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Whistle And Motion Activated Automatic Light With Visitor Counter

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Abstract: This study addresses the excessive energy consumption due to unattended lights and appliances which contributes significantly to resource depletion and environmental degradation. To address these challenges, this research focuses on developing and energy-efficient and basic whistle and motion activated automatic light with visitor counter device. This device operates when it senses that some person has entered the room and has whistled which turns on the light and automatically turns off the light when no one is in the room. This system provides us with hands-free switching of electronic and electrical appliances.

Index Terms **– Automatic Light, Automation, Voice-controlled, Motion detection**

I. INTRODUCTION

We live in an era where every device can be controlled by using our mobile phone via Wi-Fi, Bluetooth, Voice recognition, etc. But nowadays, there is a rapid proliferation in misuse of the data inputs from these devices. Like for instance, to recognize voice for turning on the appliances, the sound sensor should be continuously activated. If this device is kept in our homes or offices, it can collect the conversations which can be used for numerous malicious practices. Even when we talk about our preferences in close vicinity of our mobile phones, the social apps in our phones start displaying related ads in due course of time.

In these days, the voice recording itself can be used to create a fake AI generated voice which can be misused by cyber criminals. For example, a news article published by 'ABC News' with the topic being "The Voice Catchers: How Marketers Listen In to Exploit Your Emotions, Your Privacy and Your Wallet." By Joseph Turow which tells us how numerous companies use the voice data from voice-assisted devices kept in homes and workplaces, is used for targeted marketing of products so that they reduce the human-to-human preference difference errors. This is a big concern nowadays.

Thus, the whistle and motion activated device is built such that it isn't connected to internet and it simply works on the basis of transistors and ICs. This means that even if audio is taken as input, this won't be shared or misused which reduces the privacy concerns. This device consists of transistors and band pass filters which filter out the audio input and only the whistle frequency range which is from 3kHz to 5kHz can activate the device. But what if the person standing outside the room whistle? For that, another circuit is integrated which consists of 2 IR sensor modules which detect the incoming and outgoing of a person from the area where the device is used.

II. CONSTRUCTION

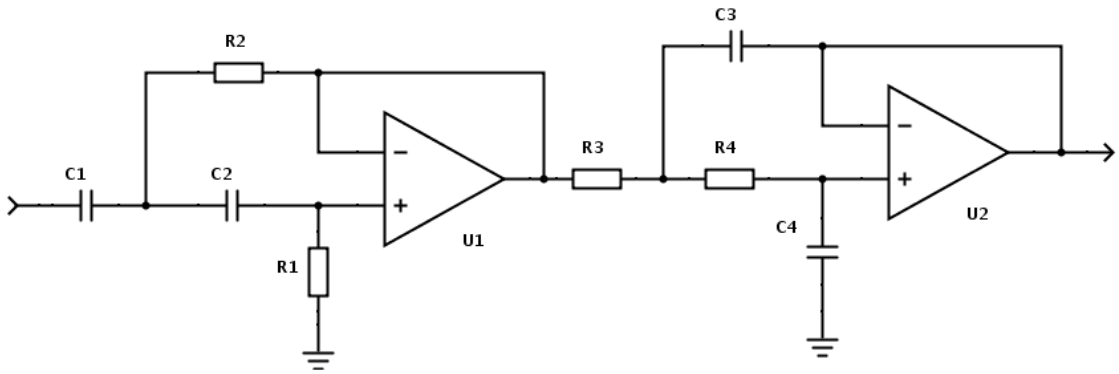
Construction of this involves creating 2 circuits – first circuit is used for whistle recognition and the other for motion detection and room occupancy.

II.I COMPONENTS

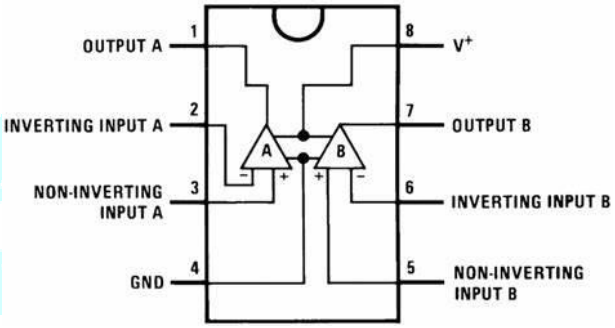
1. 5V Electret Microphone/ Microphone module (locally sourced)
2. Resistors –
   a. 1kΩ
   b. 22kΩ
   c. 10kΩ
   d. 4.1kΩ (Can be achieved by two 2kΩ and 100Ω connected in series)
3. Electrolytic Capacitors –
   a. 10nF
   b. 1µF
   c. 10µF
   d. 100µF
   e. 220µF
4. BC549
5. 9V battery
6. LM358
7. LM7806
8. 2 terminals switch
9. LM339
10. 74LS74
11. Any IR sensor modules with 3.3V to 5V DC (here we have taken locally sourced 5V output IR sensor module)
12. 74LS85
13. 74LS32
14. 74LS191
15. 74LS08
16. Connecting wires (single strand) and jumper wires (male-female)

II.II CIRCUIT CONFIGURATION

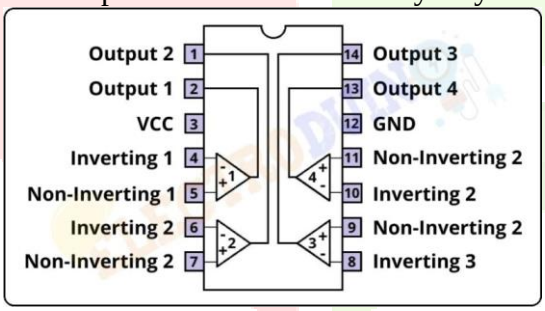
1. Use V_{cc} as 9V battery which will power the device.
2. Bias the electret microphone (ECM) using voltage divider with positive terminal of battery connected to 1kΩ resistor. The other terminal of the resistor is connected to the positive terminal of ECM. The negative terminal of ECM is connected to negative terminal of battery.
3. The output of ECM is taken from the point where the resistor is connected to ECM. This is then connected to a 10nF capacitor's positive terminal.
4. The other terminal of this capacitor is connected to the base terminal of $BC549^1$ transistor.
5. The emitter terminal of this transistor is connected to one terminal of 10kΩ resistor which is connected in parallel with 100µF capacitor (positive terminal is connected to emitter terminal) and the other terminal of this resistor and the negative terminal of the capacitor is connected to the negative terminal of the battery.
6. The collector terminal of this transistor is connected to positive terminal of battery through a 22kΩ resistor. This together creates a voltage divider biasing for $BC549^1$ transistor.
7. The output is taken from the collector terminal of $BC549^1$ transistor which is directly coupled to the base terminal of $BC549^2$ transistor.
8. The collector terminal of $BC549^2$ transistor is directly connected to positive terminal of battery and the emitter terminal is connected to a 1kΩ resistor.
9. The other end of this resistor is connected to one end of 1kΩ resistor and it is also connected to positive terminal of 220µF capacitor, i.e., the other 1kΩ resistor and 220µF capacitor are connected in parallel.
10. The other ends of other 1kΩ resistor and 220µF capacitor which are connected in parallel, are connected to negative terminal of the battery.
11. A 1kΩ resistor is connected from between the 2 1kΩ resistors and to the base terminal of $BC549^1$ transistor.
12. The output is taken from the emitter terminal of $BC549^2$ transistor and this output is connected to positive terminal of a 10nF capacitor.
13. The negative terminal of the 10nF capacitor is connected to a second order Sallen Key configuration Band pass filter and amplifier configuration using LM358



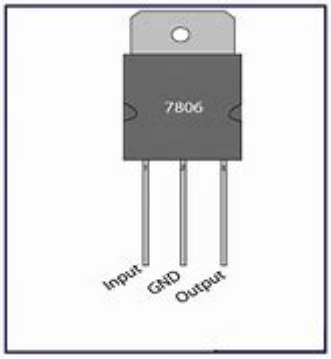
14. The above is a circuit diagram (taken from the website mentioned in the references) for second order Sallen Key configuration Band pass filter and amplifier configuration. Here –
    a. C1 = 10nF (which is already connected to output of BC549[2] emitter terminal output)
    b. C2 = C3 = C4 = 10nF
    c. R1 = R2 = R3 = R4 = 4.1kΩ
    d. U1 = LM385 (pins – 2,3,1)
    e. U2 = LM358 (pins – 5,6,7)
    f. The pin 8 of LM358 is connected to positive terminal of battery.
    g. The pin 4 is connected to negative terminal of battery



15. The output of the 2nd order Salley Key circuit is connected to pin 5 of LM339.



16. Connect the input terminal of LM7806 is connected to positive terminal of battery.



17. Ground terminal of LM7806 is connected to negative terminal of the battery.
18. The output terminal of LM7806 is connected to pin 4 of LM339.
19. Connect pin 3 of LM339 to positive terminal of battery.
20. Connect pin 12 of LM339 to negative terminal of battery.
21. Connect pin 2 of LM339 to pin 2 and 3 of 74LS74 IC.
22. Connect pin 1, 14 and 4 of 74LS74 IC to positive terminal of battery.
23. Connect pin 7 of 74LS74 IC to negative terminal of battery.

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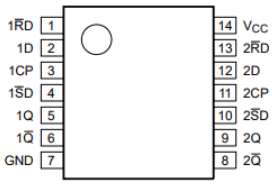
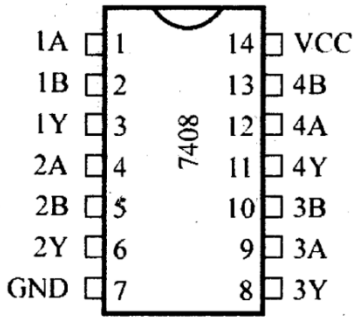
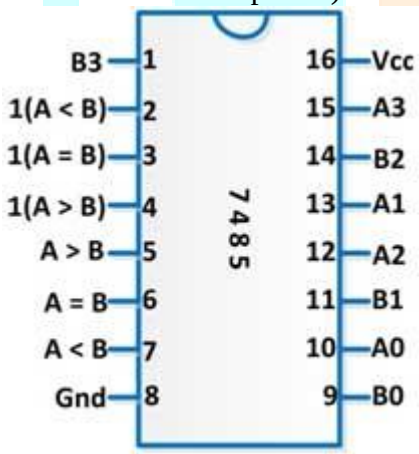


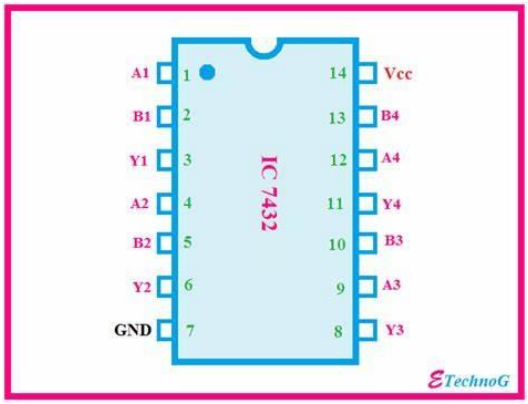
24. Connect pin 5 of 74LS74 IC to pin 1 of 74LS08 IC.
25. Connect pin 14 of 74LS08 IC to positive terminal of battery.
26. Connect pin 7 of 74LS08 IC to negative terminal of battery.



27. Connect the 2 IR sensor modules –
    a. V_{cc} pins of both IR sensors to positive terminal of battery.
    b. GND pins of both IR sensors to negative terminal of battery.
    c. OUTPUT pins of both IR sensors to pin 9 and 10 of 74LS85 IC (one output pin goes to pin 9 and the other to pin 10).

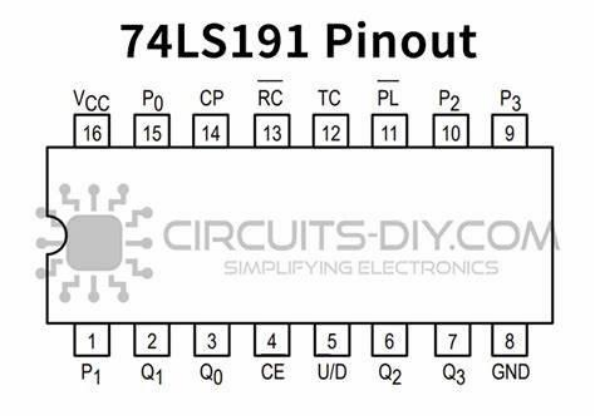


28. Connections of pins of 74LS85 –
    a. Pins 16 and 3 – positive terminal of battery
    b. Pins 1,2,3,6,8,11,12,13,14 and 15 – negative terminal of battery



29. Connections of pins of 74LS32 –
    a. Pin 1 – pin 5 of 74LS85
    b. Pin 2 – pin 7 of 74LS85
    c. Pin 14 – positive terminal of battery
    d. Pin 7 – negative terminal of battery

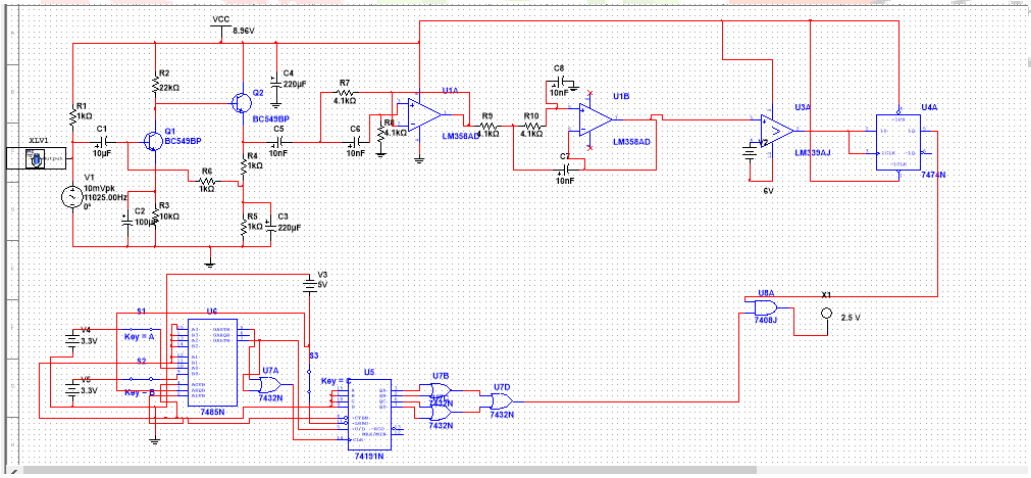
e. Pin 6 – pin 12 of 74LS32
f. Pin 8 – pin 13 of 74LS32
g. Pin 11 – pin 2 of 74LS08



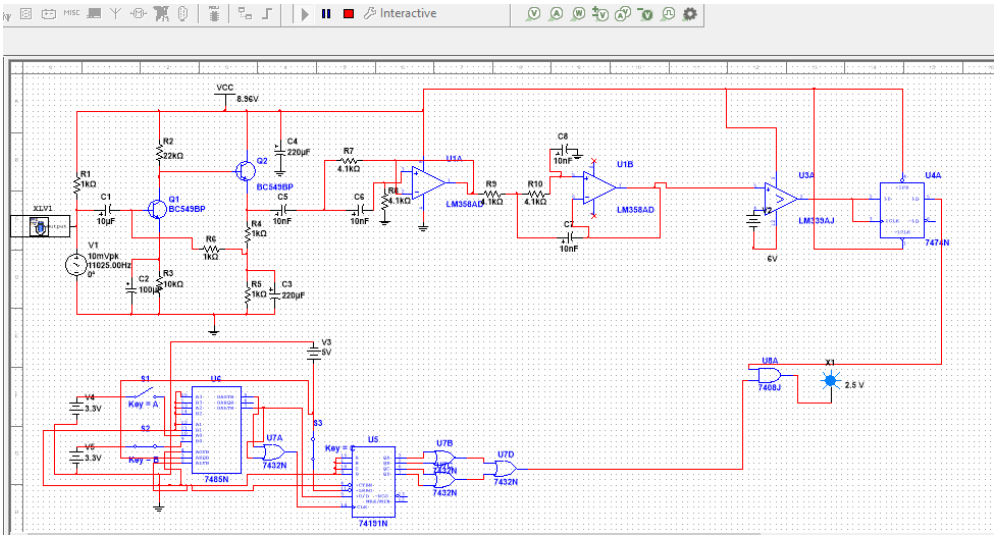
30. Connections of pins of 74LS191 –
    a. Pins 1, 4, 15, 9, 10, 11, 12, and 8 – negative terminal of battery
    b. Pin 16 – positive terminal of battery
    c. Pin 14 – pin 3 of 74LS32
    d. Pin 5 – pin 7 of 74LS85
    e. Pin 3 – pin 4 of 74LS32
    f. Pin 2 – pin 5 of 74LS32
    g. Pin 6 – pin 9 of 74LS32
    h. Pin 7 – pin 10 of 74LS32
    i. Pin 11 – positive terminal of battery through a normal 2 terminal switch.
31. Connect pin 3 of 74LS08 to 2kΩ resistor and connect the other end of resistor to positive terminal of LED.
32. Connect the negative terminal of LED to negative terminal of battery.

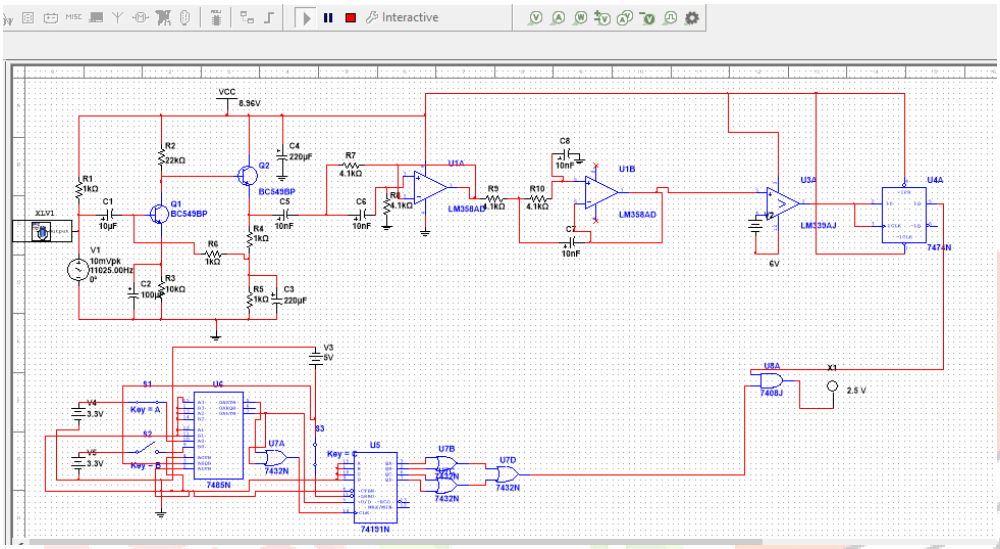
III. CIRCUIT DIAGRAM (MULTISIM)

Simulation using NI Multisim Software



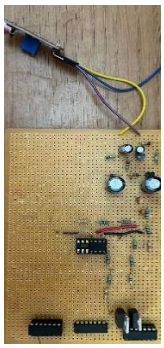
Results –

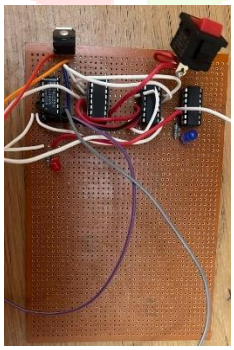




(here as the were no IR modules, we replaced it with 3.3V DC supplies and switches to copy their behavior and also instead of LED we have used digital probe so we don't need to put resistor in simulation)

Circuit Pictures –





Here we have put jumper wires to connect to battery and sensors and microphone module

IV. WORKING

- Electret Microphone Module – The module captures the sound signals which are in the room where it is kept (range depends from module to module). This signal's amplitude is very less (in mV) and for the further processes in the circuit, the signal's amplitude should be more than 6V when a person whistles. To do so the modules might have in built pre-amplifying circuit which can give 10mV V_m AC signal when sound signal is sensed.
- Pre-amplifying circuit 2 – To amplify the sound signal from 10mV to 500mV, a pre-amplifying circuit using two-stage amplifier circuit made using two BC549 transistors. The Common Emitter configuration is used with voltage divider biasing for first BC549 transistor and thus, output is taken from the collector terminal and is fed as input signal to the base of second BC549 transistor. The second transistor is in Common Collector configuration. The emitter terminal is connected to a voltage divider circuit using resistors to give a sufficient amount of feedback to reduce the noise levels in the circuit. The output is taken from the emitter of second BC549 transistor and is fed to the amplifying, band pass circuit.
- 2^{nd} order Sallen Key Configuration – This configuration is widely used for analog filter designs. It consists of op-amps along with resistors and capacitors to create various types of filters such as low-pass, high-pass, band-pass and band-stop, as well as it amplifies the input signal fed to it. In this circuit a band-pass filter is used to filter the sound input and only allow the signals within 3kHz to 5kHz frequency range (frequency range of human whistle) for further amplification. LM358 op-amps are used to attain a voltage gain of 14 –

$$A_v = \frac{V_{out}}{V_{in}} = \frac{7V}{0.5V} = 14$$

  There are 2 amplifier circuits one is low-pass and other is high-pass. The RC networks determine the frequency response of the output signal. The output of this configuration is fed to the LM339 comparator.
- Comparator circuit – This circuit is to compares the input sound with a reference voltage that is set by the 7806 voltage regulator IC. This circuit is included so that the necessary sound input should trigger the circuit only and the rest of the sound signals should not be taken into consideration. For this LM339 comparator is taken which can compare AC as well as DC signals and provide a DC high or low output. So, when someone whistles, the amplifier circuits will amplify the signal such that signal voltage is above 6V and band-pass filter will be applied to ignore the unnecessary noise and sound then this input will be compared with 6V reference voltage and if the input signal has greater voltage than the reference voltage the comparator will give a high signal which will be passed to 74LS74 IC to latch the signal. As a person will whistle for a very short period of time, the high input of comparator should be stored for continuous working of light. For this 74LS74 is used. But if someone has whistled once the light will be on at all times. To solve this problem, the output of D flip flop (74LS74 IC) is connected to AND gate (74LS08 IC) so that when someone enter the room and whistles, the light will turn on.
- Latching – As the whistle input will be active for a short period of time, a D flip flop (74LS74 IC) is used to latch the input. D flip flops are mainly used to provide the same input but after a short delay. In this circuit, the input and clock of D flip flop are connected to the output of the comparator such that if the comparator input is high for few seconds, the clock will turn on and the input will be transferred as output of D flip flop which will also be high. But when the comparator input turns to low again, the clock input will also be low so the D flip flop will not turn on and the input values will not change.
- AND gate – The above circuit will always be in on state once any person has whistled. So, to take into account that the light should turn on only when someone in the room whistles, the circuit includes AND (74LS08 IC) gate. The output of D flip flop is given as input to AND gate.
- Sensor Modules and Motion Detection circuit – There are 2 sensor modules (say S1 and S2) kept at a distance such that when someone enters the room S1 turns on first and then S2 (while S1 is turned off till then) and when someone goes outside the room, the S2 sensor turns on first and then S1 (while S2 is turned off). Thus, 2 sensor modules are needed to differentiate if person is coming inside the room or going outside. The outputs of these sensors are given to the 74LS85 comparator which is the main part of differentiating the movements. This comparator has 3 outputs – A>B, A<B and A=B where A is output of S1 and B is output of S2. The circuit uses the A<B and A>B to differentiate the movements and A=B is not considered as this in real life represents that a person is standing at the door and this should not turn on the light. These A>B and A<B outputs are fed to the 4-bit synchronous bidirectional counter IC – 74LS191 in such a way that it will add 1 when someone comes inside the room and will subtract 1 when someone goes outside the room. As 74LS191 is a 4-bit bidirectional counter, there a 4

output namely – Q_A, Q_B, Q_C and Q_D. If even 1 person is inside the room, one of the outputs will be high. Using this logic, Q_A and Q_B fed as inputs to one OR gate (74LS32) and the other 2 outputs are fed to other OR gate. The outputs of both OR gates are fed as inputs to one more OR gate and this OR gate's output is fed as the second input to AND gate mentioned above. This is done to satisfy $Q_A + Q_B + Q_C + Q_D$ equation and to turn on the light when someone inside the room whistles.

V. Conclusion

We can't stop using new technology voice-assisted and motion-controlled devices. But we can use such devices which are reliable and don't hinder our privacy. By continuing to improve this technology, society can achieve more safer hand-free switches, which are energy efficient as well. Thus, making such automatic electrical appliance switches is necessary for the people who are concerned of nowadays cyber-crimes.

VI. References

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