Abstract
Fall and fear of falling is one of the leading causes of death for the elderly and stroke suffered patients. There is a growing demand for quantifying the performance and efficiency of rehabilitation programs. Researchers are advocating home based rehabilitation devices and continuous monitoring of patients status in real time through wearable sensor. This paper investigates the use of inertial measurement sensors for recording the dynamic gait status. In order to facilitate long term recording and minimal interface of recording devices, these MEMS sensors are advantageous in many ways over the conventional laboratory methods. There is need of sensors are advantageous in many ways over the conventional laboratory methods. There is need of sensors are advantageous in many ways over the conventional laboratory methods. There is need of sensors are advantageous in many ways over the conventional laboratory methods. There is need of sensors are advantageous in many ways over the conventional laboratory methods. There is need of

Keywords: Gait rehabilitation, Ambulatory system, Wireless Gait Sensors, survivors without fear of falling.

Introduction
- HUMAN gait is most affected disorder due to aging population and increasing number of stroke survivors each year.
- According to an estimate given by National Institute of Neurological Disorders and Stroke (NINDS), In USA: 795,000 strokes cases / year
- Serious long-term disabilities: Mobility
- Gait Rehabilitation: • Research Evidence: Robotic Rehabilitation having HAS: effective, efficient, beneficial for early recovery
- Home-based rehabilitation programs
- Expensive
- Portable Harness Ambulatory System: • Affordable
- Home based rehabilitation with minimum support

Harness Ambulatory System
- Harness Ambulatory Suspension used in physical therapy and exercise training for people with neurological or musculoskeletal injuries or diseases or muscle weakness
- Patients uses a body harness and lifted partially against gravity
- Amount of support provided is dependent on the musculoskeletal strength and stability of the patient
- Suspension systems function by offsetting a percentage of body mass while providing balance support
- Reduces fear of falling

Design Aspects of PHAS
- Rehabilitation in home environment without fear of falling
- Easy to maneuver in house in every possible direction without limiting gait in all possible direction of movements
- Integrate wireless gait sensors which can record the patient gait information and informs the patient to correct the gait if patient is following abnormal gait pattern
- Data was stored in a PC to be analyzed offline by physiotherapist
- Recordings can also uploaded to a website for remote monitoring by experts at rehabilitation centers

Sensor for intent monitoring
- Curb weight ~ 80lb with winch.
- Forward pulling force FPF: 10-12N
- Curb weight ~ 80lb with winch.
- Reverse pushing force RPF: 14-16N on carpeted surface
- Estimated FPF: 8-10N & RPF was 10-12N on tile surface

Gait Experiments
- Normal human subject: Shoulder-Shoulder
- Shoulder-Shank
- Lumbar vertebra
- Variation in Gait Speed: Slow & fast
- Simulating Fall environment: Right & left fall
- Forward fall

Results

Conclusion
- PHAS: Enhance the quality and ease of rehabilitation of elderly and stroke patient
- Designed according to the present day requirement and accessing the limited space available in house
- Increase the efficiency and suggest new methods for patients to reach the near natural gait
- Wireless sensor modules. The modules are portable and have onboard power.
- Can also be used to record the range of joint motion of any human body segment with little modification
- The gait data was reported on a normal healthy person acts as a reference database

References

Wearable Wireless Inertial Sensors for Estimation of Gait Parameters and its integration with Portable Harness Ambulatory System for Rehabilitation
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Figure 1: Gait Rehabilitation
Figure 2: NaviGator
Figure 3: Portable Harness Ambulatory System
Figure 4: Control schema for intent monitoring and motion control of PHAS unit
Figure 5: Data acquisition system using wearable wireless inertial measurement sensors
Figure 6: Sensors attached to subject at shoulder-shank
Figure 7: Sensor at Shoulder -Shoulder joint; Slow speed and fast speed
Figure 8: Sensors at Wrist-Wrist joint; Slow speed and fast speed
Figure 9: Sensors at Thigh-Ankle joint; Slow speed and fast speed

Sensor for Gait Measurement
- Gait Measurement: Study of human walk
- Range of motion of joint segments, gait speed, orientation & postural assessment of patient
- Inertial measurement sensors
- 3 axis accelerometer
- 3 axis gyrooscope

Figure 5

Figure 6