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# Development of a Compact and Accurate Auto-Update Digital Clock with Real-Time Location Display using Organic Light Emitting Diode and Crystal Oscillator

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**ABSTRACT:** Research has been going on for a lengthy time on digital clocks but with restraints to auto-updating based totally on location. The objective of the paper is to produce a portable and accurate auto-update digital watch (clock) that shows the real time and the current location of the user with the aid of crystal oscillator to generate clock pulses which interfaced with the GPS modules with *organic light-emitting diode* (OELD). The system was able to automatically update the co-ordinate of locations whenever the user moves from one place to another, It also auto-update time whenever the battery is removed and reinserted or when switched OFF and then switch ON after sometime. It also eliminate the stretch associated with time adjustment whenever the battery is down and replaced or when the watch is switched OFF and then ON. It performed satisfactorily and as a result, the system can be adapted and integrated to the new technology of modern watch as it can be adopted by the user to locate his/her position at any point in time.

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Over the years, human beings have been inventing devices to make life comfortable. One of the oldest human inventions is the clock. It is used to measure, keep, and indicate time (Yarlagadda, 2018). Clock measures intervals of time shorter than the year, month, or day. Over time, gadgets running on distinctive physical procedures have been used to measure time. Climate conditions improved with the aid of the moon, the sun, and the rain had been adopted as means of measurement in the early days (Kom *et al*., 2022). Development in clocks has experienced different ranges of evolution and advancement. These range from the discovery of the sundial, the water clock, the pendulum clock, the mechanical clock, and the spring-driven clock to the digital clock and of lately the atomic clock (Davies, 2022). A clock with a digital time base that typically operates on frequency pulses is known as a digital clock (usually 1Hz) (Perotoni *et al*., 2022). As microchip LEDs were inexpensive, digital timepieces became ubiquitous. It was a significant revolution in the watch industry because it produced timepieces at a lower cost and with greater precision than those built using mechanical processes (Kavtaradze, 2022). Although it is customary to believe that such categorization may be based on the driving mechanism. However, if a digital clock and an analog clock both use the same time update mechanism requiring movement to the clock's location and physical contact with it (or, in certain situations, opening it - to update the time - then they might not be that distinct from one another) (Antonova *et al*., 2022). Over time, digital clocks powered by microcontrollers have taken the role of mechanical and electromechanical clocks, offering additional benefits such as portability, zero maintenance, lower cost, great dependability, etc. (Tun, 2008). To maintain a steady and regular interval, clocks must either use the associated power's

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frequency (often 50 or 60Hz) or a separate crystal oscillator(Jain et al., 2021).The study of timekeeping is called horology (Allehabi *et al*., 2022). More often than not, the need to automatically update the time displayed on a clock arises as a result of factors such as vibrations, electrical transients, and so on, which can distort the workings and displacement of electronic components, affecting the accuracy of the time. Automatic updating the time reduces the risk of accidental falls, manhandling, and so on, while also incorporating user-friendliness and the overall design (Idiaghe *et al.*, 2020).Pan Thu Tun of the World Academy of Science and Technology's Department of Electronics Engineering created and implemented a microcontroller-based digital clock.

The project was built with a PIC16F77A and its application software was written in C, the input frequency was taken from a 50 Hz clock frequency circuit, and a 7-segment display and four LEDs were used. The study concentrates on time but did not display the date and does not auto-update (Tun, 2008). Arefin *et al.*, (2004) proposed a digital Bengali clock and calendar based on a microcontroller and an LCD. The project's goal was to create a digital clock that displays the time and date in Bangla numerals. The authors used an Atmel 8051 microcontroller, an LCD, and a 7-segment display in their design to display time and calendar in Bengali. However, the project was unable to auto-update and when there is a power outage, it does not have a backup power supply (Arefin *et al*., 2004). In addition, Sarker *et al*., (20120 created a microcontroller-based digital clock in 2012. To measure and display the time and date, the authors used an ATMEGA 32 microcontroller, a crystal oscillator, and a seven-segment display, the time is measured by the crystal oscillator and sent to the microcontroller and the microcontroller sends the time to the seven-segment display.

The project used LED, which uses less power than LCD and another limitation is that it cannot auto-update. A 12/24 Hours Digital Clock with Stop Watch and Date Indicator was once designed, simulated, and carried out utilizing G.S.M. Galadanci and Gana in 2014. In this project, a synchronous counter, fundamental logic gates, and a seven-segment display have been used in the layout to show time and date. Synchronous counter and the logic gates were used to measure time and the result was then confirmed on the seven-segment display (Version *et al*., 2014).

The task had low accuracy (0.3%) and it used to be manually operated. With the advancements in digital clock design thus far, it has become necessary to incorporate a location-based method of updating. Hence, the objective of this work is to produce a compact and accurate auto-update digital watch that shows the real time and the current location of the user with the aid of crystal oscillator to generate clock pulses which interfaced the GPS modules with *organic light-emitting diode* (OLED).

## MATERIALS AND METHOD

Hardware Components: The hardware consists of the power supply unit, Arduino microcontroller module, GPS module, and OLED display unit. Figure 1 shows the block diagram of the auto-update digital watch based locationsystem.

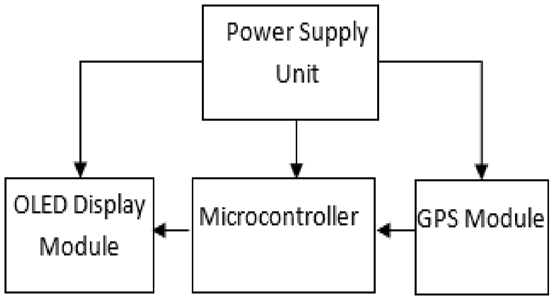


**Fig 1**: Block Diagram of the Auto-update Digital Watch Based Location System

OLED Display Module: A 0.96 in, 64 X 128 OLED display is used in this research work. It has a high resolution of 128by64 pixels, a viewing angle of 160 degrees, a low power consumption rate of about 0.06W, a DC power supply range of 3V-5V, and a working temperature range of -30 to 70 degrees Celsius, and a size of 27.8 x 27.3 x 4.3 mm.

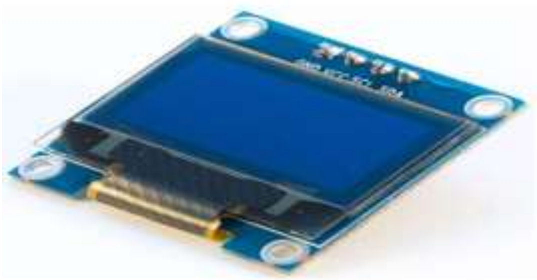

**Fig 2:** Picture of the 0.96 in, 64 X 128 OLED Display Module

Figure 2 shows the picture of the0.96 in, 64 X 128 OLED Display Module. GPS Module: A Neo-6M GPS module is used in this research work. It is of a low cost, portability, and a short time to hot restart. It has approximately 50 channels that communicate with GPS L1 frequency, C/A Code, and a time to first fix of approximately 27 seconds for cold start and 1 second for the hot start. It also has a navigation update rate of 5Hz, an accuracy of 30ns, a 3.6v- 5v dc power supply, and a DC of 10-35mA.

Figure 3 shows the picture of theNeo-6M GPS.

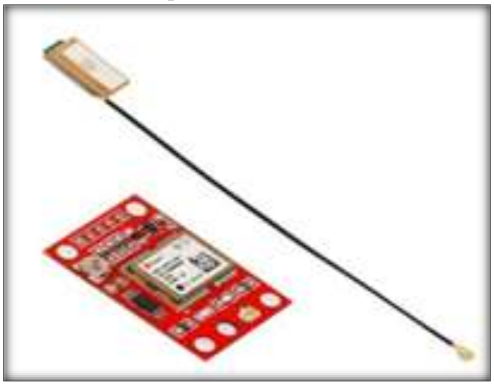

**Fig 3**: Picture of theNeo-6M GPS

Microcontroller Module: The microcontroller employed is Arduino Nano A000005, it is a small compatible, bendy and breadboard friendly Microcontroller board, developed by using Arduino.cc in Italy, based on ATmega328p. It small size, allows it to be easily integrated into portable projects such as a digital clock. It has each analog and digital ports and consists of both a bodily programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on the pc that is implemented in C programming language.

Figure 4 shows the picture of the Arduino Uno A000005. Power Supply Unit: Figure 5 shows the circuit diagram of the power supply unit. It consists of a 12 V dc battery (B1), LM7805 voltage regulator (U1). Capacitors C1 and C2 were chosen from the datasheet of the voltage regulator LM7805 to be 0.1 F and 100 F, respectively.

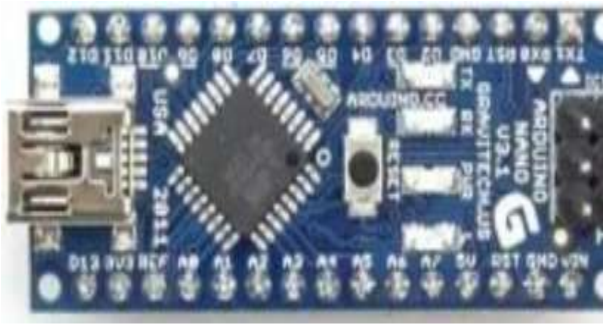

**Fig 4**: Picture of the Arduino NanoA000005

Software: Arduino IDE was used to provide the software program development tools for the Arduino Nano A000005 microcontroller, write, debug and simulate embedded C-programming language. Figure 6and 7shows the flowchart and the circuit diagram of the operation of the auto-update digital watch system respectively.

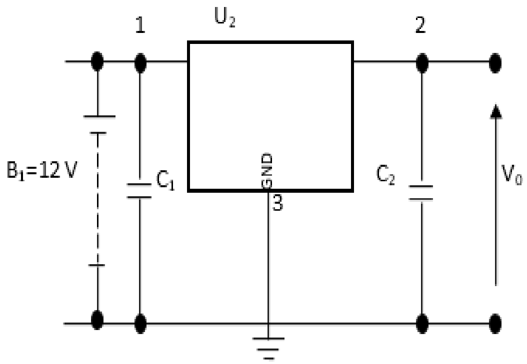


**Fig 5:** Circuit Diagram of the Power Supply Unit

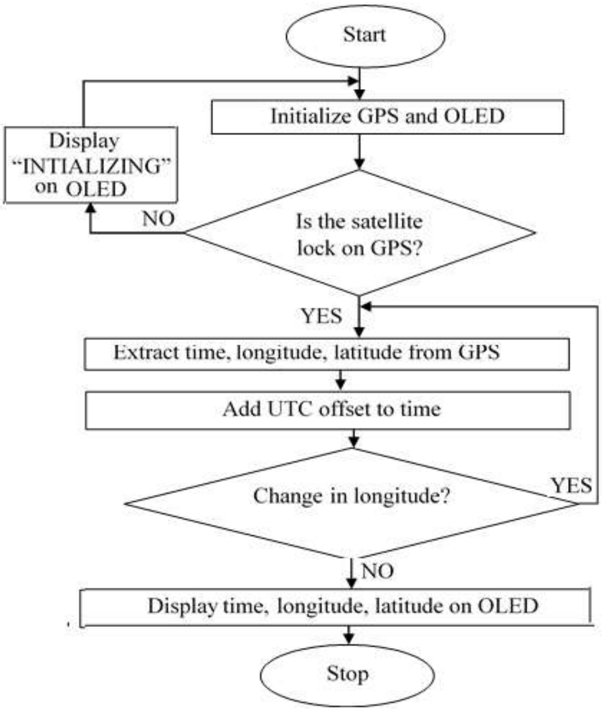


**Fig 6:** Flowchart of the Auto-update Digital based watch system

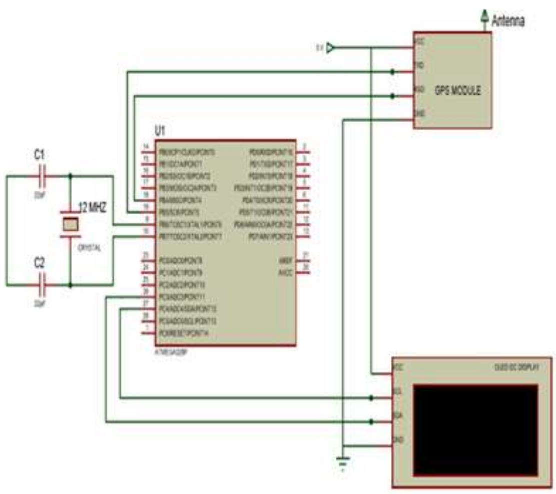


**Fig 7:** Circuit Diagram of the Auto-update Digital based watch system

Hardware Implementation: The step taken in hardware implementation involves arrangement of the modules/components on a breadboard (Figure 8) and arrangement/connections/soldering of the modules/components on a Vero Board (Figure 9).The system casing was specifically selected to factor in the issue of convenience as well as ruggedness. Figure 10 shows the picture of the system casing.

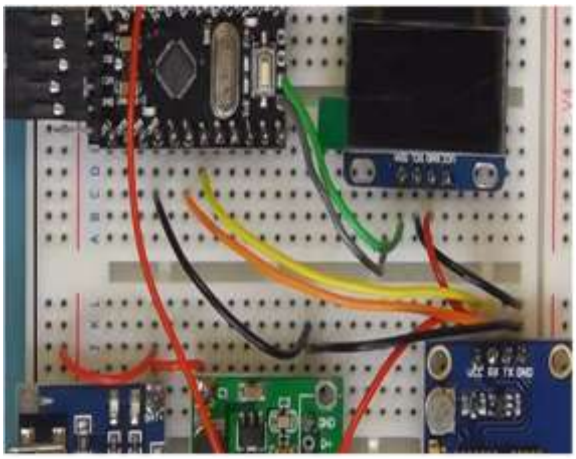

**Fig 8:** The Arrangement of the System Modules/Components on a Breadboard

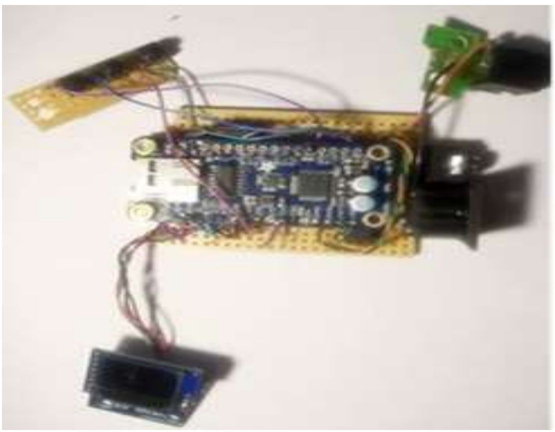

**Fig 9:** The Arrangement/Connections/Soldering of the Modules/Components on a Vero Board

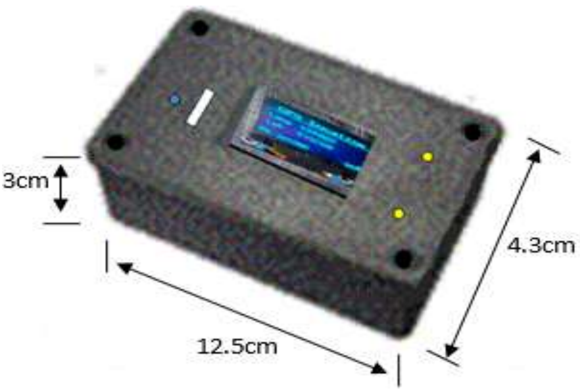


**Fig 10:** The Picture of the System Casing.

## RESULTS AND DISCUSSION

Two tests were carried out on the developed digital watch to confirm the level of its performance. The tests carried out includes: Time comparison test and location comparison test. Time comparison tests were carried out by putting the developed digital watch and a standard clock side by side and the time indicated on each of them was recorded for a period of twelve weeks. The location comparison tests were also carried out by comparing the location co-ordinates displayed on the developed digital based location watch with that on a standard GPS (Garmin-nuvi 40GPS) for ten different locations. Figure 9 and 10 shows the display of the location co-ordinate on the developed digital based location system at one of the test location and on the standard GPS (Garmin-nuvi 40GPS) at the same location and time as that of Figure 9 respectively, while Figure 11 and 12 shows the display of the local time on the developed digital based location system at one of the test location and on the standard clock at the same location and time as that of Figure 11 respectively. The result of the tests is as shown in Table 1 and Table 2. As it can be seen from Table 1, there is no disparity between the times indicated on the developed digital watch and on the standard clock. Also, Table 2 shows that the developed digital watch is in conformity with the standard GPS (Garmin-nuvi 40GPS).


**Fig 9:** The Display of the Location Co-ordinate on Developed Digital Based Location System at One of the Test Location


**Fig 10**: Standard GPS (Garmin-nuvi 40GPS) Location co-ordinate at the Same Location and as Time as that of Figure 9.


**Fig 11:** The Display of the Local Time on the Developed Digital Based Location System at one of the Test Location

**Fig 12**: Standard Clock Time at the Same Location and as Time as that of Figure 11.

*Conclusion:* An auto-update digital watch based location system that automatically updates the co-ordinate of location whenever the user changes location was developed. It also auto-update time whenever the battery is removed and reinserted or when switched OFF and later switch ON. It also eliminate the stress associated with time adjustment whenever the battery is down and replaced or when the watch is switched OFF and then ON It performed satisfactorily; as a result, the system can be adapted and integrated to the new technology of modern watch

**Table 1**: Time Comparison Tests

| Week No. | Standard clock Time | Test watch Time | Difference in Time(sec) |
|---|---|---|---|
| 1 | 13:38:00 | 13:58:00 | 0 |
| 2 | 13:58:00 | 13:58:00 | 0 |
| 3 | 13:58:00 | 13:58:00 | 0 |
| 4 | 13:58:00 | 13:58:00 | 0 |
| 5 | 13:58:00 | 13:58:00 | 0 |
| 6 | 13:58:00 | 13:58:00 | 0 |
| 7 | 13:58:00 | 13:58:00 | 0 |
| 8 | 13:58:00 | 13:58:00 | 0 |
| 9 | 13:58:00 | 13:58:00 | 0 |
| 10 | 13:58:00 | 13:58:00 | 0 |
| 11 | 13:58:00 | 13:58:00 | 0 |
| 12 | 13:58:00 | 13:58:00 | 0 |

*Conclusion:* An auto-update digital watch based location system that automatically updates the co-ordinate of location whenever the user changes location was developed. It also auto-update time whenever the battery is removed and reinserted or when switched OFF and later switch ON. It also eliminate the stress associated with time adjustment whenever the battery is down and replaced or when the watch is switched OFF and then ON It performed satisfactorily; as a result, the system can be adapted and integrated to the new technology of modern watch.

**Table 2**: Locations Comparison Tests

| Week No. | Standard GPS Location Co-ordinate | | | Test watch Location Co-ordinate | | |
|---|---|---|---|---|---|---|
| | Latitude (Degree) | Longitude (Degree) | Elevation (m) | Latitude (Degree) | Longitude (Degree) | Elevation (m) |
| 1 | N 08.49251 | E004.59482 | 349 | 8.492508 | 4.594822 | 349 |
| 2 | N 08.46873 | E004.52815 | 340 | 8.468731 | 4.528150 | 340 |
| 3 | N 08.48239 | E004.66772 | 343 | 8.482392 | 4.667721 | 343 |
| 4 | N 08.48792 | E004.56598 | 304 | 8.487922 | 4.565980 | 304 |
| 5 | N 08.48369 | E004.60481 | 345 | 8.483693 | 4.604812 | 345 |
| 6 | N 08.49056 | E004.55156 | 290 | 8.490560 | 4.551561 | 290 |
| 7 | N 08.45870 | E004.57254 | 325 | 8.458701 | 4.572543 | 325 |
| 8 | N 08.48196 | E004.54606 | 319 | 8.481962 | 4.546063 | 319 |
| 9 | N 08.48157 | E004.57423 | 331 | 8.481573 | 4.574232 | 331 |
| 10 | N 08.51171 | E004.51351 | 301 | 8.511713 | 4.513513 | 301 |

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