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Development of Wi-Fi based Moving Target Tracking System for Precise Shooting

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Abstract:- In modern times where analysis of foot traffic is essential for effective resources management and security, moving target systems that use Wi-Fi-based movement counter offers an innovation solution. This paper summarizes the fundamental idea, the methodology as well as the potential uses of the system. The proposed system makes use of the widespread characteristic of Wi-Fi networks to detect and track the movement of moving targets within a given area. With a thorough analysis of Wi-Fi signals generated by tablets, smartphones or any other wireless-enabled device carried by people, the proposed system is capable of accurately counting and recording the movements of individuals in real-time. The system operates passively by eliminating the requirement for sensors or manually counting. Furthermore, it captures live data, which allows rapid making of decisions regarding security, crowd management and resource allocation. Potential possibilities for applications of the wireless moving target counter are diverse. For retail environments they can help enhance the store's layout and personnel according to peak times for traffic as well as popular pathways. Moving target counters that use Wi-Fi provides a high-end yet easy option for precise and instant pedestrian analysis. The potential for it to transform the management of crowds and improve security across a variety of settings is a powerful device for today's environments.

Keywords:- *Arduino; Hit Counter; Moving Target; Relays; Wi-Fi; Target Shooting Mechanism.*

I. INTRODUCTION

The tradition of shooting target with firearms was first discovered more than a century ago, and during that time, this was essential in order to enhance the ability to shoot and kill enemies or wild animals. Particularly many countries provide perfect training with modern equipment for their soldiers. The training of soldiers in shooting with moving targets enhances the abilities of a soldier. In a general battle field, enemies run here and there, and the solders must aim them. It is therefore essential to enhance the shooting abilities for our troops. A Wi-Fi-based moving target hit counter can be achieved through various innovative systems[1]. One approach involves utilizing Wi-Fi for moving target tracking and monitoring, enabling real-time tracking and selective transmission of image data[2]. Another method involves implementing a moving target tracking system using Wi-Fi, where the system comprises a target tracking robot and a remote server for stable tracking within a Wi-Fi network coverage range[3]. These systems demonstrate the diverse applications of Wi-Fi technology in tracking, monitoring, and security functions. The proposed system overcomes the shortcomings of the current system and focuses on the need to enhance shooting abilities to various types of persons such as police officers, soldiers, hunting as well as sporting enthusiasts. Additionally, a Wi-Fi-enabled moving POS machine can incorporate functions like dish ordering, card swiping, and interphone capabilities, simplifying operations and enhancing convenience[4]. Particularly, the issue that is addressed is the manual evaluation of the shooting ability by visiting the shooting target following exercises. The creation of an automated moving target system specifically designed to solve this issue is examined. This mechanism aims to track the impact of a bullet, send the data via Wi-Fi based monitoring and improve shooting abilities through the application of a movable target mechanism. Furthermore, a keystroke recognition system called WiKey utilizes Wi-Fi signals to analyze keystroke interference, improving accuracy in inferring user inputs for security purposes[5]. Additionally, the paper highlights its importance as a technology in coaching and military situations, where wireless recording of shots can help improve the training process and evaluate.

II. LITERATURE SURVEY

During the Middle Ages and early modern times, round wooden targets were commonly used for firing rifles. American frontiersmen utilized pieces of wood with painted marks as targets. In the 19th century, long-range rifle shooting incorporated iron targets that produced audible clangs upon impact[6]. However, the development of

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Electronic Scoring Testing(EST) began in 197, they became mandatory for Olympic and international shooting competitions since 1990.An accurate scoring system is crucial in modern pistol and rifle competitions to ensure participants receive all their earned marks[7]. Shooting is a sport which offers tremendous competition and popularity, while its fast and effortless scoring process plays a pivotal role in increasing its popularity among participants, coaches, fans and viewers.

The article "On the Mark" aims to assist junior officials, competition officials, coaches and parents alike with understanding of modern scoring strategies. This article further addresses scoring concerns, while emphasizing the necessity of conveying results of competitions in an engaging and stimulating manner to keep shooting exciting and competitive with other forms of sports participation. Rifle or pistol competitions typically employ three distinct scoring strategies for contests: manual scoring, and electronically scoring. Manual scoring has long been used and it involves people using tools such as templates, scoring gauges and magnifying scoring templates (such as Eagle Eye)[8]. They rely on their eyesight. Manual scoring allows players to exchange scorecards or assess each other's goals before having their targets scored by volunteers who often score manually. While manual scoring may be cheaper and simpler than its electronic equivalents, its inaccuracy makes manual scoring slower and vulnerable to inconsistencies more prone than its digital equivalents.

Today's professional shooters use Automated Moving Targets (AMT) to hone their craft further and expand their repertoire. Certain targets move horizontally or vertically at high speed; others zigzag back and forth across an arena so shooters must target these accurately to improve. This work presents a miniature model of horizontally moving targets[9]. If a shot hits one, a signal processing device equipped with microphone receives and amplifies its sound signal; furthermore, receiving devices can be placed near shooting point to observe for coach or shooter conveyance[10].

III. PROPOSED METHODOLOGY

The electrical signal from the condenser microphone is fed into the inverting input (-) of an op-amp configured as a voltage comparator. A reference voltage(V_ref) is given connection to the non-inverting input (+) of the op-amp. The op-amp compares the input voltage from the microphone (V_in) to reference voltage (V_ref).If the input voltage (V_in) from the microphone is greater than the reference voltage (V_ref), the op-amp's output will be at its positive saturation voltage, indicating a bullet hit. If not, it indicates no bullet hit. In this project, the limit switch has a long lever and is intended to limit the mechanical transmission at a particular prescribed position. On activating the switch, the contact gets closed, and a logic zero signal is generated for the microcontroller. The mechanical section is designed with a limit switch, where one end of the switch is shorted to the power supply ground. It is a single-pole, double-throw (SPDT) switch. The open contact is selected, so when the switch is activated, the normally open contact gets closed, and a logic zero is rised for the controller chip.

The mechanical movement of the container is restricted through the limit switch, which is interfaced with the controller as an input signal. This limit switch has a long lever, and when a small amount of force is applied to the long lever, the switch will turn on automatically. If the lower-level container is in its home position, this switch remains in the activated condition. In this paper, the Arduino Nano is used to read inputs from the Condenser Microphone and gives output by turning the motor ON. The Arduino Nano in our project is programmed using the Arduino IDE. In this project, we wrote a program that reads the sensor input, processes the data, and then controls the LED by displaying the counter number. The main functionality of the L293D board in our project is to drive two small DC motors in two directions. This board can interface not one, but two DC motors. The L293D has two built-in H-bridge driver circuits, which help in driving our motors in two different directions simultaneously, i.e., both forward and backward. The Wi-Fi module used in our project enables the soldier to display the hit counter on the mobile phone, laptop, or any other electronic device. We used the ESP8266 Wi-Fi module, which gives access to the microcontroller to get connected to Wi-Fi.

IV. DESIGN IMPLEMENTATION

In this paper, condenser microphone is used which picks up the sound, when a bullet hits the moving target. As mentioned in the block description the sound signal is converted into electrical signal. The property of this is the sound energy is transformed into electrical variations. In the condenser microphone, a parallel plate air condenser consists and one plate of the condenser is rigidly fixed and the other is arranged near to it, is a steel diaphragm of 0.002 inch thick, stretched nearly to its elastic limit (so that its resonant frequency is very high) on a steel ring. The distance of the air gap between the two plates is approximately 0.001 inch. The fixed plate has groves along its surface to provide adequate damping. When the sound waves are incident on the diaphragm, it begins to vibrate, thus decreasing or increasing the distance between the two plates forming the condenser and consequently its capacity changes. This electrical signal, which is in audio frequency range acts as a modulating signal. The output of the MIC amplifier is fed into the digital converter.

The output of the microphone should be high compared to the self-generated and thermal noise The general requirements are as follows for the microphone we use in our project: The response of the microphone is not dependent on the frequency The body or shape of the microphone is such that the frequency response does not depend on the angle of occurrence of sound waves The microphone is free of harmonics The output should be high in comparison with the self-generated or thermal noise The mechanical construction is set such that it can withstand handling in service

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The condenser microphone output is connected to the pre-amplifier. Condenser microphone is very sensitive MIC so that it can picks up very low-level sound signals also accurately and converts the sound signals into electrical signals. The electrical signals produced by the microphone are fed to MIC amplifier, which amplifies the signal. This is an audio amplifier and the output of this amplifier is fed into the digital converter. In this block an op-amp is used to give the digital data into the controller. The op-amp is also called as a comparator. It is so called because it compares the two input signals and gives high or low signal i.e., digital information or data. The amplified electrical signals from the MIC amplifier will be in analog voltages, which are not read by the micro controller. So the comparator will be giving the digital data that is easily read by the controller. So here an LM 324 IC is used which is called as Quad Op-Amp. The micro controller does not recognize the analog voltage so the inputs are given in the digital format i.e., high (1) or low (0). In order to derive the digital information that is recognized by the controller, here we use a digital converter. It is nothing but an Op-Amp, which has two inputs and a single output. Here an LM 324 IC is used which has four Op-Amps internally. In the two inputs, one will be the inverting pin and the other is the non-inverting pin. So in the circuit, at the inverting pin reference voltage is set, and the output coming from the MIC amplifier is given connection to the Op-Amp's non-inverting pin. Using a potential divider network sets the reference voltage. Now the input voltage at the non-inverting pin will be compared with the reference voltage and the output is given by the Op-Amp in digital format i.e., high or low. And thus the obtained digital information is fed to the controller. Whenever the input voltage is equal or greater than the reference voltage the output of the Op-Amp becomes high. So when the bullet hits the target the controller receives a logic high signal, which is to be transmitted to the field area.

An open-source bread board built on the Microchip ATMEGA 328P is called the Arduino Nano. The Arduino Nano has 30 male I/O headers. The panel can be powered by a 9 V battery or a type-B mini-USB cable. Arduino Nano has a a microcontroller having three times the RAM is the ATmega4809. The software for Arduino has a serial monitor that makes it possible to send and receive basic text data between the Arduino on board. When data is being communicated through the FTDI, the LEDs on the board flash chip and USB links to the PC (but not for pin 0 and serial transmission Any of the digital pins on the Nano can be used for serial communication thanks to a Software Serial library. In addition, the ATmega328 facilitates SPI and I2C connectivity. The Wire library is part of the Arduino software, which makes using the I2C bus easier. The Arduino Nano is designed such that software on a connected computer can reset it, eliminating the requirement for a physical reset button push prior to an upload. One of the hardware flow control lines (DTR) of the FT232RL is connected to the reset line of the ATmega328 via a 100 nano farad capacitor. When this line is asserted (taken low), the reset line lowers sufficiently to reset the microprocessor. In this project, the limit switch is turned on, the contact closes, and the microcontroller receives a logic zero signal. A limit switch is incorporated within the mechanical transmission portion, with one end of the switch connected to the ground of the power supply. This switch is an SPDT (single-pole, double-throw) switch. Since the open contact is chosen, a logic zero is produced for the controller chip when the switch is actuated, closing the normally open contact.

The current module uses a 16-bit LCD, meaning that a message can include a maximum of 16 characters at once. The text length can be increased in the future by using LCDs with 32 bits or more. This block's LCD panel interfaced with the microcontroller via the output port. This LCD module has 16 characters by 2 lines, and its availability will determine which LCD panel is used. Panels with three or four lines can be utilized for this, allowing for the display of additional information. These panels have the ability to show characters, numbers, and graphics. Two internal byte-wide registers are present in the display: one is used for commands (RS=0) and the other is used for characters that will be shown (RS=1). It also has a user-programmed RAM section called the character RAM, which can be used to create any kind of character by utilizing a dot matrix.

The twin H-bridge motor driver IC utilized in this project is the L293D. "The L293D is a 4-channel, high voltage, high current, monolithic integrated driver." Two DC motors are supported by the L293D. The motor voltage is on pin 8, and the chip's +5 voltage is on pin 16. Therefore, we may interface two clockwise and counterclockwise-controlled DC motors with a single integrated circuit (IC). If the motor has a fixed direction of motion, we can use all four I/Os to connect to four DC motors. Pins 3 and 6 are connected to the first motor. Sending a high signal to pin 1 (enable) and either pin 2 or pin 7 (one of the two direction pins) turns on the motor. The enable pin must be high and pins 2 and 7 must be low in order to stop the motor. Peak output current per channel for the L293D is 1.2A, with an output current of 600mA.

Additionally, the IC contains output diodes to protect the circuit from reverse electromagnetic fields. Because of its wide range (4.5V to 36V) output supply (VCC2), the L293D is the ideal option for a DC motor driver.

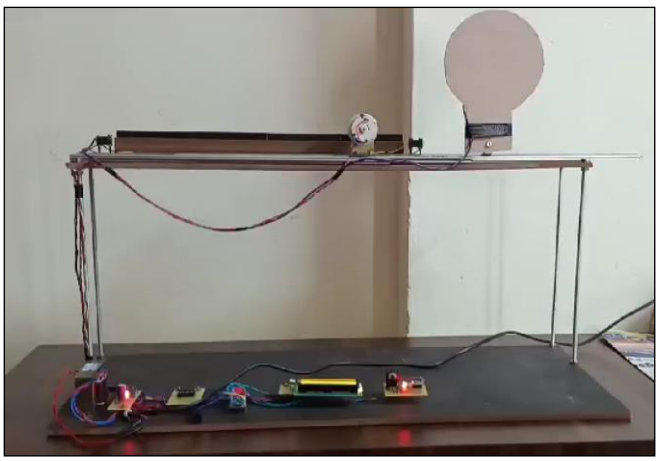

Fig. 1. Wi-Fi based Moving Target Tracking System for Precise Shooting

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V. EXPERIMENT RESULTS AND DISCUSSIONS

The work being presented in this paper is compared with some notable works in the literature and the same has been summarized.

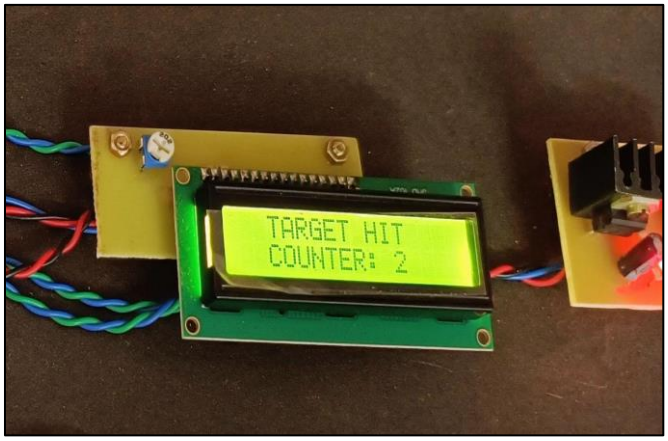

Fig. 2. Target Hit Count Value Shown in the Figure

Table 1. Reference Paper Patents

Reference no.	Major Contribution	Communication Technology	Pros	Cons
US 2018/ 0005048 A1 [11]	A traffic-counting system and method that utilizes computer vision technology to automate the process, provide accurate and real-time traffic data.	LTE, 2G, 3G, 4G, 5G	Accuracy	High Cost
US 11,536,544 B1[12]	Sound waves more intensity which can cover target distance	LoRa technology	Low-Power Consumption	Latency
US 2022/0099414 A1[13]	The development of a reactive target system that provides immediate feedback to shooters during training exercises	NA	Immediate feedback	Complexity
US 2014/0151965 A1[14]	A innovative scoring system for archery that enables electronic detection of scores, real-time data evaluation	Wireless RF connection	Electronic Data-Processing	Limited Information
This work	Wi-Fi technology is used to detect the target which are hit to the movable target.	Wi-Fi	Accuracy, low cost, Immediate feedback, Electronic Data Processing	Distance

VI. CONCLUSION AND SCOPE FOR FUTURE WORK

The “Development of Wi-Fi based Moving Target Tracking System for Precise Shooting ” has been discussed in this paper. A prototype model is built for the demonstration, and the findings are judged to be satisfactorily. Only one target is designed at remote place, but in practical many targets can be designed with individual transmitters and all the transmitters can be tuned to a single receiver. For identifying the target is hit a condenser MIC is placed over the target. And when the target is hit the sound signals are converted into electrical signals that are amplified and fed to the controller in digital format and will be displayed in the LCD. Preparing the software to carry out the duties based on the inputs is the main and crucial duty. The software (code) that we define in the controller is the only thing that affects the machine's performance. The technology used here is solely for developing the prototype module; more development is required to turn it into a functional system. The invention's mechanism allows for fast score displays—up to one second—as well as the ability to display the individual's score at the score display. Consequently, following every shot, it is feasible to assess the true standing of the arched in the tournament.

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