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Leveraging Arduino for Automated Bell Ringing to Optimize Time and Effort in Schools

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Abstract

This study introduces an automated school bell system that replaces manual bell ringing with a pre-programmed schedule, enhancing the accuracy and efficiency of school time management. The system comprises a central control unit, one or more bells, and scheduling software. It allows for precise timing of events such as class periods, breaks, and transitions, streamlining school operations. Key advantages include improved reliability, reduced manual labor, and customization to individual institutional needs.

Keywords: *Relay, Timer, Electric Sequencer, Buzzer.*

I. INTRODUCTION

The automated school bell is an electronic solution designed to ring bells or play alerts at scheduled intervals, indicating class transitions and break periods. This time management tool supports operational efficiency in schools by ensuring activities commence and conclude punctually. The system usually integrates a microcontroller, real-time clock (RTC), relay module, bells/speakers, power supply, and required wiring. The microcontroller governs the system's timing, while the RTC ensures synchronization. The relay handles high-voltage outputs like bells. This project benefits institutions by reducing staff workload, promoting student discipline, and supporting structured learning environments. It ensures schedule adherence without human intervention.

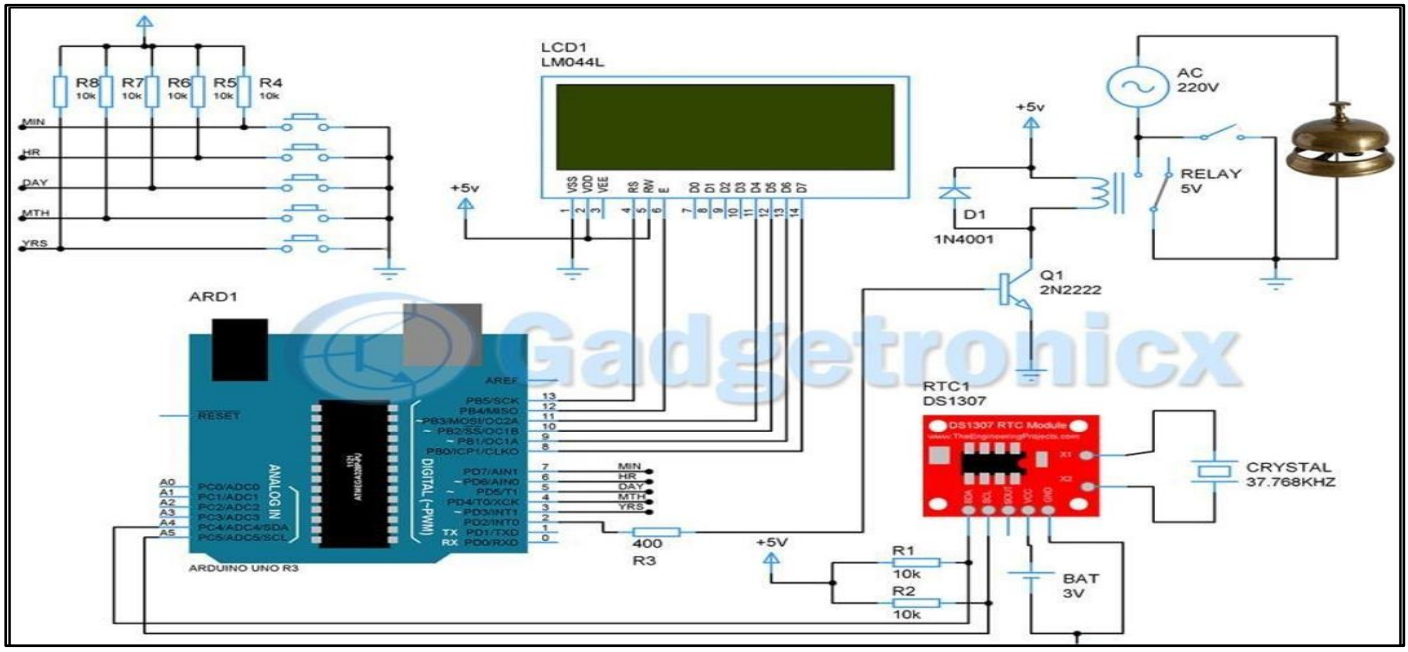

Fig 1 Automatic School Bell

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➢ *Research Objective*

This project explores the implementation of an automated bell system to streamline school operations. Automating bell ringing allows staff to focus on other responsibilities, while ensuring consistent and timely alerts reduces confusion. The system is also budget-friendly and simple to deploy, depending on component choice. Furthermore, its design allows for flexible customization to accommodate individual school needs. Security is another consideration—automation can keep staff within safe areas during transitions, reducing potential risks associated with manual operation.

➢ *Disadvantages*

Despite its benefits, this system has some limitations:

- *Initial Investment:*

High setup costs, although offset over time by reduced labor.

- *Technical Challenges:*

Susceptibility to software or hardware failures that may need expert support.

- *Power Dependency:*

Outages can halt operations, disrupting school routines.

- *Maintenance Demands:*

Regular upkeep (e.g., battery changes, software updates) is needed.

- *Security Concerns:*

Potential vulnerability to unauthorized access or hacking.

Nonetheless, with careful planning and maintenance, the benefits generally outweigh these drawbacks.

II. TIMER RELAY

A timer relay is a specialized component with built-in timing functions used to control the activation and deactivation of the bell based on preset durations. It ensures precise operation—e.g., ringing a bell for five seconds every hour.

Key contact types in timer relays include:

➢ *Normally Open (NO):*

Conducts current only when activated.

➢ *Normally Closed (NC):*

Conducts current by default, breaks when powered.

➢ *Common (C):*

Shared terminal connecting to either NO or NC depending on the relay's state.

Relays typically have five terminals, but variants with more connections exist for complex applications.

➢ *Points of Timer Relay:*

- *Open Contact Point:*

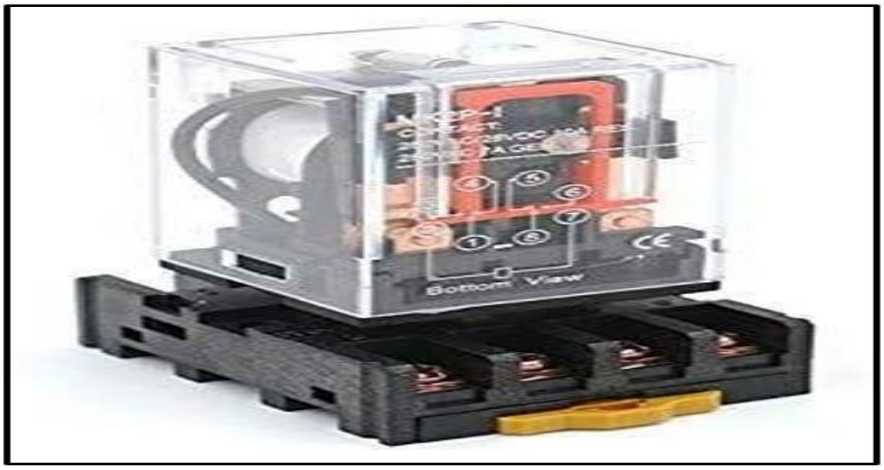

Fig 2 Open Contact Point

It is the point that is in its normal state open, that is, it does not conduct an electric current, and it is symbolized by the two letters NO, which is an abbreviation for Normally Open, and it is numbered with the following numbers: 13-14 or the following numbers starting with the number 3. The NOpoints are closed when feeding the relay coil with electric current.

- *Closed contact point:*

They are the points that are in their natural state closed, i.e. connected when the relay coil is not fed with current, and open when the relay coil is fed withcurrent. Closed points are symbolized by the letters NC, which is an abbreviation for Normally Closed, and are numbered with the following numbers: 11- 12 or the following numbers starting with the number 1.

- *Common point:*

Refers to the common end of the relay, and represents the end of the output point, which is connected to the load or to any other circuit, and is connectedeither to the closed or open point depending on the state of the relay, and thecommon point is symbolized by the letter C.

➢ *Key points for relay:*

Most relays that use digital control panels have 5 basic points as follows:

- Two points for the relay file
- Open point NO.
- Closed point NC.
- Common point C.
- You may find relays with 8 points and 11 points, whichever you choose according to yourneed.

➢ *Relay Contact Points*

As shown in front of us are the contact points and the ends of the coil for one of the relays, you will find that the scheme is a little complicated for beginners, but it is actually very easy to understand and clear, and it only needs some practice.

We note that the numbers written in red, 11, 21, and 31, are common points, that is, output points, while points 12, 22, and 32 are closed points NC, and points 14, 24, and 34are open points NO.

Finally, points A1 and A2 or 2 and 10 are the relay coil points.

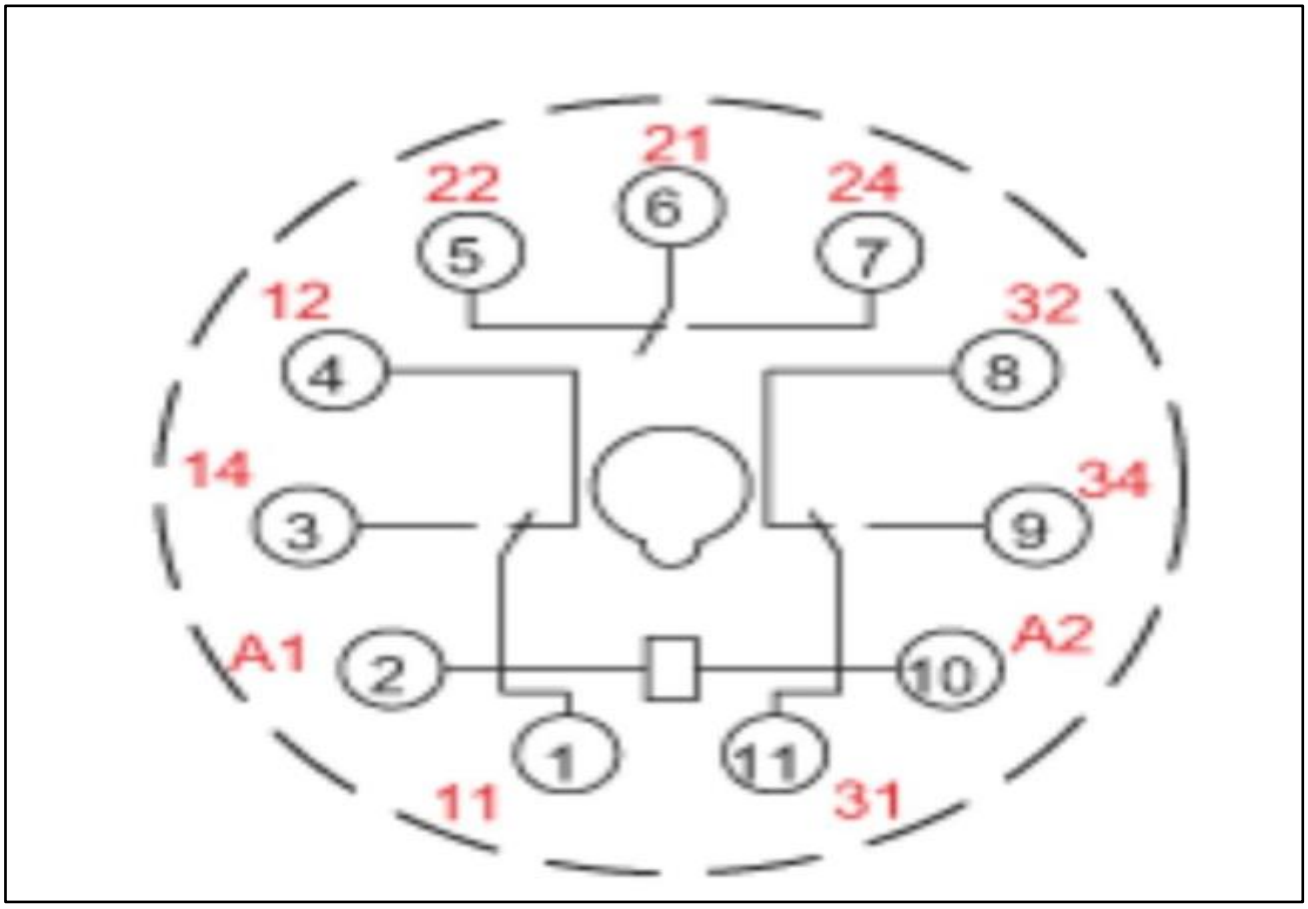

Fig 3 Relay Contact Points

➢ *How its work*

The operation of a timer relay depends on the specific type of timer relay being used. However, in general, timer relays work by receiving an inputsignal that triggers a timing function, which then controls the output circuit of the relay.

For example, let's consider an on-delay timer relay. When an input signal is received, the relay's timing circuit is activated, and the outputcircuit is energized after a pre-set delay. This delay time is usually adjustable and can be set using a knob or a digital display. Once the delay time has elapsed, the output circuit is de-energized.

In the case of an off-delay timer relay, the input signal triggers the timing circuit, and the output circuit is energized immediately. However,when the input signal is removed, the timing circuit is activated again, and the output circuit remains energized for a pre-set delay time before itis de-energized.

Interval timer relays and recycle timer relays work by using a combination of on-delay and off-delay timing sequences to provide repeatable timing cycles. Programmable timer relays can be customizedto provide various timing sequences and can be programmed using a keypad or a computer interface.

In an automatic school bell project, the timer relay would receive an input signal from a timer, which would activate the timing circuit andcontrol the output circuit that controls the school bell. The timer relaywould then turn the school bell on or off based on the pre-set timing sequence.

➢ *Timer*

Timers are electronic circuits used to measure and regulate time intervals. They are fundamental in systems requiring precise timing control, including this bell system. Timers consist of a clock source, counter, and comparator to trigger events after specific intervals.

They are categorized as:

- *Analog:* Use mechanical parts (e.g., gears).
- *Digital:* Utilize electronics for precision.

In this context, timers initiate the bell circuit based on scheduled intervals through relay control.

➢ *Timer Contact Points:*

- *Normally Open NO*:

In the normal state, it is open, and when feeding the timer, it counts until the end of the present time, and then changes the open contact points to closed ones.

- *Normally Closed NC:*

In the normal state, it is closed, and when the timer isfed, it waits until the pre-set time expires and changes the closed contact points to open ones.

- *Common Point:*

It is the point where the electric current is connected.

➢ *Selector Switch*

Selector switches allow users to choose between different modes or schedules within an electrical circuit. By rotating a knob or lever, different internal contacts are engaged, reconfiguring the circuit. In the school bell system, this can switch between various bell schedules—useful for weekdays, exams, or special events.

Fig 4 Selector Switch

The operation of a selector switch is straightforward. When the knob or lever is rotated to a different position, the switch contacts inside the switch change their state, connecting or disconnecting different parts of the circuit. This allows the circuit to be reconfigured for a different option or function.

For example, in an automatic school bell project, a selector switch canbe used to select between different timing modes or bell schedules.

When the switch is rotated to a different position, it connects a differentset of contacts, which configures the timer and relay circuits to activatethe school bell according to the selected schedule.

Overall, selector switches are essential components in many electrical circuits, providing a simple and reliable way to select between differentoptions or functions. They are available in various sizes, shapes, and configurations to suit different applications and can be used in combination with other switches, relays, and controllers to create complex control systems.

➢ *Bell (Buzzer)*

The electric bell uses electromagnetism to strike a metal surface, generating a loud and recognizable sound. Controlled by a relay, it activates based on the timer's signals. This type of alert is ideal for environments needing clear audible signals. Electric bells are commonly used in various applications, such as alarm systems, doorbells, and telephones. They are relatively simpleand reliable, and they produce a distinct and loud sound that is easilyrecognizable. However, they can be relatively loud and may not be suitable for some applications where a more subtle sound is desired.

Fig 5 BELL (Buzzer)

➢ *Wire*

The conductive material used to connect the different components together. In this project, wires would be used to connect the timer, timerelay, selector switch, and bell in the appropriate way.

➢ *Circuit Board*

A platform used to mount and organize the different components of theproject. In this project, a board could be used to mount the timer, time relay, selector switch, and other components, and to provide a safe andconvenient way to connect them together.

➢ *Hardware Implementation*

The system employs five relays and four timers. Different time periods require individual timers and relays for accurate control. Additional components include a buzzer and a selector switch.

➢ *Circuit Operation*

The electrical design was created using AutoCAD. It supports different operational phases:

➢ R1 activates the buzzer.
➢ T1 manages buzzer duration.
➢ R2 handles class timing.
➢ T2 governs lesson time.
➢ R3 transitions to break mode.
➢ T3 sets break duration.
➢ R4 & T4 reset the cycle.

Each component is connected based on timing logic, coordinating bell rings for each stage of the school schedule.

III. RESULTS

➢ *The Parts of Auto School Bell Project and its Work*

- Five Timer relay pieces : A specialized relay that includes a timer circuit. In this project, the time relay would be used to turn the school bell on and offbased on a pre-set timer.
- Four Timer pieces: A device that can measure and control time intervals. Inthis project, the timer could be used to set the time intervals for the time relay, which would in turn control the school bell.
- Selector switch: A switch that can be used to select between different options or modes. In this project, the selector switch could be used to choose between different bell schedules or to enable/disable the bell.
- Bell (Buzzer): The sound-making device that signals the start and end of classes. In this project, the bell would be connected to the time.
- Wire: The conductive material used to connect the different components together. In this project, wires would be used to connect the timer, timerelay, selector switch, and bell in the appropriate way.
- Board: A platform used to mount and organize the different components ofthe project. In this project, a board could be used to mount the timer, timerelay, selector switch, and other components, and to provide a safe and convenient way to connect them together.

➢ *Hardware Working*

To make automatic bell, five relays and four timers are used as shown in figure (3.1). And because there is more than one different time period, this requires the presence of a timer for each time period, as well as a relay for the purposeof controlling and controlling these times, in addition to the electric switch and also theelectric buzzer as shown in figure 6.

Fig 6 The Number of Relays and Timers used

Fig 7 Electric Switch and Electric Buzzer

➢ *Electronic Circuit Working*

For the drawing and simulating electrical circuits and automatic control circuits, there are several programs tio be used. In this project, the AutoCAD program was used to draw the electrical circuit diagram and to explain the connection method. As it is certified in drawing classic control circuitsas shown in figure 7.

We have Three Different Times:

- *First:* the duration of the bell (usually takes one minute)
- *Second:* Lesson duration (usually takes 35 minutes)
- *Third:* the duration of the break (usually it takes five minutes)The fourth timer is used to restart the cycle again

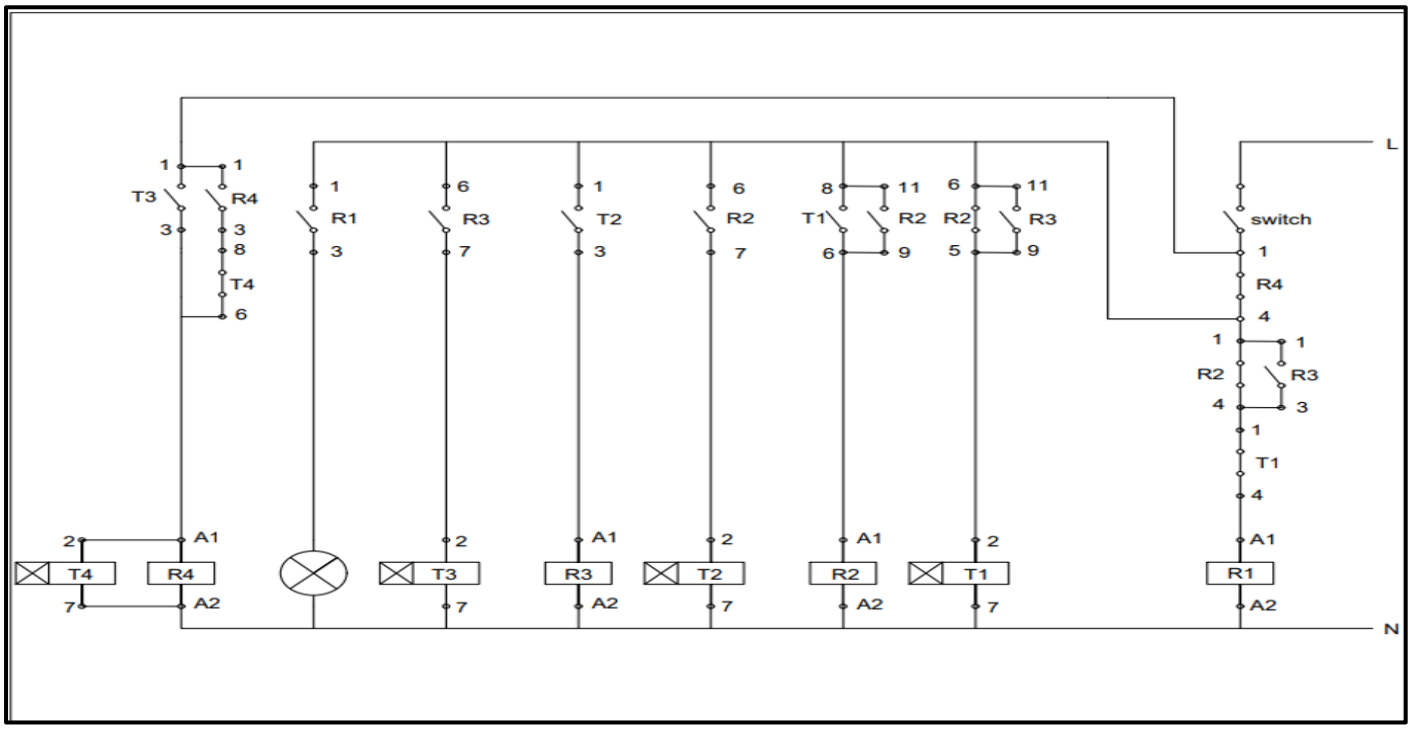

Fig 8 Electrical Circuit Diagram of the Automatic School bell

In the above Fig 8, it refers to the sequence diagram of connecting the projectelements, as we will explain in several steps as follows:

- The relay responsible for operating the buzzer [R1] by the open point [1-3]
- The timer[T1] turns off the buzzer by the close point [1-4]

- The timer [T1] turns off Relay [R1] through the close point [1-4] and at the sametime it turns on [R2] via the open point [6-8]
- [R2] It continues to work by feeding itself by point [9-11] Then it stops [T1] and [R1] and the lesson begins for 35 minutes (in this project a six-minute timer was used because a 35-minute timer was not available at the moment).
- The timer [T2] starts to work, which was turned on [R2] by the point[7-6] , andstarts counting the lesson time
- After the end of the 35-minute lesson time, it [R2] turns off [T2] at the point [1-3]and turns on [R3]
- When you turn on[R3] it closes [R1] through the point [1-3] in the coil line (R1) (which is responsible for turning on the buzzer) and also closes the point [9-11]to run the timer again [T1] its responsible for the running time the buzzer, at the same time[R3] you turn on [7-6] to turn on the timer [T3]
- When the timer is running [T3] at the same time, the timer is running [T3] at thecoil line (coil 4), which is responsible for the time of break.
- When the duration of the break is complete, the timer [T3] closes the point [1-3]which in turn turns on [R4] and also [T4]
- When you turn on [R4] on the coil line, it will open [R4] (normally close) on theswitch line, and the circuit is restarted.

➢ *The Result*

An automatic school bell was made by some parts of the classic control circuits (timers as well as relays in addition to the switch and the electric buzzer).

It has been found that it is possible to control the time period for each timing according to the control of the existing timers, where for each time there is a timer (break time and lesson in addition to the duration of the bell ringing and also re-circuiting again)

The electrical circuit has been connected to the school bell

According to the above steps.

IV. CONCLUSION

This automated bell system significantly improves time management in schools. By using four timers and five relays, the project eliminates manual operation while maintaining schedule accuracy. Components include buzzers, switches, and timers, with the entire design visualized in AutoCAD.

RECOMMENDATIONS

To further improve the system:

- ➢ Implement PLC systems for easier configuration.
- ➢ Use a flashing timer for reduced component count.
- ➢ Consider Arduino integration for programmability and scalability.

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