire Extinguisher Robot Based on DTMF, Bluetooth and GSM Technology with Multiple Mode of Operation", in 2016 International Workshop on Computational Intelligence (IWCI) 12-13 December 2016, Dhaka, Bangladesh.