Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 6, Number 2, April 2022
DOI : https://doi.org/10.33395/sinkron.v7i2.11403
e-ISSN : 2541-2019
p-ISSN : 2541-044X

Fall Detection using Sensors on a Smartphone

Budi Priswanto[1)*], Haryono[2)]
[1)2)] Universitas Pradita, Tangerang, Indonesia
Budi.priswanto@student.pradita.ac.id, haryono@pradita.ac.id

Submitted : Apr 22, 2022 | **Accepted** : Apr 25, 2022 | **Published** : April 27, 2022

Abstract: A work accident on a technician causes injury. When doing work, even though the technician is equipped with work safety, there are still factors that can cause accidents intentionally or unintentionally. The development of technology is now more advanced. Now the industrial revolution has reached the era of 4.0. Its progress is accompanied by information technology that is growing very rapidly. Many internets of things devices can already be used in everyday life. In today's life, the use of IoT devices has become a habit of today's modern society. For example, to travel using public transportation, there are many mobile apps that are connected to transportation providers. Including trade, the number of marketplaces has caused the growth of smartphones to be very fast. Smartphones are now equipped with many sensors, ranging from GPS sensors, wi-fi sensors, temperature sensors, and various sensors. Often the technicians in charge of climbing towers or heights are never caught by management or project leaders. Even though this causes losses both losses for technicians and losses for management. Therefore, how to monitor the technicians to be careful in carrying out their duties. Android smartphone devices have many sensors. Sensors in Android are used as a fall detection tool. By using Android sensors, the use of Internet of Thing sensors on smartphones will produce very useful monitoring tools. The use of Flutter framework as a medium for utilizing the accelerometer sensor and gyroscope sensor as a fall detection tool. This study aims to create a prototype of a fall detection application system.

Keywords: Gyroscope; Accelerometer; Flutter; Android; Internet of Things

INTRODUCTION

Android smartphones have been planted with several sensors. Many sensors in smartphones have not been optimally used as tools for Internet of Things devices. Internet of things is an electronic device that can communicate with other electronic devices. Communicating in one direction or two directions, the most important thing is to be able to send and receive data. Smartphone devices have now developed into devices to meet office needs, telecommunications needs, entertainment needs, and various needs. This is what drives the presence of smartphones with extraordinary capabilities. Nowadays smartphone devices in terms of features, at least there are camera sensors, wifi sensors, speakers, gps, maps, accelerometers. Smartphones (Paziewski et al., 2021), (Gunawan et al., 2019) with a minimum of features have met the basic needs for a device.

Information technology is also experiencing very fast growth. IT products are also flooding around the community. Especially now that desktop, website, mobile IT products are no different. Everything makes it easy for people to get by downloading on the website or on the playstore and other download service providers. Google provides application download services with smartphones based on Android (Kristensen et al., 2022). Apple also provides application download services with smartphones based on IOS or Apple. Service provider companies such as the AppStore (H. Chen et al., 2022) and Playstore, continue to provide the latest software and software updates, this shows commitment as a service provider.

The internet of things (Long, 2022) is currently experiencing very fast growth. Many devices function as internet of things. Internet of things devices help a lot for people's daily needs. For example, weather forecast information every day, is an internet of things service that is often used. The public does not need to wait for the weather forecast to occur from television, the weather forecast can also be directly notified on the smartphone, if you install weather forecast apps. Other examples abound. Such as e-tickets used by the police and the transportation department. And there are still many examples of internet of things devices that have helped the community a lot. Especially now that it is very easy to get micro-controller components, sensors for internet of things needs. Besides that, there is also a lot of software that can support it. Such as Flutter software, node js, php, dot net and many more.

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 6, Number 2, April 2022
DOI : https://doi.org/10.33395/sinkron.v7i2.11403
e-ISSN : 2541-2019
p-ISSN : 2541-044X

Currently the needs of offices and office projects, especially projects outside the office require a lot of attention. One of them is monitoring technicians in the field, especially technicians who carry out activities above the room, such as tower workers, supervision of those who have to climb heights. There is a very high risk of falling on workers or technicians or supervisors. If an accident occurs, there will be losses for both the technician and the company. There are still many companies that have not implemented how to monitor their technicians, let alone check that the technician has fallen from a height.

Smartphones also provide many sensors. So the research question arises, how to take advantage of the sensors in smartphones without having to buy a micro-controler? (RQ1). How to make an application system that can monitor technicians who fall from a height? (RQ2).

The purpose of this study is to solve the problem of monitoring employees on an offsite project who falls from a height. This research makes a mobile application system to detect technicians who fall from a height. For the safety factor, the vibration sensor and sound sensor immediately give warnings about equipment such as safety belts, helmets and various safety alerts via smartphones, so be careful. This application system was developed using the Flutter framework and took advantage of the sensors on the smartphone.

LITERATURE REVIEW

This research will present previous studies which are very useful as a basis for scientific reference. In table 1 will discuss the topic as well as advantages and disadvantages. This research is not looking for weaknesses, but as a complement to previous research.

Table 1 Previous studies

Author	Topic	Advantage	Disadvantage
(Tsani & Mulyadi, 2019)	Wearable Fall Detection System for Elderly Using Accelerometer and Gyroscope	The discussion about the fall sensor is still only a prototype and the concept of an accelerometer and gyroscope	Weaknesses in this study did not develop an application system or did not build a fall detection hardware prototype. It would be better if the concept is realized in the form of a prototype or application system.
(Yulastri et al., 2020)	Low Cost Fall Detection Device With Tracking Position For Vertigo and Syncope Patients	Discussion about fall sensor detection using hardware such as: MPU6050 accelerometer, push button, RTC, DF Player, GSM SIM800L module. For the microcontroller using Arduino Nano	Disadvantages of not developing a mobile application system and website. Many smartphone devices have embedded accelerometer, gyroscope, GPS sensors, which are cheaper than using Arduino hardware control and other sensors. Develop monitoring system can also be seen by others.
(Pratiwi & Fatmaryanti, 2020)	Development of Physics Teaching Media Using Speed Sensors as Speed Analysis in Realtime Based on Arduino to Remind Students' Problem Solving Abilities.	Discussion about speed sensors for physics lessons, using Arduino in the application of the prototype. Arduino as controller and speed sensor as measurement medium.	Disadvantages of not developing an application-based application system, and an internet of things system based on car devices with sensor features that are not widely used.
(Kusuma et al., 2018)	Monitoring walking devices for calorie balance in patients with medical rehabilitation needs	Application for monitoring medical rehabilitation needs, using a micro-controller device using Arduino Wemos, MPU 6050.	The weakness in this research is that it does not develop an Android-based application system, so there is no need to make purchases

*name of corresponding author

			in making prototypes.
(Marsa & Syaryadi, 2019)	Application of Wearable Device to Detect Elderly Falls in Aceh's House	Application for Wearable Device to Detect, using the ATMega328 microcontroler, MPU 6050 as a detection for the fall of an aceh hospital patient.	The Wearable Device to Detect research did not develop using an Android-based application system, where Android smartphones have abundant sensor features.

Previous research has discussed a lot about sensors for both speed sensors and fall sensors. Most studies use microcontrollers (Singh Gehlot & Jain, 2020), (Anshori et al., 2022) such as Arduino, ATMega328, MPU 6050 and other sensors. **State-of-the-art** in this research is to conduct research by utilizing accelerometer, gyroscope, gps sensors to detect altitude and provide notifications if technicians occur from a height. The system involves minimal equipment, with sufficient cloud and database. **The main contribution** in this research is to maximize in terms of benefits for sensors in the Android smartphone system.

METHOD

The methodology proposed in this study is as shown in figure 1. All work equipment is checked, whether all equipment is functioning properly. Including smartphones and mobile applications are also checked. The battery on the smartphone is also checked whether it is fully charged. So that during one day of work, the smartphone battery drops. To avoid this problem, it is necessary for the smartphone to be fully charged.

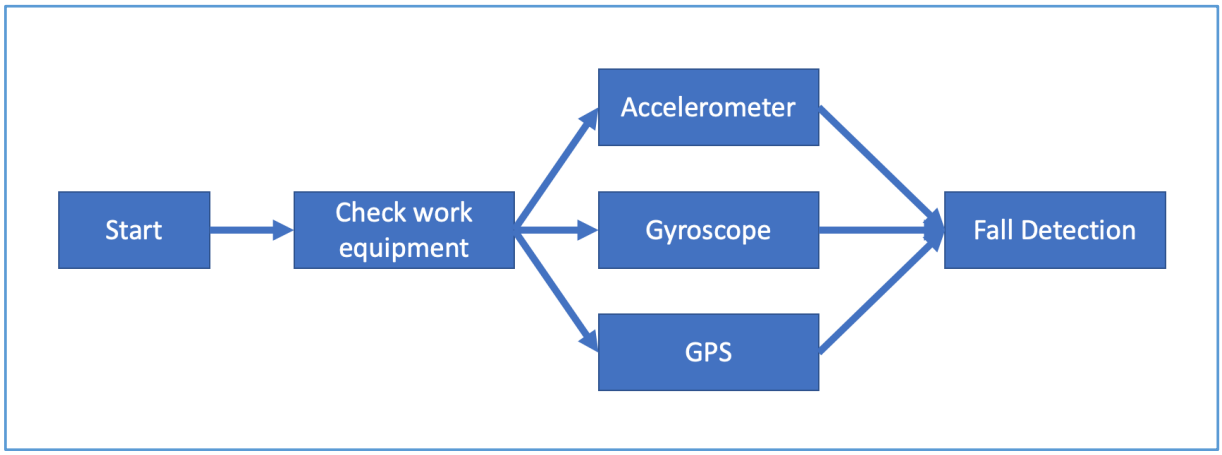

Fig. 1 Proposed fall detection sensor methodology
Source : researcher property

The sensors contained in the smartphone that can be used are Accelerometer, Gyroscope, GPS. GPS sensor is a sensor that is useful for determining the position of latitude, longitude. If applied to the map, then latitude, longitude can show the position or marker position instructions from the presence of the Global Positioning System (GPS) sensor. If the GPS sensor is activated by the technician, the technician's position will be tracked. Accelerometer, this sensor has latitude, longitude, altitude. Latitude and longitude (Correa-Caicedo et al., 2021), (Gundala et al., 2021), (Kumar & Singh, 2011) are the same as GPS sensors, but they allow altitude to be detected. If likened to the use of the X axis, Y axis and Z axis, then the Z axis is to see the height. The Z axis is the same as the Azimuth used for altitude detection from aircraft. At an altitude above 5 meters, the vibration sensor has warned technicians to be careful, because a height of 5 meters is very dangerous. And so on every time you increase the height of 5 meters. The more you go up to the height level, the vibration sensor and speaker provide very careful information. In addition to the vibration sensor and speaker, notifications from android to the server continue to provide notifications. So that management knows and continues to monitor the height of the technician. In the management dashboard, you can find out that the technician has an altitude status. The risk in the event of an accident can be known by the project supervisor or management to the head office. Gyroscope sensor (Kareem et al., 2021), (C. Chen & Zhao, 2020) to detect X-axis rotation, Y-axis rotation and Z-axis rotation.

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 6, Number 2, April 2022
DOI : https://doi.org/10.33395/sinkron.v7i2.11403
e-ISSN : 2541-2019
p-ISSN : 2541-044X

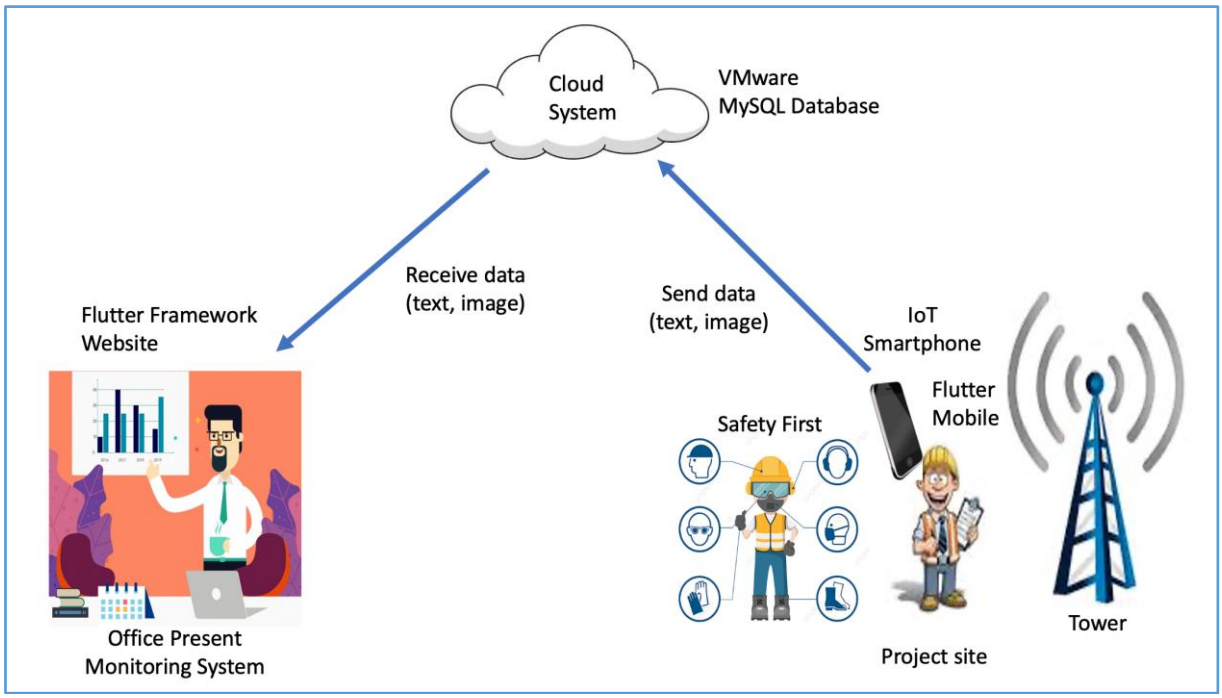

Fig. 2 Fall detection monitoring system architecture
Source : researcher property

Architecture monitoring system for technicians with work going up to the tower. Preparations before climbing to the top of the tower, carried out security checks, wearing helmets, gloves, helmets, masks, ropes, headsets for communication between teams, protective glasses, smartphones with fully charged batteries, and other technical equipment. Checks with SNI standards, carried out by supervisors and field project leaders. The goal is to ensure that technicians are safe and secure.

After that, the technician goes up to the tower, the android smartphone sends a notification to the server every 5 meters height. After doing the notification, the vibration sensor of the smartphone vibrates, the purpose is to remind technicians to be more careful. In the office, it can also monitor that technicians reach a certain height, all technician's altitude activities are always updated. Field supervisors and field leaders are always updated for the height of the technician.

Cloud server consists of application server using apache server and mysql database. HTTP Server, Apache/2.4.7 Server (Ubuntu) is selected as the web server. Apache is known as the most commonly used web server. Apache is used more than all web servers. Moreover, it is open source, highly scalable and has a system of dynamically loadable modules. Apache installation is done via the apt-get command line package manager. Any additional configuration is not required for this scope of work (Baş Seyyar et al., 2018).

Apache Tomcat. The Apache Tomcat being an implementation of the Java Servlet, JavaServer Pages, Java Expression Language and Java WebSocket technologies, is an open source software (Apache Fondation, n.d.). In this work, Apache Tomcat Version 8.0.33 is used. Atlassian JIRA Standalone Edition is used as a web application. Access log configuration of Tomcat is set to be similar to access log entries in Apache (Baş Seyyar et al., 2018).

MySQL Cluster is a technology providing shared nothing clustering and au to-sharding for the MySQL Database management system.MySQL Cluster has no single point of failure. It is d esigned to provide high availability and high throughput with low latency, while allowing for near linear scalability. MySQL Cluster is implemented as a fully distributed multi-master database ensuring updates made by any application or SQL node are instantly available to all of the other nodes accessing the cluster, and each data node can accept write operations. MySQL Cluster scales horizontally on commodity hardware with auto-sharding to serve read and write intensive workloads, accessed via SQL and NoSQL interfaces. It supports in-memory and disk-based data, automatic data partitioning with load balancing and the ability to add nodes to a running cluster with zero downtime allows linear database scalability to handle the most unpredictable workloads. It consists of multiple nodes that are distributed across machines to make sure the system can work, even in case a node having a problem such as network failure (Tummalapalli & Machavarapu, 2016).

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 6, Number 2, April 2022
DOI : https://doi.org/10.33395/sinkron.v7i2.11403
e-ISSN : 2541-2019
p-ISSN : 2541-044X

RESULT

The results of the monitoring system development, development using Flutter and Ubuntu operating system server with PHP programming and mysql database are as follows:

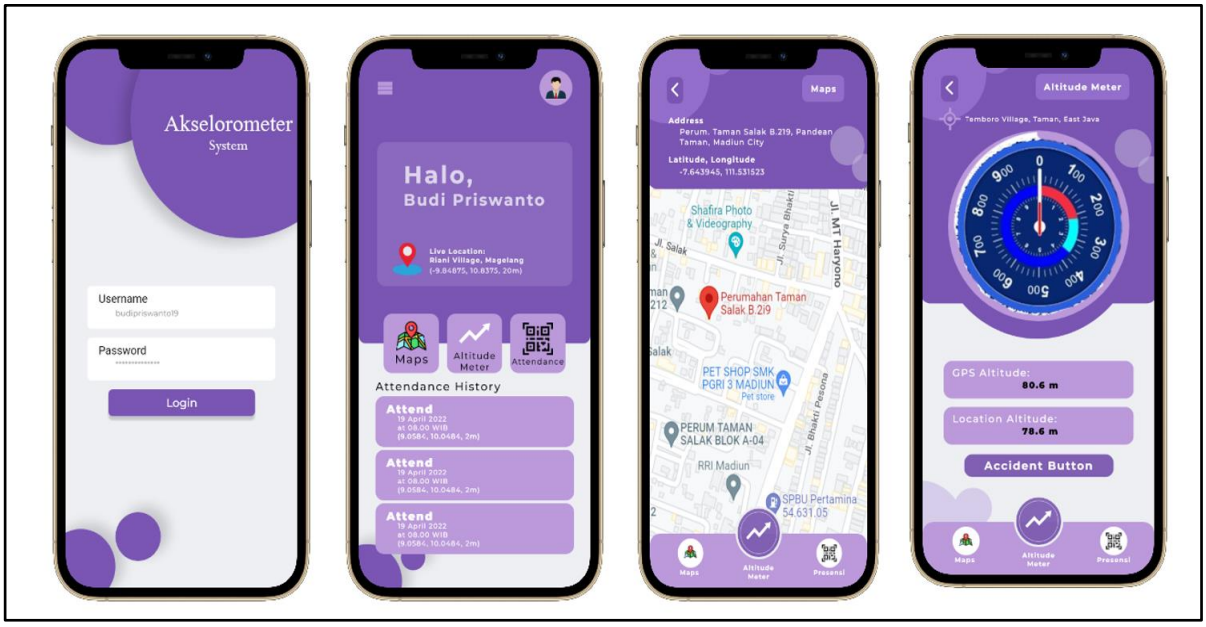

Fig 3. UI/UX for Apps Monitoring Technician
Source : researcher properti

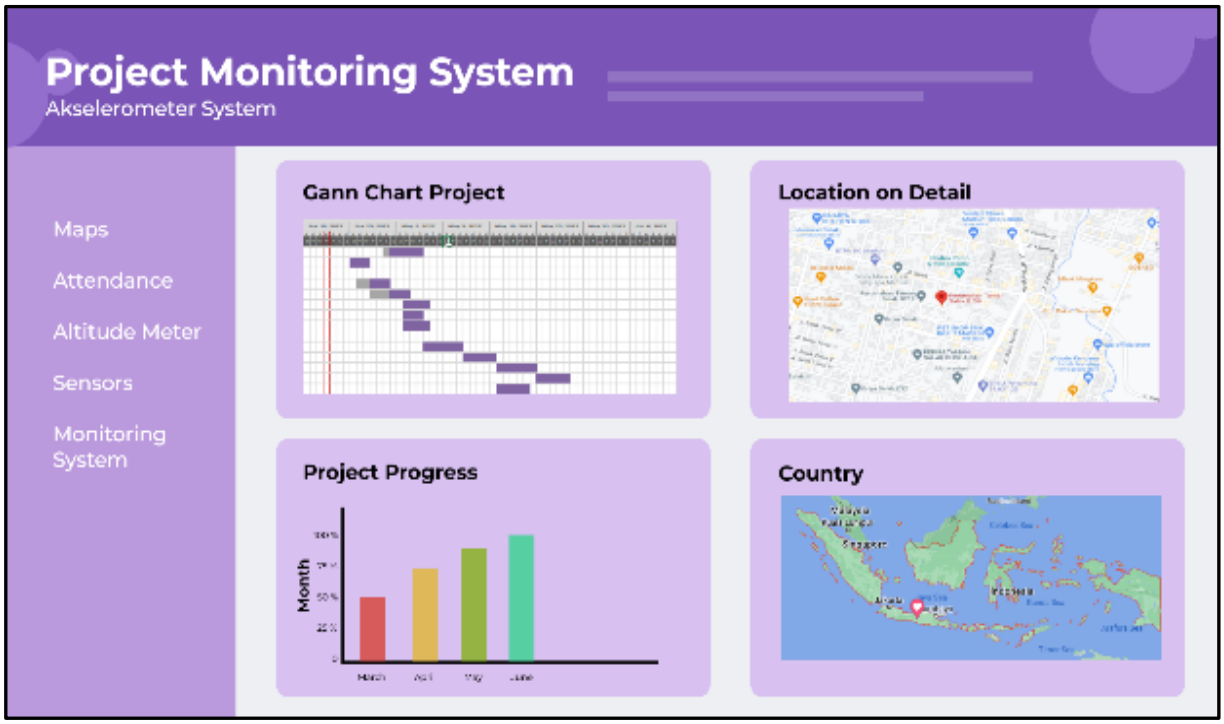

Fig 4. Dashboar System Monitoring for Project Management
Source : researcher properti

Figure 3, system monitoring technician, these are mobile apps for system applications in the field. User login is useful for entering into the technician monitoring system. The next view is the UI to view attendance. The third UI is used to see the position or location of the project in the field. The fourth UI to see the height of the technician.

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 6, Number 2, April 2022
DOI : https://doi.org/10.33395/sinkron.v7i2.11403
e-ISSN : 2541-2019
p-ISSN : 2541-044X

Figure 4, the dashboard management system display, all project activities are recorded in the system dashboard. Gann charts are useful for knowing the progress of a project. The location of the currently running project. Project progress, to see what percentage of all activities have been.

DISCUSSIONS

Here is a script snippet for height detection using Flutter. The application system in figure 3, describes the results built using Flutter.

```
import 'dart:async';
import 'package:flutter/material.dart';
import 'package:sensors/sensors.dart';

void main() => runApp(MyApp());

class MyApp extends StatelessWidget {
  @override
  Widget build(BuildContext context) {
    return MaterialApp(
      title: 'Accelerometer',
      theme: ThemeData(
        primarySwatch: Colors.blue,
      ),
      home: MyHomePage(title: 'Accelerometer'),
    );
  }
}

class MyHomePage extends StatefulWidget {
  MyHomePage({Key key, this.title}) : super(key: key);

  final String title;

  @override
  _MyHomePageState createState() => _MyHomePageState();
}

class _MyHomePageState extends State<MyHomePage> {
  // color of the circle
  Color color = Colors.greenAccent;

  // event returned from accelerometer stream
  AccelerometerEvent event;
  setColor(AccelerometerEvent event) {
    // Calculate Left
    double x = ((event.x * 12) + ((width - 100) / 2));
    // Calculate Top
    double y = event.y * 12 + 125;

    // find the difference from the target position
    var xDiff = x.abs() - ((width - 100) / 2);
    var yDiff = y.abs() - 125;

    // check if the circle is centered, currently allowing a buffer of 3 to make centering easier
    if (xDiff.abs() < 3 && yDiff.abs() < 3) {
      // set the color and increment count
      setState(() {
        color = Colors.greenAccent;
        count += 1;
      });
    } else {
      // set the color and restart count
      setState(() {
        color = Colors.red;
        count = 0;
      });
    }
  }

  setPosition(AccelerometerEvent event) {
    if (event == null) {
      return;
```

*name of corresponding author

```
  }
  // When x = 0 it should be centered horizontally
  // The left positin should equal (width - 100) / 2
  // The greatest absolute value of x is 10, multipling it by 12 allows the left position to move a total of 120 in either direction.
  setState(() {
    left = ((event.x * 12) + ((width - 100) / 2));
  });
  // When y = 0 it should have a top position matching the target, which we set at 125
  setState(() {
    top = event.y * 12 + 125;
  });
}
```

CONCLUSION

The conclusion of this study is that smartphones can be used as sensors in detecting the fall of technicians. The use of the accelerometer sensor can also be used for others, it does not have to be used for altitude detection, in this study the accelerometer sensor was used as altitude detection. System monitoring also provides updates to the server. So that the head office management knows the activities of technicians and the height of technicians climbing the tower to complete their work. Provide reports on each completed work. After the technician comes down, all the activities of the technician's work are immediately updated. The research question has been answered by building a monitoring system.

REFERENCES

Anshori, I., Mufiddin, G. F., Ramadhan, I. F., Ariasena, E., Harimurti, S., Yunkins, H., & Kurniawan, C. (2022). Design of smartphone-controlled low-cost potentiostat for cyclic voltammetry analysis based on ESP32 microcontroller. *Sensing and Bio-Sensing Research*, *36*(December 2021), 100490. https://doi.org/10.1016/j.sbsr.2022.100490

Apache Fondation. (n.d.). *The Apache Software Foundation, Apache Tomcat*. https://tomcat.apache.org/

Baş Seyyar, M., Çatak, F. Ö., & Gül, E. (2018). Detection of attack-targeted scans from the Apache HTTP Server access logs. *Applied Computing and Informatics*, *14*(1), 28–36. https://doi.org/10.1016/j.aci.2017.04.002

Chen, C., & Zhao, L. (2020). The effect of thermal-induced noise on doubly-coupled-ring optical gyroscope sensor around exceptional point. *Optics Communications*, *474*(April), 126108. https://doi.org/10.1016/j.optcom.2020.126108

Chen, H., Lachaud, K., & Zhou, W. (2022). The sales effect of “Free App of the Day” on Amazon Appstore: An empirical study. *Digital Business*, *2*(2), 100020. https://doi.org/10.1016/j.digbus.2021.100020

Correa-Caicedo, P. J., Barranco-Gutiérrez, A. I., Guerra-Hernandez, E. I., Batres-Mendoza, P., Padilla-Medina, J. A., & Rostro-González, H. (2021). An FPGA-based architecture for a latitude and longitude correction in autonomous navigation tasks. *Measurement: Journal of the International Measurement Confederation*, *182*(June). https://doi.org/10.1016/j.measurement.2021.109757

Gunawan, A. A. S., Stevanus, V., Farley, A., Ngarianto, H., Budiharto, W., Tolle, H., & Attamimi, M. (2019). Development of smart trolley system based on android smartphone sensors. *Procedia Computer Science*, *157*, 629–637. https://doi.org/10.1016/j.procs.2019.08.225

Gundala, S. S., Jakkampudi, C. S., Yadavalli, A., Vankadara, R., & Panda, S. K. (2021). Ionospheric total electron content and scintillations characteristics from GPS signal observations at a low latitude station. *Materials Today: Proceedings*, *xxxx*. https://doi.org/10.1016/j.matpr.2020.12.1041

Kareem, Z. H., Ramli, K. N. bin, Malik, R. Q., & Zahra, M. M. A. (2021). Mobile phone user behavior’s recognition using gyroscope sensor and ML algorithms. *Materials Today: Proceedings*, *xxxx*. https://doi.org/10.1016/j.matpr.2021.04.639

Kristensen, P. L., Olesen, L. G., Egebæk, H. K., Pedersen, J., Rasmussen, M. G., & Grøntved, A. (2022). Criterion validity of a research-based application for tracking screen time on android and iOS smartphones and tablets. *Computers in Human Behavior Reports*, *5*. https://doi.org/10.1016/j.chbr.2021.100164

Kumar, S., & Singh, A. K. (2011). GPS derived ionospheric TEC response to geomagnetic storm on 24 August 2005 at Indian low latitude stations. *Advances in Space Research*, *47*(4), 710–717. https://doi.org/10.1016/j.asr.2010.10.015

Kusuma, W. A., Sari, Z., Wibowo, H., Norhabibah, S., Ubay, S. N., & Fitriani, D. A. (2018). Monitoring walking devices for calorie balance in patients with medical rehabilitation needs. *International Conference on Electrical Engineering, Computer Science and Informatics (EECSI)*, *2018-October*, 460–463. https://doi.org/10.1109/EECSI.2018.8752761

Long, L. (2022). Research on status information monitoring of power equipment based on Internet of Things. *Energy Reports*, *8*, 281–286. https://doi.org/10.1016/j.egyr.2022.01.018

Marsa, M., & Syaryadi, M. (2019). Penerapan Wearable Device Untuk Mendeteksi Lansia Jatuh Pada Rumah

*name of corresponding author

Aceh. *Jurnal Karya Ilmiah Teknik Elektro*, *4*(3), 12–18.

Paziewski, J., Fortunato, M., Mazzoni, A., & Odolinski, R. (2021). An analysis of multi-GNSS observations tracked by recent Android smartphones and smartphone-only relative positioning results. *Measurement: Journal of the International Measurement Confederation*, *175*, 109162. https://doi.org/10.1016/j.measurement.2021.109162

Pratiwi, U., & Fatmaryanti, S. D. (2020). Development of Physics Teaching Media Using Speed Sensors as Speed Analysis in Realtime Based on Arduino to Remind Students' Problem Solving Abilities. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *5*(3), 151. https://doi.org/10.26737/jipf.v5i3.1789

Singh Gehlot, K., & Jain, D. (2020). Biometric finger print based voting machine using ATmega328P microcontroller. *Materials Today: Proceedings*, *xxxx*. https://doi.org/10.1016/j.matpr.2020.11.087

Tsani, S. D., & Mulyadi, I. H. (2019). Sistem Pendeteksi Jatuh Wearable untuk Lanjut Usia Menggunakan Accelerometer dan Gyroscope. *Journal of Applied Electrical Engineering*, *3*(2), 44–48. https://doi.org/10.30871/jaee.v3i2.1824

Tummalapalli, S., & Machavarapu, V. R. (2016). Managing Mysql Cluster Data Using Cloudera Impala. *Procedia Computer Science*, *85*(Cms), 463–474. https://doi.org/10.1016/j.procs.2016.05.193

Yulastri, Madona, E., Irmansyah, M., & Nasution, A. (2020). Alat Deteksi Jatuh Berbiaya Murah Dengan Tracking Position Untuk Pasien Vertigo dan Sinkop. *Jurnal RESTI (Rekayasa Sistem Dan Teknologi Informasi)*, *4*(6), 9–11. https://doi.org/10.29207/resti.v4i6.2608

*name of corresponding author