Watch 360: Advanced Digital Watch for Mountaineers

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Abstract— Now a days people prefer digital clocks more than an analog clock because of their elegant outlook, inexpensiveness, small size and accuracy. As a result many smart digital clocks are manufactured by different popular companies. Because of its low price and tiny size, it is often incorporated into all kinds of devices such as cars, radios, televisions, microwave ovens, standard ovens, computers and cell phones to enhance the quality of that device. Our project 'Watch 360' is an attempt to try giving possible workings on the single microcontroller which can be useful for us. Arduino as a microcontroller helps to fulfil the requirements of the smart device i.e the ability of a device to perform many tasks at same instant. The project is meant to approach the advancement of the existing technology regarding the smartwatch. Moreover, Watch 360 is equipped with MPU6050 gyro sensor to get inclination angles of watch. Depending on this inclinations made by the device, various events will be triggered like reading and showing the temperature, pressure, humidity or displaying actual time on LCD screen. For interacting with this watch user have to just move watch by some angle to any direction, which makes it simpler.

Key words: Watch 360, MPU6050, LCD Display

I. INTRODUCTION

The technology today is getting smaller in size and advanced in ideas. The use of technology is not limited only for single purpose rather; it can be moulded as per our requirements. Using the device that can perform multiple tasks is the need of the world. The examples of such devices are mobiles, laptops, and many more. Arduino is an open source computer hardware and software company and user community that designs and manufactures single board microcontroller. The most simple and yet cutting edge controller is atmega328p [1]. A real-time clock (RTC) DS1307 is used to keep track of the current time. Although the term often refers to the devices in personal computers, servers and embedded systems, RTCs are present in almost any electronic device which needs to keep accurate time [2] for precise work to be maintained. Atmega328p uses I2C protocol to communicate with Real time clock DS1307 for getting current date and time which will be displayed on 16*2 LCD screen. This serves basic working of a digital clock. Now along with this we have added multiple features for the purpose of helping mountaineers such as air pressure, temperature and air humidity. Depending on requirements, these sensors will be activated and sensor data will be displayed on LCD screen. These sensors communicate with the help of different protocols, like DHT11 sensor from D-Robotics Company is used for getting temperature and humidity data. It is interfaced with help of single line communication.

Along with this, we have used BMP180 for getting accurate pressure reading. BMP180 also uses I2C protocol for communicating with atmega328p. To make this clock more interactive, we have added gyro sensor from MPU6050. The MPU-6050 features three 16-bit analog-to-digital converters (ADCs) for digitizing the gyroscope outputs.

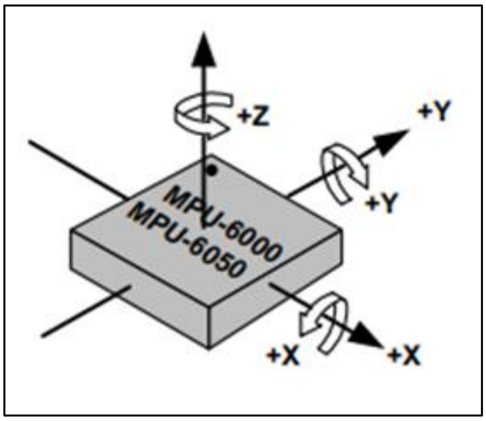

Fig. 1: Orientation of Axes of Sensitivity and Polarity of Rotation [3]

Above figure shows orientation of axis that can be calculated with the help of MPU6050. These data then will be then converted into angles (0 to 180 degree) and actual inclination can be calculated. Depending upon these angles, respective sensors are turned on and data will be displayed on LCD screen. This is why, project is called as Watch360. Because of this, interaction with clock becomes easier as user just have to tilt the watch in the direction depending on data which needs to be displayed.

II. HARDWARE ARCHITECTURE

The implemented system consists of a microcontroller (atmega328p) as a main controller for the entire system and all the sensor and devices are connected with the microcontroller through I2C and analog pins. Following figure shows block diagram of Watch 360 project.

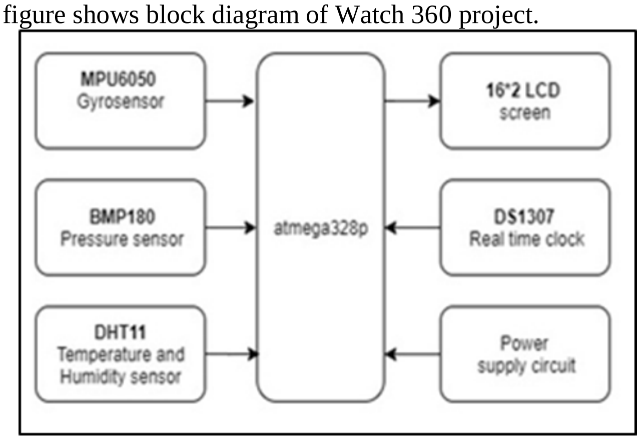

Fig. 2: Block diagram of Watch 360

A. Atmega328p

Atmega328p is a low-power CMOS 8-bit microcontroller based on the AVR® enhanced RISC architecture. The ATmega328/P provides the following features: 32Kbytes of In-System Programmable Flash with Read-While-Write capabilities, 1Kbytes EEPROM, 2Kbytes SRAM, 23 general purpose I/O lines, 32 general purpose working registers, Real Time Counter, three flexible Timer/Counters with compare modes and PWM, 1 serial programmable USARTs , 1 byte-oriented 2-wire Serial Interface (I2C), a 6- channel 10-bit ADC, a programmable Watchdog Timer with internal Oscillator, an SPI serial port, and six software selectable power saving modes [4].

B. Real Time Clock DS1307

The DS1307 serial real-time clock (RTC) is a low power, full binary-coded decimal (BCD) clock/calendar, which uses I2C for transferring data. It consumes less than 500nA in Battery Backup Mode with Oscillator Running and Automatic Power-Fail Detect and Switch Circuitry helps to work for longer time [5]. The DS1307 is capable to count accurately the second, minute, hour, day of the week, date of the month, month and year include the leap year until the year 2100; with its I2C interface capabilities make this chip easily to be integrated with widely available microcontrollers that have built in I2C peripheral [6].

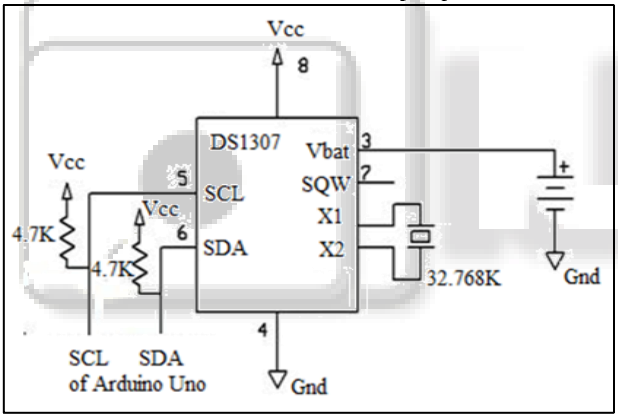

Fig. 3: Real time clock DS1307 pinout and general connection diagram

C. I2C Protocol

I2C is a serial data bus protocol that allows multiple devices to connect to each other with fairly slow data transfer rates for better collaboration [7]. Many microcontrollers have libraries to support I2C. The I2C bus use only 2 bidirectional data lines for communicating with the microcontroller. The I2C protocol use master and slave method, the master which is usually the microcontroller while the slave can be any I2C device such as Real Time Clock DS1307. I2C communication requires two ports, one for the serial data called SDA (serial data) to communicate with SCK pin of PIC IC and the other for synchronize clock called SCL (serial clock) to communicate with SDI pin of PIC IC.

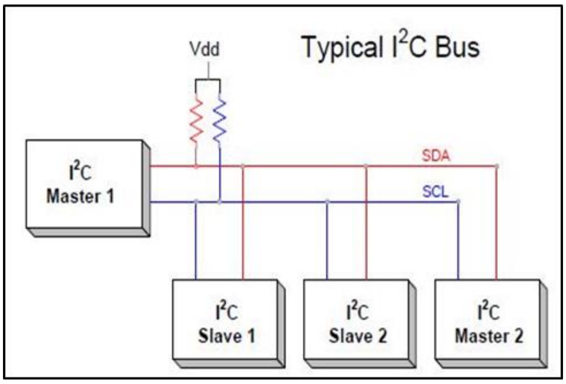

Fig. 4: Typical I2C bus hardware connection overview [8]

D. MPU6050

The MPU-6050 is integrated with 6-axis motion tracking device that combines a 3-axis gyroscope, 3-axis accelerometer, and a Digital Motion Processor. The MPU-6050 features three 16-bit analog-to-digital converters (ADCs) for digitizing the gyroscope outputs and three 16-bit ADCs for digitizing the accelerometer outputs. For precision tracking of both fast and slow motions, the parts feature a user-programmable gyroscope full-scale range of ±250, ±500, ±1000, and ±2000°/sec (dps) and a user-programmable accelerometer full-scale range of ±2g, ±4g, ±8g, and ±16g. Communication with all registers of the device is performed using I2C at 400 kHz [9].

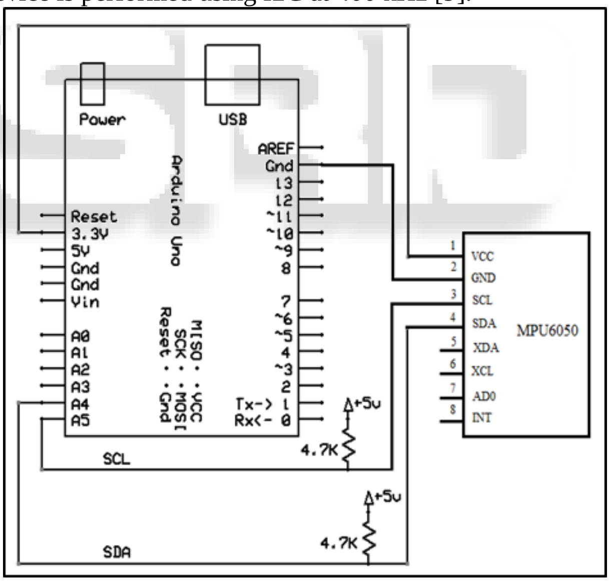

Fig. 5: Connection diagram of MPU6050 with atmea328p

E. BMP180

The BMP180 consists of a piezo-resistive sensor, an analog to digital converter and a control unit with E2PROM and a serial I2C interface. The BMP180 delivers the uncompensated value of pressure and temperature. The E2PROM has stored 176 bit of individual calibration data. This is used to compensate offset, temperature dependence and other parameters of the sensor. With a low altitude noise of merely 0.25m at fast conversion time, the BMP180 offers superior performance. The I2C (Inter Integrated Circuit) interface allows for easy system integration with a microcontroller [10]. The BMP180 is based on piezo-resistive technology for EMC robustness, high accuracy and linearity as well as long term stability. The BMP180 is designed to be connected directly to a microcontroller of an embedded system via the I2C bus. The BMP180 consists of a piezo-resistive sensor, an analog to digital converter and a control unit with E2PROM and a serial I2C interface. The operating pressure and temperature range of BMP180 is 300hPa to 1100hPa and 0 to 850C.The operating voltage of the sensor is 3.3V.

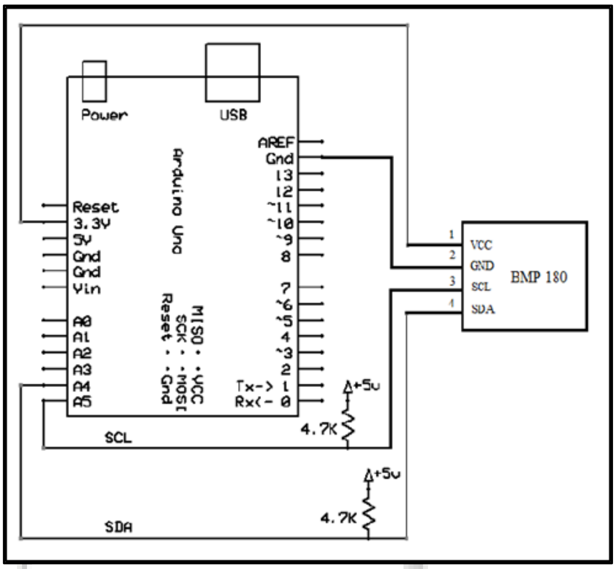

Fig. 6: Connection diagram of BMP180with atmega328p

F. DHT11

This DHT11 sensor features a temperature & humidity complex sensor with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability [11]. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, and anti-interference ability. Single-bus data format is used for communication and synchronization between MCU and DHT11 sensor. When MCU sends a start signal, DHT11 changes from the low-power-consumption mode to the running-mode, waiting for MCU completing the start signal. Once it is completed, DHT11 sends a response signal of 40-bit data that include the relative humidity and temperature information to MCU. When DHT is sending data to MCU, every bit of data begins with the 50us low-voltage-level and the length of the following high-voltage-level signal determines whether data bit is "0" or "1" [12]. On controller side, this is detected by taking multiple samples of input pin. Then it determines time intervals of input data and distinguish between digital high and low inputs.

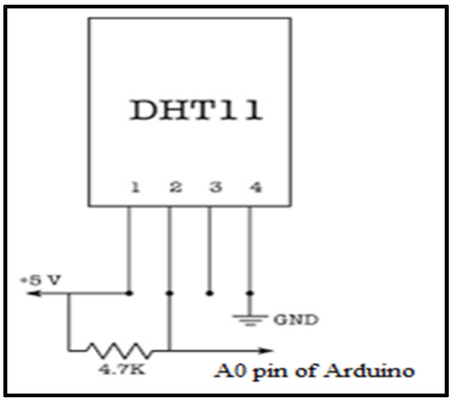

Fig. 7: General layout of DHT11

III. SOFTWARE ARCHITECTURE

Complete sensors are controlled through 8 bit atmega328p based Arduino uno. I2C protocol is used for communicating with BMP180, DS1307 and MPU6050, which helps data communication on much faster rate. Watch 360 is built for helping mountaineers with all data they need. When watch is powered on first time, it calibrates gyro sensor by taking multiple readings from MPU6050 and stores average of reading for further manipulations. This can be easily seen when Watch 360 is powered on first time.

Fig. 8: Actual output taken from Watch360 while Gyro-sensor calibration

Above image is taken from actual hardware, which is showing calibration of gyro-sensor. After calibrating gyro reference data, LCD screen is powered off through transistor and it remains off whenever watch is horizontally levelled, thus helps in maintaining low power consumption. Now with reference to figure [10], if watch is moved by 25 degree in backward direction, microcontroller starts communicating with DS1307 for getting exact date and time. After getting data 16*2 LCD screen will be turned on and current time will be showed on screen [13].

When watch is retrieved to original position, LCD screen will be turned off. Similarly when watch is moved towards front by 25 degree, atmega328p communicates with DHT11 and gets actual humidity data and shows it on LCD screen. When watch is moved further by 50 degree, controller stops getting data from DHT11 and turns off LCD screen.

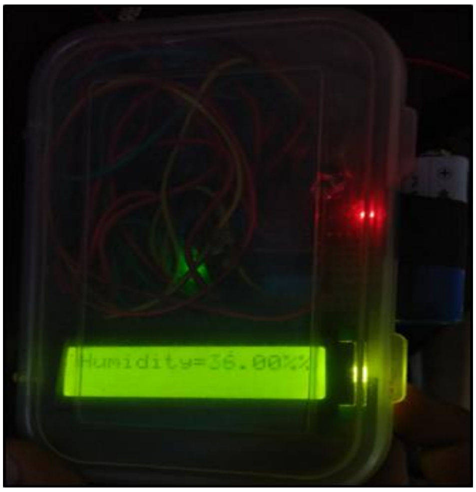

Fig. 9: Actual output taken from Watch360 while displaying Humidity

Above image shows actual photograph of Watch360 product, displaying humidity when moved by around 35 towards front. Similarly when watch is moved towards right side, it starts getting temperature data from DHT11 and display it on LCD display and for left side, atmega328p gets deals with BMP180 and displays pressure data on screen. Due to this 360 degree working environment, this watch is named as Watch360. On every 10 mili-seconds atmega328p communicates with MPU6050 through I2C and gets roll angle and pitch angle. Depending on this values atmegs328p decides whether to read sensor data or keep display off. If any angle is in between 25 to 50 degree in any particular direction, it communicates with respective sensor and display data on LCD screen [14].

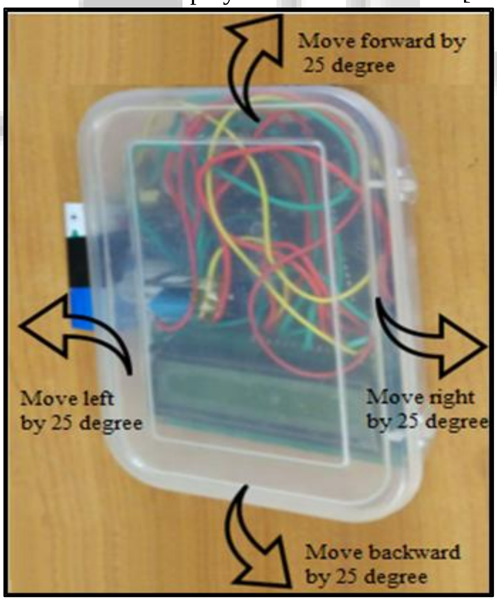

Fig. 10: Actual output taken from Watch360, Showing Direction of. Movement

IV. FLOW CHART

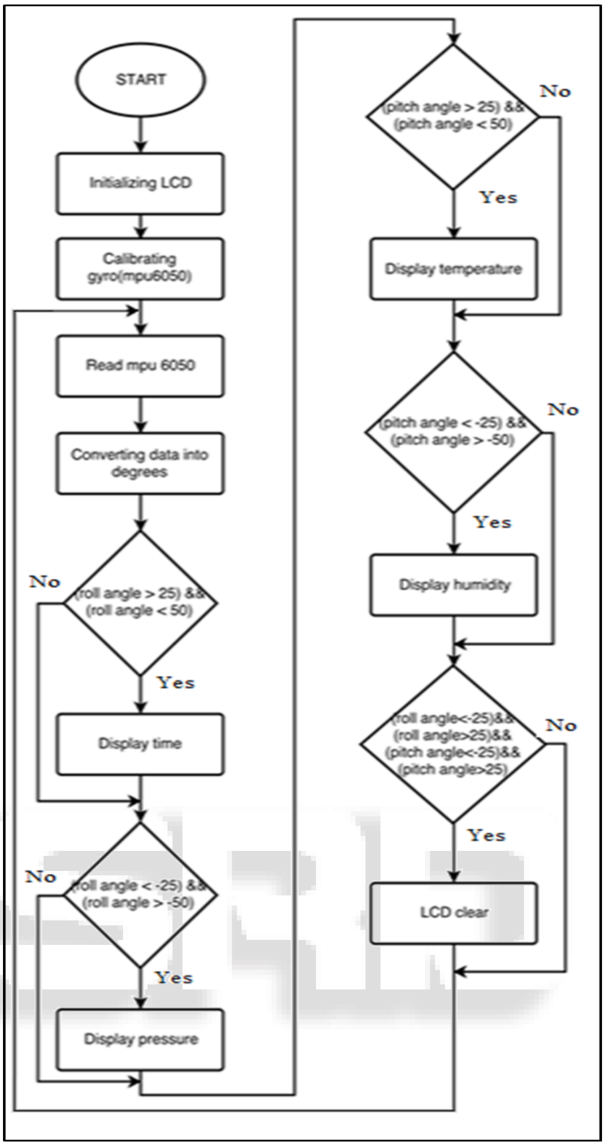

Fig. 11: Flowchart of Watch 360

Above flow chart explains actual working of Watch 360. Initially LCD screen will be initialised and controller starts getting data from MPU6050. This data will be compared with pre stored reference values and actual position of watch is calculated. Now depending upon this, particular sensor will be triggered and sensor data is calculated, which will be displayed on 16*2 LCD screen. The minimum angle (25 degree) and maximum angle (50 degree) are limited.

V. CONCLUSION AND FUTURE WORK

From this system we have achieved our moto of designing a watch, from which we can get temperature, pressure and humidity data along with accurate date and time. Now a days different pattern of digital clocks are available in market. Most of them are of very high price and low quality. Many of those cannot provide the time accurately for longer period as those are designed with timer IC's like 555 timer. Again some digital clocks loss their data whenever the power supply shuts down. But our designed multipurpose digital clock is accurate because of its Real Time Clock module that keeps track of the system time and update. The

DS1307 has a built-in power sense circuit that detects power failures and automatically switches to the 3V Li Cell battery supply which is incorporated with the RTC. Along with this, we have incorporated multiple low cost sensors, which provide accurate data.

There are multiple products in market which serves same purpose, but those are too costly and not work for longer time. Also they are not much reliable. This product is using plug and play sensor, so any sensor can be replaced with new one, in case of if it is not working. So this version of digital clock is really a cheap, precise and well featured device for the present market. Future scope for this is making this more compact and more power efficient, along with adding new sensors to it.

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