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Internet of Things Based Smart Prayer Time Management System

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***Abstract*— Technology intervention for better user experiences in religious or spiritual practices has become a new focus for researchers from different disciplines. In different religions, prayer time is maintained with importance in prayer houses such as in mosques, temples, churches, etc. Muslim perform five-time prayer in a day and prayer is performed at a fixed time in a day. Therefore, mosques maintain two type of times named *Owakt* time and *Jammat* time. We designed a low-cost Internet of Things (IoT) based smart prayer time management system so that an attendant of the mosque do not need to worry about the *Owakt* time management at all since the times get automatically updated in the clock from our system. In case of *Jammat* time, the attendant of the mosque can set the convenient time according to the expectation of the local mosque using the web interface of the system. He can access the interface from any device by accessing the local network and does not require to engage with clock every day physically.**

Keywords—*prayer time, web interface, IoT.*

I INTRODUCTION

Researchers are working for the development of social, economic, cultural norms and our day to day practices through Information and Communication Technology (ICT). ICT aims for the improvement of people's daily activity in many ways. Religious or spiritual practices constitute a part of daily activities. User experiences on religious or spiritual practices have drawn attention from the researchers of HCI or ICTD community [1], [2]. The goal of this type of research is to improve the experience of religious or spiritual cultures, norms, and practices. As a result, a new buzzword "**Digital Religion**" which is a new understanding of religious or spiritual practices or reflexivity via digital technologies [3]. Different types of digital communications have impacts on the religious norms and practices of major religions such as Christian, Islam, Buddhism, Judaism, etc. [4].

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Islam is one of the largest and major religions with 1.6 billion [1] followers which is nearly 23% of the world's population. Muslim people call for prayer five times in a day recognized as *Salat* which is one of the fundamental pillars of Islam. Five times prayer in a day is maintained according to a timetable. This timetable is not global rather it is a local timetable. That means prayer time is maintained according to the time of a local area. The maintenance of prayer time is very important for five times prayer in a day. Moreover, five times prayer is conducted at the *mosque* (prayer house where people call for prayer together) at a fixed time of the corresponding locality. Therefore, five fixed time along with the main time is maintained in every mosque. An attendant needs to update these prayer times regularly since these times actually depend on the sunset and sunrise time of the local region.

The technical intervention took place from the beginning of the nineteenth century in different religion and impact of printing technology in Islam is described here [5]. Prayer is maintained in a fixed time in other religions also. Researchers have introduced many smart ways for the maintenance of such prayer. In this study [6], the support of technology in complex religious practices have been discussed as well as the acceptance of these technologies in techno-spiritual practices have been surveyed. Observing media technology such as loudspeaker or radio usage in urban Singapore for the call of prayer, authors explore a complicated relationship between technology and spatial organizations in society [7].

In this study, we have found that prayer time is managed by manual interaction with a number of clocks and updated regularly. An attendant of a corresponding mosque has to physically attend at the mosque to do the job. However, one of the main purposes of the intervention of technology in religious practices is to gain flexibility and more user satisfaction in spiritual deeds. Following the theme, we have designed a low-cost Internet of Things (IoT) based smart time management for Muslim prayer. In a nutshell, our contribution is following:-

[1] https://www.worldstopmost.com/2018/largest-religions-world-fastestgrowing

- Muslim prayer time is basically divided into two categories:- *Owakt* time and *Jammat* time. The *Owakt* time is a fixed time, however, *Jammat* time varies from mosque to mosque. We have injected the five times *Owakt* time along with sunrise and sunset time for a year into the flash memory so that an attendant need not check or update the *Owakt* time regularly. Every year the *Owakt* time can be injected into the flash memory in order to maintain the time. The clock reads times form the memory gets updated every day without manual interruption of the clock.

- We have designed a simple web interface (not an extra mobile or desktop application at all) which is operable from a desktop or any mobile device such as cell phone, tablet, etc. An attendant connected to the corresponding local network (mosque network) just knowing the address can access the web page and update the *Jammat* time without attending physically before the clock. The feature does not require an extra application and thus remove the overhead of installation an extra application.

II RELATED WORKS

Researchers have shown how technological intervention have brought impact and changes in the habit of spiritual practices in different religion in many extents. A study indicates iTune app-store contains about six thousand apps related to religious or spiritual contents, however, there is a gap of HCI research in this relevant domain [8]. It is a growing research topic that how people use technology in practices of any spiritual activities such as mortality, death, dying, etc, however, have not drawn expected attention from HCI or CSCW communities [2].

A study [9] gave some insights about the perception of the participants on home automation technologies to be used in religious practices and how they utilized the technology in religious norms. They conducted a study of 20 American Orthodox Jewish families on home automation for religious purposes. In this study, [10] uses of technologies in three aspects of religious practices: religious study and reflection, church services, and pastoral care are discussed. HCI community has also shown interests in how technological engagement is accepted by the practitioner and improves their experiences. Following the interests, in this study, [11] how large displays, projection systems, software are used in American megachurches to improve religious experiences are discussed. A GPS based mobile application is introduced to find the nearest mosque in an unfamiliar area along with the feature of synchronization of prayer time for the particular area [12]. A raspberry pi based system is introduced as a reminder of prayer time integrated with LCD display and GPS enabled coordinate system is exploited [13] for the purpose of finding the location of prayer house. A mobile application of sacred imagery is employed to support Islamic prayer practices and how technological involvement improves the experience [14]. A survey was conducted over seven older participants to find out why Islamic websites failed to satisfy users' spiritual experience [15]. The role of ICT and Social Networking Sites (SNS) are discussed with respect to spiritual experiences [16]. Moreover, religious prayer houses also encourage to utilize ICT for different purposes. In this study, children and adolescents are inspired by the church to utilize ICT mediated technology in religious activities [17].

Researchers showed interests in Muslim prayer time management system particularly. *Sun Dial* [18] is a mobile application specially designed for the smart management of prayer time. The motive of the research is to find the experience of techno-spiritual activities. A chip microcomputer based prayer alarming system has been introduced here [19]. The system compares the current time with pre-memorized prayer time and notifies a user with alarm. A device can tell the correct prayer time by taking the latitude and longitude can determine the prayer time. A GPS based device is designed to indicate the direction of prayer and displayed in screen [20]. A proximity sensor-based system that counts the *Rakah* of Islamic prayer is another interesting related work to be mentioned [21]. A portable device that notifies about the prayer time and the detail information about the corresponding prayer time by maintaining a database [22]. A device for announcing the call for Muslim prayer at a certain locality named as *Adhan* is designed here [23].

III MOTIVATION

Salat, one of the five fundamental pillars of Islam, is a must doing practice for Muslim. *Salat* is performed daily five times in a day according to a fixed time depending on the local time of an area. Basically, prayer is dependent on the sunrise or sunset time. Since the sunrise or sunset times are different all over the world, prayer time (*Salat* time) vary from place to place. Prayer is called five times a day from Mosque, prayer house of Muslim where people pray together. Staffs of the mosque always maintain the sunrise, sunset time of the day and according to those times, they adjust prayer times every day. An attendant of a mosque needs to adjust the clock manually to show the correct prayer time**.** Our investigation finds that an attendant has to be present physically to perform the task daily, however, this need not require at all. Therefore, we have designed and implemented a smart IoT based payer time management system so that an attendant need not to physically attend to update the time clock daily. The objective of our simple design is to remove the physical engagement and thus provide flexibility or comfort in religious practices which is one of the goals of technological attachments in religious or spiritual activities.

User acceptability of new technology in religious practices is also an important factor for techno-religious design. Therefore, we plan to do a survey over the mosques' attendant in order to determine whether we need the new system and how the responsible people will accept this. In the following section, we will discuss the survey and the findings of our survey.

IV SURVEY

We plan to investigate some mosques to find out the details how the prayer time is maintained. We have selected five large mosques in Dhaka city for our survey by dividing the whole Dhaka city into five territories. Here, the large mosque means the central mosque of a locality. Dhaka is recognized as ***The Land of Mosque***, therefore, it becomes an easy task for us to take a survey on mosques. We prepared five questions about the prayer time, how the responsible body manage it and how they accept the integration of proposed technology in traditional practices. We went to the selected mosques and expected elaborated answers from the attendants of the corresponding mosques about our open-ended questionnaire. In every mosque, two type of time is maintained - *Owakt* time and *Jammat* time for each prayer in a day. That means, for five times *Salat*, in total ten times are managed. Moreover, in total twelve times are managed including two sunrise and sunset time. *Owakt* time means the starting time of any prayer. *Owakt* time remains same for all mosques in a particular region. For example, *Owakt* time for each of the prayer in a day in Dhaka city remains same, however, it changes slightly (one or two minutes) every day. Sunrise and sunset times also change slightly every day, however, remains same for a region. Then, there is *Jammat* time which is the actual time for performing the prayer time together in a mosque. *Owakt* time means anyone is not allowed to perform the particular *Salat* before the *Owakt* time. However, *Jammat* time is the time for performing prayer together. Therefore, *Jammat* time varies from mosque to mosque and actually it is actually set in any convenient time of the mosque or local area. According to our findings, *Owakt* and *Jammat* time both are maintained regularly and displayed in large seven segment display in these mosques. *Jammat* time is set after a while of *Owakt* time. *Owakt* time remains constant in a certain locality, however, *Jammat* time is set according to the flexible time by discussing with all practitioner of the area. We have also found out that, an attendant always remains careful about maintaining the time daily. According to our investigation, we have found out that, fixed timetable that means *Owakt* time along with sunrise and sunset time need not be adjusted manually every day. A smart device that is loaded with *Owakt* time along with sunrise and sunset data of one year can give more comfort and flexibility than before. We have consulted the responsible persons from these mosques and ask for their opinion about such advice.

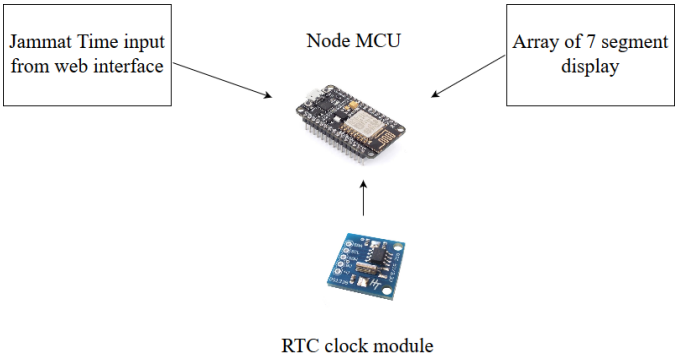

Fig. 1: Block Diagram

They showed interest in such device and gave a positive response in integrating such device with the clock. In the case of *Jammat* time, we proposed them about a simple web interface. They can log in into the local network by authorized password and can easily access the page. Eventually, they can easily update the time through the interface without physically attending the clock. Primarily, we have proposed these two features and according to their opinions, we have designed and developed the system. The responsible people of the mosque agreed with us that, the implementation of the proposed IoT device may give flexibility in their work and obviously ease their lives.

V SYSTEM DESIGN

Our system consists of three modules:- micro-controller module, the input module, a display module. We have used Node MCU as our micro-controller unit. We have designed a web interface for giving input for *Jammat* time (5 times prayer time for Muslim in the mosque). An array of 7 segment display has been employed for displaying prayer time. The block diagram of our proposed is shown in Fig. 1.

A. Micro-controller Module

The micro-controller unit is the controlling unit of the system. We have preferred Node MCU to traditional micro-controller unit such as Atmega32, Arduino, etc for some reasons. Firstly, the ESP8266 Wi-Fi module is used generally for wireless data transmission along with a micro-controller**.** However, Node MCU has an integrated ESP8266 Wi-Fi module. As a result, it reduces design complexity by removing an extra ESP8266 device Moreover, the cost of a separate Arduino unit and ESP 8266 is about 450 and 325 BDT and in total around 775 BDT (9.13 USD). In the case of Node MCU it just needs 500 BDT (5.86 USD). Moreover, integrating a separate ESP8266 with Arduino is challenging since a slight

inconsistency in voltage can burn the module. Our proposed system requires continuous data transmission, therefore, this type of vulnerability is not acceptable at all. Considering the simplicity of the design and cost of the system, we have chosen Node MCU in lieu of traditional micro-controller unit.

1. RTC ds 1307 real-time clock chip

Every digital clock has a clock chip. When power fails, this chip memorizes the time and restores the correct time when power is on. The chip requires a 3V battery to maintain its internal functionality keeping away from the main power source**.**

B. Input Module

We have designed a web interface for giving input for *Jammat* time of five times prayer daily. According to our investigation, we have found that all mosques use at least 12 times. Five times stand for the *Owakt* time (prayer time starting time) including two times for sunrise and sunset. The rest five times stand for *Jammat* time which is actually the prayer conducting time when all people call their prayer together. These times differ from mosque to mosque according to their convenience. Therefore, the attendant of a corresponding mosque needs to set these times manually. According to our survey, the responsible attendants considered it as a tiring work since they need to engage with digital clock or traditional dialed clock manually. They prefer a smarter way indeed. Therefore, we have employed a simple web interface by which they can update their clock at any time without being engaged with the clock manually. The web interface is not a mobile application indeed, therefore they do not require an extra mobile application. We will discuss the detailed functionality later.

C. Display Module

A digital clock is generally made with seven segment display. Power consumption rate of seven segment display is low and the illumination rate is better than any other display system such as the LCD based display or dot matrix. One segment display consists of seven separate LED and requires 2.5V ~ 3.5V to illuminate those LED. Voltage regulation within 5V definitely enhances the brightness at an expected level. We need to consider brightness as an important factor for good visibility since these clocks must be visible to all people in the mosque. An array of seven segment display has been employed for displaying these times. Our design includes hour and minute for displaying one time. Therefore, displaying one time we require four 7 segment display, as a result, for 12 times we require 12 * 4 = 48 seven segment display. It becomes a tricky part of our design for illuminating all these displays simultaneously with low power consumption with a trade-off with expected brightness.

1. Displaying a character in seven segment display

A character is fragmented into several frames and in case of seven segment display for displaying a digit we need to illuminate the seven segments at a time. After illuminating one digit we need to illuminate the next one and so on. However, the sequence of illumination must be operated within 0.1 second which is the human perception of vision. As a result, it seems that all displays illuminate simultaneously.

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2. Power, registers, and IC

We have used shift registers (74HC595) for shifting the character frame from one LED to another instead of traditional MUX to make our circuit more robust and cheap. We used 5 V power supply to meet up the power demand of displays.

VI PROPOSED METHODOLOGY

In this section, we describe the interfacing process of all these above-mentioned components. Our survey indicates that each mosque maintains at least 12 times along with a normal clock. An attendant needs to update these times manually regularly. According to our investigation, *Owakt* time is fixed for all mosque and *Jammat* time differs from mosque to mosque. Therefore, we have planned to integrate the following features into our system.

- We have incorporated *Owakt* time of five times prayer along with sunrise and sunset time for one year into the Node MCU ROM. Therefore, the attendant of the mosque need not update the *Owakt* time daily. Our system reads from Node MCU's ROM and updates every 24 hours.
- Since the *Jammat* time differs from mosque to mosque, we have designed a simple web page for giving input to the clock. The clocks are connected to the mosque network and by knowing the address of the network an attendant can update through the web interface without the physical engagement with the clock.

A. Owakt Time Management

We have collected a calendar of *Owakt* times. This calendar provides one-year data of *Owakt* time along with sunrise and sunset every day. Each day has five *Owakt* times

along with two additional sunrise and sunset time. Therefore, in total

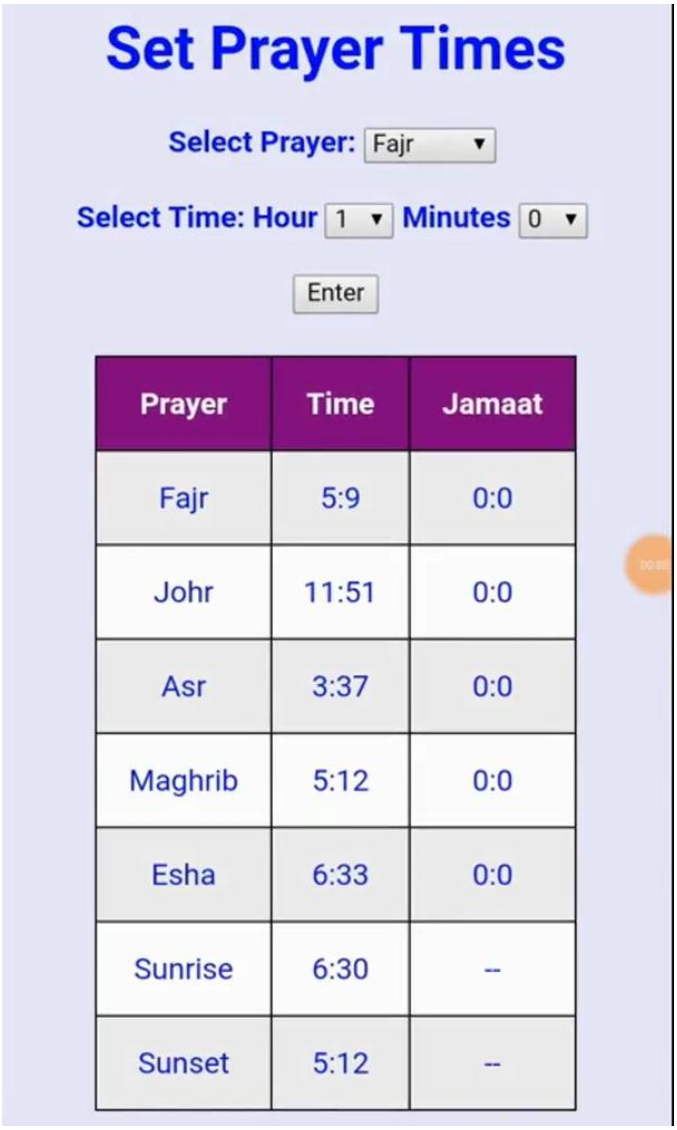

Fig. 2: Web interface for *Jammat* time input

7 * 365 = 2555 need to be injected into the Node MCU's ROM. Node MCU's flash memory is about 4 MB, so we can easily inject those data into the memory. The data are arrays of character or string format. Clocks dedicated for *Owakt* time update these times every day by reading data from Node MCU's flash memory. The data read from the memory are displayed into the clock which is nothing but an array of seven segment display.

A. *Jammat Time Management*

All mosque do not maintain the same *Jammat* time five times a day. *Jammat* time management requires some manual input from the attendant according to the convenient time of the corresponding mosque. We designed a web interface for taking input for *Jammat* time from the attendant of the mosque. Node MCU provides an excellent feature for this. It creates a local network and we just need to know the corresponding IP address for connecting with the network from the web interface. In this system, data is received from the web interface to Node MCU and data is sent to an array of a seven-segment display from Node MCU. The whole data transmission process is handled by the integrated ESP8266. Fig. 2 indicates web interface for *Jammat* time. A video figure is given in the link demonstrates how the system works. https://youtu.be/Wvu3Wlt1V9g.

B. *Algorithm*

Algorithm 1**: *Owakt Time Read From Flash Memory*:**

1. Power on the system with an external 5V power source.
2. Integrated ESP8266 connects with the corresponding local network (mosque network)
3. RTC checks for current date
4. Node MCU read data from flash memory with current date
5. ***while*** Current date is unchanged:
   Prayer schedule *Owakt* time is shown in seven segment display.
6. End ***while***

Algorithm 2***: Jammat Time Input from Web Interface:***

1. Power on the system with an external 5V power source.
2. Integrated ESP8266 connects with the corresponding local network (mosque network)
3. Wi-Fi module waits for an update request *Jammat* time update request
4. ***if*** the update request is received:
   Corresponding *Jammat* times are updated.
5. End ***if***

VII FUTURE WORK

The responsible authority of any particular mosque can update the *Jammat* time through the web interface without any manual intervention with clock. An attendant just needs to be at the local network of the mosque and he does not need an extra application for this. In the future, we plan to widen the scope of the feature. We plan to add a gateway so that an attendant can update the time from anywhere of the country**.** Moreover, we plan to scale up our deployment to some other mosques also. It is yet to be investigated that, how the technology is accepted in case of small mosques.

VIII CONCLUSION

Techno-religious practice is a new concept and draws the attention of researchers from different disciplines. Providing better user experience in practicing religious norms and culture is the principal goal of the technology designer. Moreover, researchers want to find the perception of a user or the responsible authority of religious organizations about different ICT solutions in spiritual practices. In this study, we have designed and developed a low-cost IoT based smart prayer time management system for Muslim prayer. *Salat* is one of the fundamental pillars of Islam and Muslim perform *Salat* five times a day. Muslim prayer time is dependent on sunrise and sunset time in a day, therefore, time varies from place to place. According to our investigation, we have found out every mosque actually maintains two times:- *Owakt* and *Jammat* time. *Owakt* time is fixed, however, *Jammat* time is different for all mosques in a territory. We plan to incorporate two features in our system. Our system can be with any type of seven segments digital clock according to our investigation and opinions from mosque authority. The first feature is *Owakt* time management, in which, by integrating the system an attendant need not manually update the time. The system checks the current time and updates the *Owakt* time from its flash memory. The second one is the *Jammat* time management where an attendant of the mosque can update the *Jammat* time with a web interface without any manual intervention with the clock. The web interface is not a mobile application rather the attendant just needs to know the corresponding local (mosque) network address and password to access the page and update the time without physically present at the clock. Moreover, the features remove the overhead of installing an extra application in a mobile device and the feature is accessible from any type of device. We plan to scale our deployment and add a gateway so that the attendant can update the clock from any part of the country.

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