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Design of Morse Message Transmission and Reception using LASER

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Abstract: **In this paper, we have implemented Morse code transmission using an Arduino and a laser. The Arduino board is used to control the transmission process, while the laser serves as the light source for emitting the Morse code signals. The Arduino is programmed to generate the appropriate patterns of dots and dashes based on the input text. Each character is converted into its corresponding Morse code sequence, and the Arduino controls the laser to emit short flashes for dots and long flashes for dashes. By combining the Arduino's control capabilities and the laser's light emission, we can effectively transmit Morse code messages. This paper provides a practical and hands-on approach to learning about Morse code communication while utilizing the Arduino platform for control and the laser for optical signal transmission. Building upon this work, future research could explore enhancing the Morse code transmission system by integrating advanced communication protocols and expanding its applications in fields such as remote signaling, secure communication, and underwater or long-range optical communication.**

Index Terms **- Morse code, Transmitter, Receiver, Laser, Optical communication, Communication system, Information transmission, Photodetector.**

I. INTRODUCTION

Throughout history, humanity has continuously sought innovative means of communication, from ancient methods like smoke signals and carrier pigeons to transformative inventions like telegraphs and telephones. However, in today's digital era dominated by Wi-Fi technology, it's crucial to recognize the limitations of older communication techniques. The challenge lies in the obsolescence of traditional communication methods, such as telegraphs and Morse code [1], that once revolutionized long-distance interactions. In comparison to modern alternatives, these methods have become outdated. As the demand for rapid and efficient data transfer grows, it's imperative to explore and embrace innovative approaches that align with the evolving communication landscape. This study addresses this issue by spotlighting a pioneering technology known as Li-Fi (Light Fidelity) [6]. Li-Fi employs visible light communication (VLC) for data transmission, offering an alternative to conventional wireless methods like Wi-Fi [6]. By harnessing the potential of light-emitting diodes (LEDs) and laser technology, Li-Fi has the capacity to revolutionize data transmission [4]. By scrutinizing the shortcomings of traditional communication techniques and delving into Li-Fi's advantages [8], this research underscores the significance of embracing new communication paradigms. Moreover, through an exploration of Li-Fi's potential scope and implications, this study contributes to the ongoing discourse on the future of communication.
This paper is structured as follows: Section 2 discusses the proposed methodology and device specifications. In Section 3, we delve into the device's characteristics and outcomes, followed by conclusions in Section 4.

1 PROPOSED METHODOLOGY

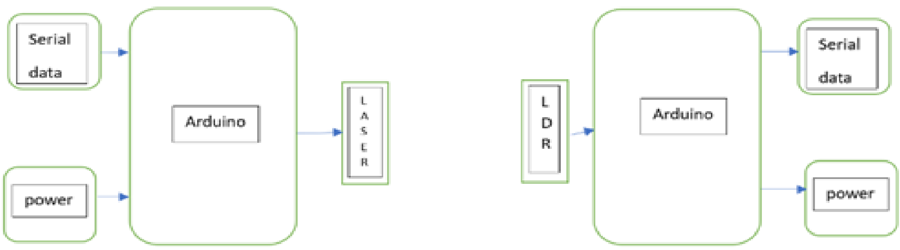

Fig:1 The block diagram of the proposed system
(a) transmitter b) Receiver

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In Figure-1(a), the transmitting process is illustrated, demonstrating the conversion of messages into dots and dashes and elucidating the algorithm employed for transmission. We've considered both LASER and LED as potential transmission mediums. Our choice gravitated towards LASER due to its capacity to emit a highly focused and intense beam, rendering it suitable for applications demanding precise targeting or long-range transmission. This characteristic grants LASERs a distinct advantage over LEDs [9], as they deliver elevated power output, which proves advantageous in scenarios necessitating a potent and concentrated beam. Moreover, LASERs emit light within specific wavelength ranges, optimizing their utility for applications reliant on designated wavelengths.

LEDs, in contrast, generally showcase superior energy efficiency in comparison to lasers. They can provide ample brightness for Morse code transmission while consuming lower power. LEDs also enjoy affordability and wider availability relative to lasers, making them a cost-effective choice for various applications. Notably, LEDs are solid-state devices, devoid of moving parts, thus endowing them with enhanced durability and resilience against shocks and vibrations.

After meticulous comparison of LASERs and LEDs, the choice to employ a LASER aligns seamlessly with our goals. The foremost rationale behind this decision pertains to the necessity of achieving communication across extensive distances through the chosen medium. LASER lights boast a range of advantageous traits that harmonize with this objective [10]. Their focused and intense beams facilitate precise, long-range transmission, ensuring the accurate conveyance of Morse code signals across extended distances [12]. Additionally, the heightened power output of lasers, particularly relative to LEDs, bolsters the requirement for effective long-distance communication. Taken collectively, these attributes position lasers as the optimal selection for catering to specific communication requisites [20].

Arduino, an open-source electronics platform, offers the tools to create interactive IOT applications and prototypes with a blend of hardware and software components. The hardware component centers around a microcontroller board that serves as the heart of the system. This board is complemented by a variety of input and output elements that can be easily connected.

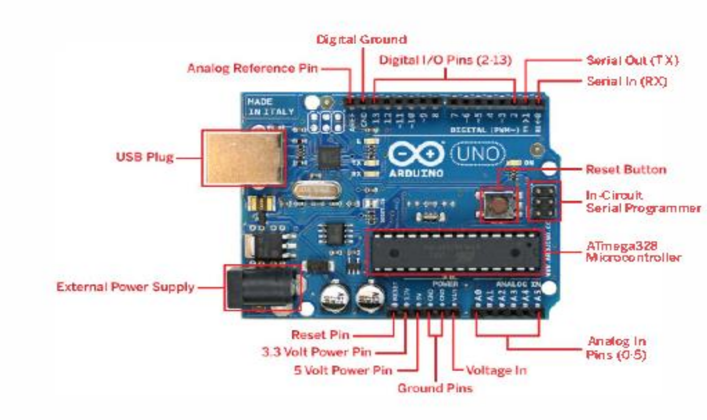

Fig-2. The schematic view of the Arduino system

Arduino boards can be powered in various ways, depending on the specific board and requirements. Among the common methods for powering an Arduino, the majority of boards come equipped with a USB port that conveniently allows them to draw power from a computer's USB port or a dedicated USB power adapter. Alternatively, they can be powered through batteries connected to the board's power jack or Vin pin, with the stipulation that the battery voltage aligns with the board's input voltage, typically set at 5V or 3.3V. Additionally, external power supplies can be harnessed by linking them to the board's power jack [16]. Some specialized Arduino boards include a Vin pin capable of accepting input voltages ranging from 7-12V, which the onboard regulator adeptly steps down to match the board's operational voltage. In the context of this paper, the chosen method for powering the Arduino was via USB. The decision between opting for a photo detector or a Light Dependent Resistor (LDR) hinges on the particular application and its unique requirements. Several factors come into play during the comparison of these two options:

- Photo detectors, exemplified by photodiodes or photomultiplier tubes, typically exhibit heightened sensitivity in comparison to LDRs. Their ability to discern even minute levels of light with remarkable precision sets them apart. The response times of photo detectors are notably quicker, rendering them well-suited for applications necessitating rapid sensing or high-speed data acquisition. These detectors encompass a diverse range of spectral responses, effectively enabling them to detect light spanning various wavelengths or specific bands. On the other hand, LDRs are a cost-effective alternative, widely available at affordable prices, making them particularly fitting for perspective constrained by budget considerations. LDRs are relatively straightforward to employ, requiring minimal circuitry for seamless integration. They can be effortlessly incorporated into circuits designed for light sensing applications. LDRs exhibit resistance fluctuations in response to changing light intensity, a characteristic that lends itself to scenarios where analog light detection or device control based on varying light levels is crucial.

The LDR was selected to ensure heightened accuracy. Within the receiving segment for our goal, an Arduino was utilized to process received signals, discerning dots and dashes in Morse code. Notably, a signal duration of 250ms was classified as a dot, while a more extended duration of 750ms was categorized as a dash. Should the received signal fall below the 250ms threshold, it would be identified as a space. For the creation of a Morse code transmission circuit using an Arduino and a laser, a collection of components is essential, including an Arduino board, a Laser module, Jumper wires, and a Breadboard. To establish this circuit, follow these steps [18]:

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1. Connect the laser module to the breadboard: Attach the positive terminal of the laser module to an Arduino digital pin using a jumper wire. Simultaneously, connect the negative terminal of the laser module to the breadboard's negative rail.
2. Open the Arduino IDE and initiate a new sketch.
3. Code the necessary commands to facilitate the control of the laser module via serial communication.

Similarly, when crafting a Morse code reception circuit utilizing an Arduino and a light detector, assemble the following components: an Arduino board, a Light detector module, Jumper wires, and a Breadboard. Execute the ensuing steps:
1. Establish the connection for the light detector module: Connect the signal terminal of the detector module to a designated Arduino digital pin through a jumper wire. Additionally, link the positive and negative terminals of the module to the power rail on the breadboard.
2. Commence by opening the Arduino IDE and initiating a new sketch.
3. Author the appropriate code to effectively receive light signals via the employed module.

A. Proposed algorithm

Our algorithm encompasses the entire spectrum of alphabets spanning from A to Z (or a to z) and numbers spanning 0 to 9. Each individual letter within the alphabet is uniquely associated with its own distinct Morse code representation. For instance, "A" corresponds to ".-" and "B" corresponds to "-...", continuing in this manner for the entire set [20]. We have meticulously crafted an algorithm that presides over the precise timing of signals denoting dots and dashes during the transmission process via the laser medium. In this context, I have set the variable "unit_delay" to a value of 250 milliseconds.

```
void dot()
{
Serial.print(".");
digitalWrite(led, HIGH);
delay(unit_delay);
digitalWrite(led, LOW);
delay(unit_delay);
}
```

As well as for dash time we decided multiple of unit_time with three as given below

```
void dash()
{
Serial.print("-");
digitalWrite(led, HIGH);
delay(unit_delay * 3);
digitalWrite(led, LOW);
delay(unit_delay * 3);
}
```

The process of transmitting a character in Morse code entails the conversion of that character into a sequence of dots and dashes, which are subsequently conveyed through a signaling mechanism such as a laser, as expounded upon in this paper. The International Morse Code employs a standardized collection of dots and dashes to symbolize letters, numbers, and various other characters. Each distinct letter or character is ascribed a unique amalgamation of dots and dashes. For instance, the letter "A" is depicted by a solitary dot followed by a solitary dash, while the letter "B" is characterized by a single dash succeeded by a trio of dots.

To execute the transmission of a character in Morse code utilizing an Arduino and a laser, the algorithm described earlier can be employed. Here is an illustrative instance of how the letter "A" can be transmitted in Morse code using an Arduino and a laser: Upon providing the designated character via the serial monitor within the Arduino IDE, the processing initiates. Within the program loop, the procedure begins by transmitting a dot—achieved by momentarily activating the laser for a brief interval (e.g., 250 milliseconds)—and then deactivating it for an identical duration. Following the dot transmission, a concise pause (e.g., 250 milliseconds) is observed prior to embarking upon the next signal transmission. Subsequently, the process involves transmitting a dash. This is accomplished by maintaining the laser in an active state for an extended duration (e.g., 3 times 250 milliseconds), succeeded by its deactivation for an equivalent span. Subsequent to the dash transmission, another brief intermission (e.g., 3 times 250 milliseconds) ensues before the state of the pertinent button or switch is once again evaluated. For illustrative purposes, here is a code demonstrating the transmission of the letter "A" in Morse code utilizing an Arduino and a laser:

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```
void A()
{
dot();
delay(unit_delay);
dash();
delay(unit_delay);
}
```

In a similar fashion, the transmission of all characters and numbers becomes achievable. Furthermore, the capacity to transmit an entire string of characters in one go is facilitated through the utilization of a string length analyzer. To elaborate, consider the scenario where a data string such as "MORSE CODE" is provided and subsequently retrieved from the serial monitor. Upon retrieval, the data string is directed to the designated function called "string2morse()." Within this function, the conversion of the complete string into its corresponding Morse code representation takes place.

```
void String2Morse() {
len = code.length();
for (int i = 0; i < len; i++) {
ch = code.charAt(i);
morse();
digitalWrite(led, HIGH);
delay(100);
digitalWrite(led, LOW);
}
}
```

The length of the input string, denoted as "code," is assessed through the utilization of the "len = code.length();" line. Subsequently, a for loop is employed to systematically traverse each character within the string, handling them one by one. Within this loop's framework, the current character is extracted utilizing the "ch = code.charAt(i);" command. Following this step, the "morse()" function is invoked to translate the character into its corresponding Morse code depiction. Finally, the Morse code output is conveyed through the utilization of a LASER output mechanism.

Fig-3 (schematic view of transmitting side)

It is designed to receive the transmitted signal from the source side for that we are using light detector module which is connected to pin 8.

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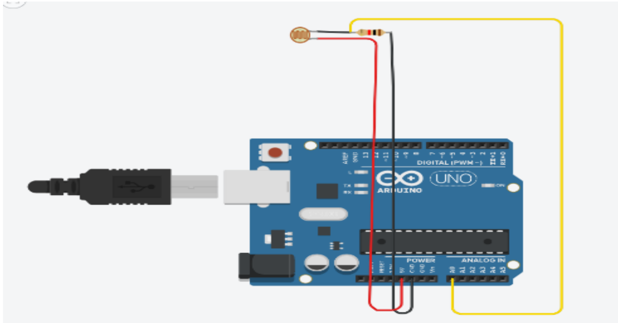

Fig-5 (schematic view of receiving side)

The program commences by establishing the definitions of two constants: LED_PIN and RECEIVER_PIN, assigned the respective values of 9 and 8. These predefined values serve the purpose of indicating the specific pins linked to the LED and the receiver. Proceeding, a pair of variables are introduced: dotDuration and dashDuration. The former is initialized at 250 milliseconds, while the latter is set to twice the value of dotDuration, totaling 500 milliseconds.

Within the setup() function, the configuration of the pins for the LED and the receiver is accomplished. The LED pin is configured for output, while the receiver pin is set as an input. Concurrently, the initiation of serial communication is triggered via the Serial.begin() function, configured to operate at a baud rate of 9600. Primarily, the LED pin is set to LOW, effectively deactivating the LED and rendering it off.

```
void setup() {

 pinMode(LED_PIN, OUTPUT);

 pinMode(RECEIVER_PIN, INPUT);

 Serial.begin(9600);

 digitalWrite(LED_PIN, HIGH);

}
```

The main loop() function commences by awaiting the initiation of a dot or dash signal. This is realized through the implementation of a while loop that remains in a waiting state until the receiver pin transitions from a LOW to a HIGH state. Upon this transition occurring, the program enters a subsequent phase, wherein it monitors the passage of time corresponding to the dotDuration (set at 250ms). This period's conclusion signifies the conclusion of a dot signal.

Following this, a pivotal determination is made: discerning whether the input pertains to a dot or a dash. This differentiation is achieved by ascertaining the duration of the HIGH signal on the receiver pin, accomplished through the utilization of a secondary while loop. The duration of this signal is captured and stored within the variable denoted as 'duration'.

```
while (digitalRead(RECEIVER_PIN) == HIGH) {}

 delay(dotDuration);

 while (digitalRead(RECEIVER_PIN) == LOW) {

 duration += dotDuration;

 delay(dotDuration);

 }
```

When the duration surpasses the dashDuration (500ms), the input is construed as a dash, prompting the program to deactivate the LED pin for the extent of the dash interval before reactivating it. Simultaneously, the program appends a '-' character to the Serial Monitor output. Conversely, if the duration proves shorter than the dotDuration (250ms), the input is recognized as a space, leading the program to indicate a space character within the Serial Monitor. In cases where the duration falls within the range of dotDuration and dashDuration, the input signifies a dot, prompting the program to extinguish the LED pin for the dot's duration, then subsequently rekindle it. In addition, a '.' character is included in the Serial Monitor output.

Consequently, the loop() function resumes its execution, awaiting the initiation of the subsequent dot or dash sequence. This iterative procedure persists indefinitely until the program is intentionally halted.

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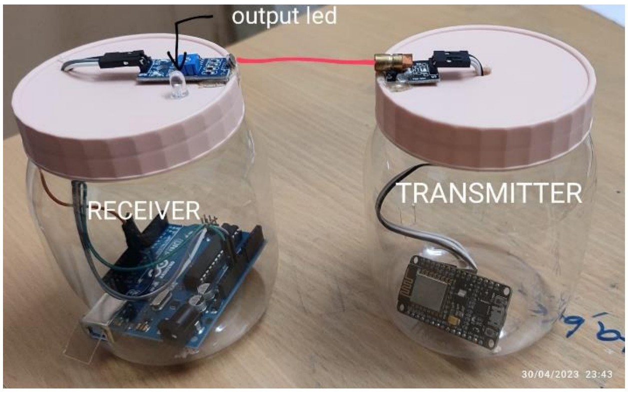
3. RESULTS AND DISCUSSIONS

This paper centers on the utilization of light-based Morse code communication, specifically employing a laser as the means of transmission. Morse code, a historical system of communication reliant on dot and dash sequences, played a pivotal role in long-distance communication in the past. Within this study, the exploration delves into both the transmission and reception of Morse code through the medium of light. In the context of transmitting Morse code using light, the chosen source is a laser. It's noteworthy that each letter, numeral, and punctuation mark in Morse code is intricately represented by a unique sequence of dots and dashes. For the reception of Morse code, the observer is tasked with visually interpreting these sequences of dots and dashes, necessitating a familiarization with the Morse code alphabet and an understanding of the timing associated with dots and dashes. Furthermore, the paper highlights the swifter communication capabilities of Li-Fi in comparison to Wi-Fi. The experimentation phase involved adhering to specific timings—250 milliseconds for dots and 700 milliseconds for dashes—aimed at testing the proposed concepts. Organized in a structured format, the paper commences with an introductory section that offers a comprehensive overview of Morse code and elucidates its historical significance. The subsequent methodology section meticulously delineates the chosen approach and the methodologies implemented throughout the study. In tandem, the results and analysis section presents the discerned findings alongside an in-depth analysis of the compiled data.

Ultimately, the paper concludes by summarizing the implications drawn from the aforementioned results and analysis, offering a well-grounded conclusion that ties together the research's objectives and outcomes.



ECE = . .-.- . → . .-.- .

Fig-6 The process of communication system

Furthermore, the paper incorporates references that have significantly contributed to the scope of this study. It briefly outlines the specific prerequisites involved in the transmission and reception of Morse code, encompassing a succinct elucidation of the algorithm employed for message transmission and the intricate process of receiving and scrutinizing the obtained signal through a photo detector.

Both lasers and LEDs serve as prevalent light sources for transmitting Morse code signals; however, they possess distinct characteristics and fundamental disparities. An essential discrepancy lies in the wavelength of the light emitted. Typically, lasers exhibit a considerably narrower wavelength range when juxtaposed with LEDs. This narrower spectral breadth empowers lasers to emit a beam of light that is notably focused and concentrated. Consequently, lasers prove to be advantageous for applications necessitating protracted transmission distances. Additionally, lasers exhibit the capability to generate higher levels of light intensity in contrast to LEDs. To summarize, a comparative analysis conducted vis-à-vis earlier models underscores that lasers offer several key advantages, including the capacity to generate a more targeted beam, heightened light intensity, and a propensity for directional emission. In contrast, LEDs shine in terms of their lower power consumption and cost-effectiveness.

4. CONCLUSION

The innovative approach of utilizing laser technology for the transmission and reception of Morse code messages marks a significant leap forward in the realm of communication systems. This design amalgamates optics, electronics, and signal processing techniques with precision, facilitating a seamless and dependable avenue for transmitting Morse code messages over extensive distances by harnessing laser beams. The incorporation of laser technology brings forth a multitude of advantages. These encompass elevated data transmission rates, resilience against electromagnetic interference, and heightened security owing to the laser beam's limited divergence. This design serves as a tangible manifestation of the potential for laser-based communication systems to surmount the limitations inherent in conventional wired and wireless technologies. The application of well-suited encoding and decoding algorithms empowers the efficient transmission and reception of Morse code messages through laser pulses. By employing proficient modulation and demodulation techniques, impeccable and error-free message transmission is assured, thereby facilitating lucid and succinct communication, particularly in scenarios of paramount importance. Furthermore, this design underscores the adaptability and versatility of laser-driven systems within a spectrum of applications, spanning military operations, emergency communications, and long-range connectivity. The choice to employ Morse code, renowned for its simplicity and robustness, emerges as a judicious one for laser-oriented communication, guaranteeing harmonious integration with pre-existing infrastructure and equipment. To

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encapsulate, the ingenuity behind the Morse message transmission and reception design, executed via laser technology, holds the promise of revolutionizing communication systems. With continued progress and refinement, laser-based communication systems possess the capability to redefine long-distance communication, establishing reliable and secure communication conduits across a diverse array of applications.

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