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Microcontroller based Autistic Child Monitoring System in Bangladesh

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ABSTRACT

Children with developmental disorders and their families face major challenges in managing the risk to a disabled child, who may be prone to becoming lost away from their own home. Health and Social care system in Bangladesh has not yet developed the capacity and infrastructure to provide safety services to children with ASD (Autistic Spectrum Disorder). There are no nationwide statistics of Autistic Children in Bangladesh. As per the global prevalence rate, 1 percent of the world population has autism. One in 160 children has an ASD. Since there are 55 million children in Bangladesh below age 14, there may be 550,000 autistic children. As the physically challenged child cannot take care of themselves and no one is there who can keep observation 24-hour like whether the child is getting panic, whether the child is on safety zone or changed his position elsewhere, whether he falls, etc. We have to keep them safe as the number of accidents with children is increasing. Our research study proposed the development of a wearable smart device, which can be a belt, wristwatch or locket. The developed device include a Microcontroller (PIC-16F876A), a global positioning system (GPS), global system for mobile (GSM), and switching unit and the monitoring unit includes sensors and mobile device in parent's hand with which parents can find the current location of the child by using Google Map. This device ensures 24-hour monitoring and works as an interface between child and parents for emergency response.

Keywords: Microcontroller: global positioning system; GSM; sensor

INTRODUCTION

Child care is a major problem in the epidemic's resolution. Fathima et al., Jawad et al. and Goel et al. implemented different systems and methods for solving this crisis. Kids with Autism or Sensory disorders need constant monitoring. But in reality, it's not always feasible, when a parent manages multiple kids at a time. A continuous monitoring system for tracking children is the best way to protect them. Nowadays parents are busy with their careers and mobile phones become very smart, easy to access and more generic, it is possible to have a solution based on mobile phones. The proposed child tracking system has a module using GPS (Global Positioning System) and GSM (Global System for Mobile Communication). In this system, the GPS is a radio navigation system used to determine the exact location (longitude and latitude) of a child and to track the child in a particular area. Then, the information of the position will be delivered to the handphone via GSM modem. The GSM modem is programmed to enable two-way communications between the modem and child to determine the child's position. The temperature sensor and vibration sensor are used in the proposed system to be concerned about the body temperature of the autistic child and rescue them after unwanted falling down. The main function of this system is to ensure that the user will be informed or know the child's position whereabouts'. This tracker will place with the child, once the child is out of the specified area, the tracker will be triggered and then send a message to the parent. The tracker can be triggered using a Short Messaging System (SMS) where the parent can communicate remotely to the GSM using a handphone.

Health and Social care system in Bangladesh has not yet developed the capacity and infrastructure to provide safety services to children with ASD (Autistic Spectrum Disorder). There are no nationwide statistics of Autistic Children in Bangladesh. As per the global prevalence rate, 1 percent of the world population has autism (Baio et al.). It is estimated that worldwide one in 160 children has an ASD which represents an average figure and reported prevalence varies across studies (Elsabbagh et al. 2012). Some well-controlled studies have, however, reported higher figures. The prevalence of ASD in many low and middle income countries is so far unknown. Since there are 55 million children in Bangladesh below age 14, there may be 550,000 autistic children in Bangladesh. As the challenged child cannot take care of themselves and no one is there who can keep observation 24-hour like whether the child is getting panic, whether the child is on safety zone or changed his position elsewhere, whether he falls, etc. We have to keep

them safe as the number of accidents with children is increasing.

The design, implementation, and deployment of risk monitoring and tracking system have been a gradual process. Analyzing some paper based on the design and development of a tracking system several key issues are identified. These issues comprise child missing, system cost and sensor integrity. The autistic kids cannot tell their parents about their body conditions. They cannot also call their parents if they fall while walking.

As we have to deal with all the limitations of reality, it is required to determine a method by which we can go on to our goal. After analyzing all limitation, an autistic children risk monitoring system has been designed with a low-cost sensor which provided better output within a considerable distance and output monitoring system was also used in our project which will provide a continuous update about the position of the child and it also ensures the security of the child.

A safety system is always ON, non-intrusive, sensitive and versatile. These features would help ease problems related to common consumer behaviors for busy parents who always performing on the desk. Less than a hundred years ago, the concept of a child monitor was unheard of and less than fifty years ago it was stills a rarity. In the beginning, a parent's best resource for monitoring their children was their watchful eye. After that, another resource for monitoring their children was a tin can on a string. It takes much more time to monitor their babies. Now a day, parents are busy with their professional works. The design and development of a child monitoring system can open a new era in preventing those problems. Various research works have been done on security issues (Nigar & Azim et al. 2018, Nigar et al. 2020). Experiments have been conducted on the child monitoring system since at least the 1900s. LED sound indicators, talk-back features, and other neat bells and whistles have made them more versatile, but overall the basic principles are the same. While wireless monitoring is convenient, parents have become concerned about getting hacked, after a stranger could tap in an outdated system (Fathima et al.).

Children's tracking system is also developed based on mobile ad hoc networks. The system developed in (kakuda et al. 2011) says that in the GPS and tag-based system, each parent cannot get group information on the vicinity of the child. Through field experiments, it is confirmed that, as long as children walked at normal speed on the predetermined way to and back from school, the system could provide location and group information of children to their parents. On children education, Wong et al. studied the influence of classroom instruction, playing road traffic safety cartoon and realistic road traffic scenario safety education on the safety education effect of children in short-term, long-term, and memory effect stability. Nigar et al. 2018 presented a comparative performance evaluation of TCP. Bakar et al. presented the use of courseware using mixed learning environments which combines interactive, multimedia, augmented reality (AR) and Virtual Environment (VE) technologies to educate children and young people about safety knowledge and skills, and help them train traffic habit. In dangerous detect, Cheng et al. present a method of detecting children in the rear of vehicles. Finn et al. propose the design of a car safety seat that offers temporary thermal protection for the occupant. Takata et al. used the object-oriented method for modeling the activity area for children.

Inspired from the above system (Mori et al. 2011) we attempted to develop a prototype which reduces the cost of multiple sensor and complexity of interfacing. Our Proposed system can be implemented as a belt, wristwatch or locket. The developed device include a Microcontroller (PIC-16F876A), a global positioning system (GPS), global system for mobile (GSM), and switching unit and the monitoring unit includes sensors and mobile device in parent's hand with which parents can find the current location of the child by using Google Map. The previous project (Fathima et al., Jawad et al., 2009, Goel, 2015) has done it Arduino and Android-based. Now we have designed this embedded system using a microcontroller.

METHODOLOGY

The proposed model is a Smart Wearable Risk Monitoring and Tracking Device Based on GPS and GSM Technology for Children with Autism. At first, System initialization is done by variable declaration. Then the system module is checked. After that, the GPS module will be on by the command "AT". If it replies yes, then the GPS will be power up. If no, then the module will be checked again. Now the GPS will check the latitude to set the start-up latitude and longitude. If it cannot set, then it will delay for a few seconds to get the GPS data again. Now the location is saved in the memory. Then the current location will be set. For measuring panic, if Pn=1, the LCD shows "Get Panic" and the message will be sent to the parents mobile. Again if the Panic button is pressed just after displaying "Get Panic", then the message sending will be canceled. If Vn=1, then the LCD display shows "Vibration Detected" and the message will be sent to parents mobile if it is not being canceled in 6 sec. Another case is that if the child exceeds a defined location, then GPS will track the current position of the child. Then a signal is given to MCU. After that MCU Processes the signal that is received from GPS and sends the latitude and longitude to display. The display will show "Location Changed". After that latitude and longitude of the device position will be displayed on LCD. Then a message will be sent to the parent's mobile referring to the parameters after 6 seconds., each case will be checked. If any change is detected from these sensors, feedback will be sent to the parent's mobile. The flow chart of the system is shown in Figure 1.

The Autistic child monitoring system block diagram is shown in Figure 2. It can be seen that the GPS module receives the signal from the satellite and sends the received geographical coordinates to the processor, MCU calculates

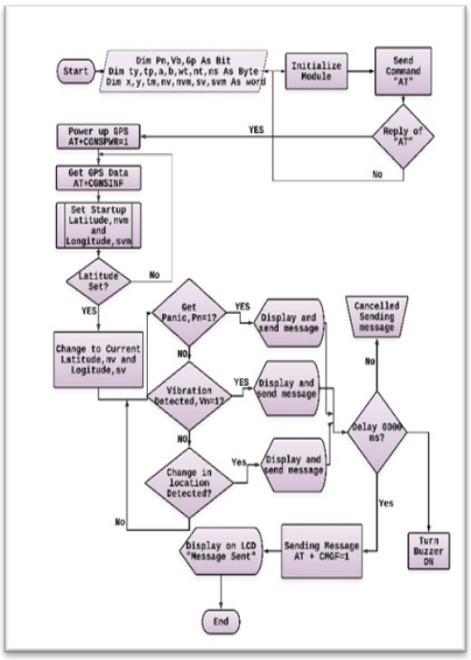


FIGURE 1. Flow chart of the autistic child monitoring system

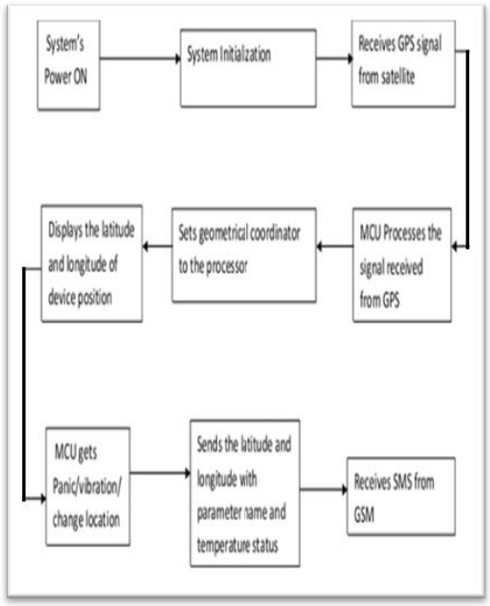


FIGURE 2. Block diagram of the autistic child monitoring system

the distance and the bearing difference between the waypoints and the current child coordinates. The vibration sensor senses the child's vibrations and transmits the signal via the microcontroller. A temperature sensor is used to detect the autistic child's body temperature and sends the information through the microcontroller. Data are processed, the correct information is sent to the mobile of a parent.

HARDWARE INTERFACE

Many components are used in the autistic child risk monitoring and tracking system. Many components are interconnected. The key components are shown in the following interface block diagram in Figure 3. It illustrates the interface of the hardware. Using serial communication, the GPS and GSM Module interface with the MCU. The GPS and GSM module RX and TX pins are connected to the 17 and 18 no MCU pins. When MCU requests data from the GPS module, GPS modules terminate NMEA sentences. These NMEA sentences are processed to achieve latitude and longitude. The GPS and GSM module use serial communication with the MCU.

CIRCUIT DIAGRAM

The autistic child monitoring system circuit diagram is shown in Figure 4. It illustrates that the system comprises Microcontroller (PIC16F876A), Vibration sensor, LCD, Piezo Buzzer, GPS and GSM module. The MCU has a 28-pin extension with 256 bytes of EEPROM data memory, self-programming, an ICD, 2 comparators, five 10-bit A / D converter channels, 2 captures/compare/ PWM functions. GPS and GSM module is connected with 17 and18 pins of MCU. The LCD is connected to both 21 and 22 pins. The LM35 is connected to 2 MCU pins. The flip flop is connected to the 4 and 6 MCU pins.

CIRCUIT OPERATION

The system is initialized in this project with a Vcc supply of five volts. The temperature sensor senses the autistic child's body temperature. When the temperature increases the resistance of the semiconductor, pin 2 receives an analog signal and processes the information in the MCU. The vibration sensor senses the child's body vibration, when the vibration sensor vibrates, the tow pin of the vibration sensor is added and the flip - flop set pin becomes a voltage.

If the RS flip flop receives a high signal from the vibration sensor or panic button, the data is held and processed. Even MCU pins are high for a few ms. MCU pin seven is low most of the time. Pin seven is added with the RS flip - flop reset pin. The information is then sent to the MCU when the RS flip flop pin is high. Because Q is high if the pin is high and the pin reset is low. Tow RS flip flop is used for vibration and panic in this project. Tow Q RS flip - flop pins are added with 4 and 6 no MCU pins. The GPS and GSM modules communicate with the MCU. MCU pins 17 and 18 that are TX and RX are connected to RX and TX of the SIM808 module. The GPS tracks the location of the child and the message is sent via the GSM to the parent's mobile. Also, the LCD shows the stages of the circuit. Pin 25 to 28 are connected to LCD data pin 11 to 14. Rs pins connected to 21 no MCU pin. LCD command

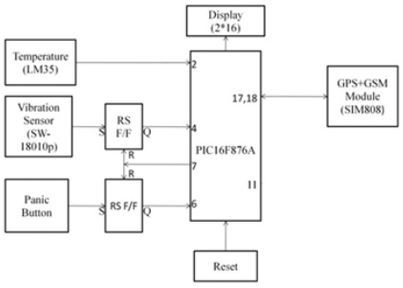


FIGURE 3. Hardware interfacing of autistic child monitoring and tracking system

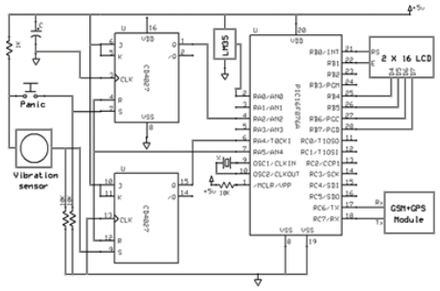


FIGURE 4. Circuit diagram of autistic child monitoring and tracking system

can be given from MCU. The alarm is connected to 11 no MCU pin. When MCU works, we receive this information through this alarm.

RESULT AND DISCUSSION

The project overview is shown in Figure 5. In this unit, the Microcontroller PIC16F876A module a sensor data processor. Temperature sensor LM35 has been used to detect children's body temperature; a vibration sensor has been used to detect an accident. The LCD shows the output used in this system to update the position of the child.

TEST RESULT

The autistic child monitoring and tracking system test results can be got in three ways. One way is to use the vibration sensor, the second way is to use the Panic button and the third way is to consider the location option changed. The test results are given below for the above processes.

VIBRATION SENSOR OUTPUT

Vibration Sensor is effectively just a delicate spring with a sturdy piece of metal in the middle which can work less than 12V. When moved, the spring wobbles around and touches the metal, momentarily making contact. As it draws absolutely no power, it is a very useful little device. When it is static, the switch is open circuit OFF-state. When external force to touch and corresponding vibration, or movement speed achieve adequate (partial) centrifugal force, conductive pick feet will produce instant conductivity which turns it instant ON-state, when external force disappear, switch back to open circuit OFF-state. Normally the two-terminal are insulated by a resistance value more than 10MOhm. When someone applies vibratory force on the switch, spring inside the switch vibrates and makes a momentary short circuit between the two terminals. The vibration sensor output is shown in Figure 6. If an autistic child accidentally falls, this sensor detects the vibration. This detection of the vibration is shown in figure 6 (a). If the vibration is detected, the message is sent to the parent's mobile referring location and the body temperature as a temperature sensor is also used to increase safety. This output is illustrated in Figure 6 (b). After receiving this message, parents can rescue their children from the place.

PANIC BUTTON OUTPUT

The Panic button output has been shown in Figure 7. If an autistic child feels that he/she is in danger. Then he/she press the panic button. The output is shown in Figure 7 (a). The message will then be sent to the parent's mobile reference location and body temperature. The output is shown in Figure 7 (b). After the message is received, parents may reach the place before the danger occurs.

CHANGED LOCATION OUTPUT

We have used SIM808 module which is a complete Quad-Band GSM/GPRS module that combines GPS technology for satellite navigation. The compact design which integrated GPRS and GPS in an SMT package will significantly save both time and costs for customers to develop GPS enabled applications. PIC-16F876A microcontroller is interfaced serially to a GSM/GPRS module. The GPS module outputs many data but in this embedded system, only the NMEA data is read and processed by the microcontroller. The processed data is sent to the parent's mobile through a GSM modem. This GPS based embedded system implements RS-232 protocol for serial communication between the microcontroller, GSM/GPRS module. The parents' mobile number should be included in the source code written for the microcontroller. Thus the mobile number resides in the internal memory of the MCU. The output of the location changed is shown in Figure 8. If an autistic child exceeds the defined location range, the signal ' location changed ' is displayed in the LCD. The output is shown in Figure 8 (a). The message is then sent to parents' mobile. It is shown in Figure 8 (b) regarding the place and body temperature. After receiving this message, the parent can search for his or her child.

From the above experiments, better output from the previous project (Wong et al., 2009) was found as they used RSSI and Bluetooth connection for location identifying, the range for children transmits data are limited only 10 meters. Another tracking system (Saranya et al., 2016) is

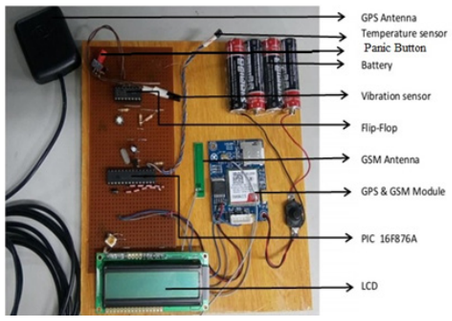
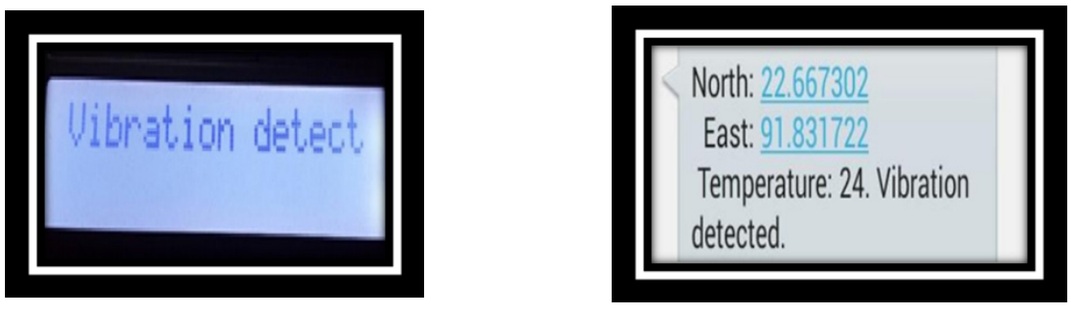


FIGURE 5. Overview of autistic child monitoring and tracking system



a b

FIGURE 6. Condition of Vibration sensor output (a) Detected condition of vibration (b) Sent message in parent's mobile

a b

FIGURE 7. Condition of Panic button output (a) After getting panic (b) Sent message to the parent's mobile

a b

FIGURE 8. Condition of Changed location output (a) shows 'location changed' signal in the display (b) Sent message to the parent's mobile

developed where the message is sent to the parent when the voice playback senses the children cry voice but cannot differentiate between a cry and background vocals. Idachaba proposed a system using a parallax GPS module to track the location of a stolen item, kidnapped and a missing person. When the signal strength is below the threshold value, the system starts to operate which gives low response time. Also, the Location coordinate is less accurate.

CONCLUSION

This embedded system contributes to child safety research by providing a new low-cost solution for this area. Our research study proposed the development of a wearable smart device that can a belt, wristwatch or locket. In this paper, we developed a prototype that offers a high level of autistic child safety and a unique safety technique. The embedded

system has overcome some of the existing aspects of current technologies by using them as tracking technology. An embedded system for autistic child risk monitoring was developed that can track position at any instant. In an unusual situation, an autistic child can press the panic button. It can also detect the children's body temperatures. Parents can easily find the child's current location using Google Maps. We have taken into account the dangerous state of an autistic child could be: missing far away from their parent, falling from bed, bumped, stuck in a locked room, etc. This device ensures 24 hours of monitoring and acts as a child-parent interface for emergency response. The current prototype is designed to provide safety, behavior and activity-related information about the autistic child, but as future work, the system could be made more attractive for children and designed to include certain gaming and social applications alongside safety features. The proposed system is proven to be efficient, reliable and low cost.

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DECLARATION OF COMPETING INTEREST

None.

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