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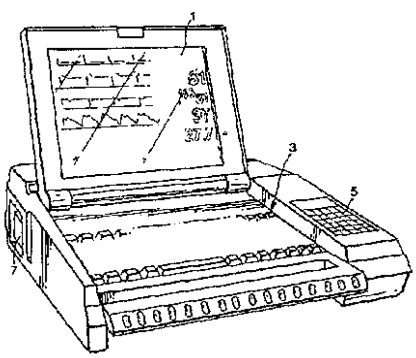
(54)【発明の名称】データを取得するシステムおよび方法

(57)【要約】
【課題】異なるサンプリング周波数でデータを出力する複数のデータ接続装置から生理的データのようなデータを取得し、表示するシステムを提供する。
【解決手段】このシステムは、データ信号を異なるサンプリング周波数で受信し、各信号の各サンプルを単一のマスタクロックから得られるタイムスタンプに関連付ける。低速度データ及び高速度データはそれぞれ別に処理される。低速度データは、高速度データとして現マスタクロックの現値に等しいタイムスタンプを与えることによってタイムスタンプされる場合、マスタクロックの現値と関連し、次のサンプルは、データ収集装置のサンプリング周波数から得られたサンプルと第１のサンプルに与えられた時間スケールとの間に予想間隔に基づいて推定タイムスタンプを与えられる。
【選択図】図２



【特許請求の範囲】
【請求項１】
各々が１つあるいはそれ以上のパラメータを監視し、かつそれぞれのシステムクロックに基づいてそれぞれのサンプリング周波数でデータ信号を出力する複数のデータ収集装置からデータを取得するシステムであって、
前記複数のデータ収集装置の各々から前記データ信号を受信する入力手段と、マスタクロック信号を供給するマスタクロックと、前記マスタクロックから導き出されたタイムスタンプを前記データ信号の各々に関連付けるタイムスタンプ手段と、を有するデータ処理手段を備えたことを特徴とするシステム。
【請求項２】
さらに、前記それぞれのタイムスタンプに基づいて時間軸に対して並べられたデータ信号の描写を表示するディスプレイを備えたことを特徴とする請求項１に記載のシステム。
【請求項３】
前記タイムスタンプは前記マスタクロックよりも高い分解能を有することを特徴とする請求項１または２に記載のシステム。
【請求項４】
サンプリング周波数が所定の閾値以下であるデータ信号に対して、前記タイムスタンプ手段が、前記タイムスタンプとして前記マスタクロック信号のサンプルを関連付け、かつサンプリング周波数が所定の閾値を越えるデータ信号に対して、前記タイムスタンプ手段が、前記データ信号のサンプルのための初期タイムスタンプとして前記マスタクロック信号のサンプルを関連付け、かつ前記データ信号の次のサンプルに対して推定タイムスタンプを関連付けることを特徴とする請求項１、２または３に記載のシステム。
【請求項５】
前記推定タイムスタンプは、前記データ信号および前記初期タイムスタンプを供給する前記データ収集装置のサンプリング周波数から計算される時間間隔に基づいていることを特徴とする請求項４に記載のシステム。
【請求項６】
前記所定の閾値は、前記マスタクロック周波数よりも小さいかまたは等しいことを特徴とする請求項４または５に記載のシステム。
【請求項７】
前記データ処理手段は比較器を備え、
前記比較器は、サンプリング周波数が所定の閾値以上である前記データ信号に対して、現サンプルと関連した推定タイムスタンプを前記マスタクロックと定期的に比較してこれらの差を決定し、
前記データ処理手段は、前記差が所定の量よりも大きい場合、前記マスタクロック信号に対応するように、前記推定タイムスタンプを修正することを特徴とする請求項４、５または６に記載のシステム。
【請求項８】
前記データ処理手段は、前記差が前記所定の量よりも大きい場合、前記現サンプルに先行する隣接セットのサンプルの前記タイムスタンプを調整することを特徴とする請求項７に記載のシステム。
【請求項９】
前記データ処理手段は、前記隣接セットのサンプルのタイムスタンプが前記現サンプルまでの時間において等間隔となるように前記現サンプルに先行する前記隣接セットのサンプルのタイムスタンプを前記差の等分数だけ調整することを特徴とする請求項８に記載のシステム。
【請求項１０】
隣接するセットのサンプルの数は、１秒に得られるサンプル数であることを特徴とする請求項８または９に記載のシステム。
【請求項１１】

前記データ処理手段は、前記差が所定の量よりも大きい場合、前記時間間隔の調整値に基づいて次のサンプルのための推定タイムスタンプを生成することを特徴とする請求項６～１０のいずれか一つに記載のシステム。
【請求項１２】
前記データ処理手段は、前記時間間隔の調整値を計算するカルマンフィルタを備えたことを特徴とする請求項１１に記載のシステム。
【請求項１３】
前記データ処理手段は、前記所定の量に達するのにかかった時間に従って前記時間間隔の精度の値を計算する計算手段を備えたことを特徴とする請求項１１に記載のシステム。
【請求項１４】
システムクロックは、前記マスタクロックに対してフリーランニングであるデータ収集装置とともに作動可能であることを特徴とする請求項１～１３のいずれか一つに記載のシステム。
【請求項１５】
さらに、前記データサンプルおよびタイムスタンプを記憶するデータ記憶装置を備えたことを特徴とする請求項１～１４のいずれか一つに記載のシステム。
【請求項１６】
前記信号は、生理的信号であることを特徴とする請求項１～１５のいずれか一つに記載のシステム。
【請求項１７】
前記入力手段は、心電図モニタ、酸素飽和モニタ、呼吸モニタ、血圧モニタ、体温計、頭蓋内圧モニタ、部分酸素圧モニタおよび部分二酸化炭素圧モニタのうちの少なくとも２つからの信号を受信するインタフェースを備えたことを特徴とする請求項１～１６のいずれか一つに記載のシステム。
【請求項１８】
前記マスタクロック、前記タイムスタンプ手段および前記ディスプレイを組み込んでいるラップトップコンピュータを備えたことを特徴とする請求項2またはそれに従属する請求項に記載のシステム。
【請求項１９】
前記データ処理手段および前記ディスプレイは、前記データ信号の描写を２つの異なる時間スケールのうちの１つで選択的に表示するように構成されることを特徴とする請求項2またはそれに従属する請求項に記載のシステム。
【請求項２０】
前記２つの異なる時間スケールは、数秒～数分の第１の時間スケールと１分～数日の第２の時間スケールであることを特徴とする請求項１９に記載のシステム。
【請求項２１】
前記第１の時間スケールは、３０秒未満の時間軸が表示されるようなものであることを特徴とする請求項２０に記載のシステム。
【請求項２２】
前記第１の時間スケールは、１０秒未満の時間軸が表示されるようなものであることを特徴とする請求項２０に記載のシステム。
【請求項２３】
前記第１の時間スケールで前記データの描写を表示する際に、低サンプリング周波数でサンプルされたデータが数値として表示されることを特徴とする請求項２０、２１または２２に記載のシステム。
【請求項２４】
前記第２の時間スケールは、１時間を越える時間軸が表示されるようなものであることを特徴とする請求項２０、２１、２２または２３に記載のシステム。
【請求項２５】
前記第２の時間スケールは、５時間以上の時間軸が表示されるようなものであることを特

徴とする請求項２０、２１、２２または２３に記載のシステム。
【請求項２６】
前記第２の時間スケールで前記データの描写を表示する際に、高サンプリング周波数でサンプルされたデータの１つのトレースが、前記第１の時間スケールで同時に表示されることを特徴とする請求項２０～２５のいずれか一つに記載のシステム。
【請求項２７】
データの１つのトレースが心電図トレースであることを特徴とする請求項２６に記載のシステム。
【請求項２８】
前記データ信号の表示描写は、前記データ信号が受信される際に前記時間軸に対してスクロールされることを特徴とする請求項１～２７のいずれか１つに記載のシステム。
【請求項２９】
データを複数のデータ収集装置から取得しかつ表示するシステムであって、
前記システムは、実質的に添付図面を参照して前述され、かつ図示されるように作動するように構成され、かつ配置されることを特徴とするシステム。
【請求項３０】
各々がパラメータを監視し、かつそれぞれのシステムクロックに基づいてそれぞれのサンプリング周波数でデータ信号を出力する複数のデータ収集装置からのデータ信号を同期させる方法であって、
マスタクロックから導き出されるタイムスタンプをデータ信号の各々に関連づけることを含むことを特徴とする方法。
【請求項３１】
前記タイムスタンプは、前記マスタクロックよりも高い分解能を有することを特徴とする請求項３０に記載の方法。
【請求項３２】
サンプリング周波数が所定の閾値未満である前記データ信号に対して、前記タイムスタンプとして前記マスタクロック信号のサンプルを関連付け、かつサンプリング周波数が所定の閾値を越える前記データ信号に対して、前記データ信号のサンプルのための初期タイムスタンプとして前記マスタクロック信号のサンプルを関連付け、かつ前記データ信号の次のサンプルに対して推定タイムスタンプを関連付けることを含むことを特徴とする請求項３０または３１に記載の方法。
【請求項３３】
前記推定タイムスタンプは、前記データ信号および前記初期タイムスタンプを供給する前記データ収集装置のサンプリング周波数から計算される時間間隔に基づいていることを特徴とする請求項３２記載の方法。
【請求項３４】
前記所定の閾値は、前記マスタクロック周波数よりも小さいかあるいは等しいことを特徴とする請求項３２または３３に記載の方法。
【請求項３５】
サンプリング周波数が所定の閾値を越える前記データ信号に対して、現サンプルと関連した前記推定タイムスタンプが、前記マスタクロックと定期的に比較され、これらの差を決定し、かつ前記差が所定の量よりも大きい場合、前記推定タイムスタンプが、前記マスタクロック信号に対応するように修正されることを特徴とする請求項３２、３３または３４記載の方法。
【請求項３６】
前記差が前記所定の量よりも大きい場合、前記現サンプルに先行する隣接セットのサンプルの前記タイムスタンプが調整されることを特徴とする請求項３５に記載の方法。
【請求項３７】
前記現サンプルに先行する前記隣接セットのサンプルのタイムスタンプは、それらタイムスタンプが前記現サンプルまでの時間において等間隔となるように前記差の等分数だけ調

整されることを特徴とする請求項３６に記載の方法。
【請求項３８】
隣接するセットのサンプルの数は、１秒で得られるサンプル数であることを特徴とする請求項３６または３７に記載の方法。
【請求項３９】
前記差が所定の量よりも大きい場合、次のサンプルのための前記推定タイムスタンプは、前記時間間隔の調整値に基づいていることを特徴とする請求項３４～３８のいずれか一つに記載の方法。
【請求項４０】
前記時間間隔の調整値を計算するカルマンフィルタリング方法を含む、請求項３９記載の方法。
【請求項４１】
前記時間間隔の精度の値が、前記所定の量に達するのにかかった時間に従って計算されることを特徴とする請求項３９に記載の方法。
【請求項４２】
前記信号は生理的信号であることを特徴とする請求項３０～４１のいずれか一つに記載の方法。
【請求項４３】
前記信号は、心電図モニタ、酸素飽和モニタ、呼吸モニタ、血圧モニタ、体温計、頭蓋内圧モニタ、部分酸素圧モニタおよび部分二酸化炭素圧モニタのうちの少なくとも２つからの信号を含むことを特徴とする請求項３０～４２のいずれか一つに記載の方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】
本発明は、各々が１つまたはそれ以上の異なるパラメータを監視する複数のデータ収集装置からのデータの取得、特にこのデータの同期に関するものである。
【０００２】
【従来の技術】
１つのシステムが複数のセンサによって監視される多数の異なる状況がある。しばしば、そのようなセンサは、異なるデータ収集装置の一部であり、システムの同じパラメータまたは異なるパラメータを監視する。この状況では、データ収集装置の各々は、監視するデータ信号のサンプリングを制御する自分自身のクロックを含んでもよい。これらのクロックは互いに対してフリーランニングであってもよい。よって、この装置からの出力信号は、同期されなくてもよく、広く異なる速度であってもよい。
【０００３】
例えば、患者の状態を監視する場合、（多数のチャネルであり得る）心電図、血圧、呼吸、パルスオキシメトリを使用する酸素飽和度や体温のような様々な生理学パラメータを監視するのが通常である。一般的には、これらは、異なるデータ収集装置によって得られ、全ては、異なるサンプリング速度で得られる。例えば、心電図（ＥＣＧ）は一般的には２５６Ｈｚで収集され、パルスオキシメトリ波形は一般的には８１．３Ｈｚで得られ、呼吸波形は６４Ｈｚで得られ、体温は１Ｈｚで得られ、血圧は１０分または２０分毎に１回得られる。
【０００４】
これら生命徴候のすべてが、臨床的に重要なものであり、医療職員が患者の状態を容易に監視できるように通常表示される。しかしながら、全ては、異なる速度で、一般的には異なる台数の装置によってそれら各装置のシステムクロックを用いて測定されるために、簡素で同期化された方法で異なるパラメータを一緒に表示することは困難である。
【０００５】
異なる信号を同期化させる問題を解決するために、同じクロック信号によって異なるモニタの全てを駆動するというある１つの解決策が提案された。

【０００６】
【発明が解決しようとする課題】
しかしながら、これは、モニタのすべてが本質的に高価で融通がきかない一体化された状態を要求し、さらにこれは既存の装置を冗長にする。ＥＣＧトレースのようなパラメータは、血圧（１０～２０分毎測定されるだけである）のようなパラメータと比べて高速の時間スケールで変わるために、そのデータの表示も、困難を極める。よって、ＥＣＧトレースのサンプルのタイミングは、正確に記録される必要がある。しかしながら、血圧のサンプルのタイミングは、臨床的に重要な損失がなければ、低い精度のものであってもよい。
【０００７】
同様な問題は、化学処理プラントなどのプラント監視や制御、エンジンまたは乗物システムのような機械の監視や制御のような他のシステムでも生じる。
【０００８】
【課題を解決するための手段】
本発明によれば、各々がパラメータを監視し、それぞれのシステムクロックに基づいてそれぞれのサンプリング周波数でデータ信号を出力する複数のデータ収集装置からデータを取得するシステムであって、複数のデータ収集装置の各々からデータ信号を受信する入力手段と、マスタクロック信号を供給するマスタクロックと、マスタクロックから導き出されたタイムスタンプをデータ信号の各々に関連付けるタイムスタンプ手段とを有するデータ処理手段を備えたシステムを提供する。
【０００９】
したがって、本発明により、様々な異なるデータ収集装置からデータを収集できるが、そのデータサンプルは、マスタクロックと同期されるタイムスタンプを与えられる。このタイムスタンプは、マスタクロックよりも高い分解能を有する。このマスタクロックは、一定の間隔で新しい時間値を生成する。１秒以内のこのような間隔数はチックレートとして知られている。その時間軸上の分解能はチックレートの逆数である。
【００１０】
好ましくは、サンプルに関連する時間スタンプは、データ信号のサンプリング周波数に応じて異なる方法で計算される。サンプリング周波数が所定の閾値未満であるデータ信号（例えば生理的な環境における血圧や体温）に対して、データの各サンプルは、タイムスタンプ（単純に、データにタイムスタンプが与えられた時間でのマスタクロック信号の値である）に関連している。
【００１１】
しかしながら、サンプリング周波数が所定の閾値を越えるデータ信号（例えば、生理的な環境における心電図、パルスオキシメトリ波形、呼吸波形など）に対して、データ信号の第１のサンプル（または第１のバッチの適切なサンプル）は、タイムスタンプ時間でのマスタクロック信号の値に関連しているが、次のサンプルには推定されたタイムスタンプが与えられる。
【００１２】
これは、その信号（データ収集装置の公知の仕様に基づいている）を供給するデータ収集装置のサンプリング周波数から計算された時間間隔に基づいてもよい。好ましくは、その推定は、現在のマスタクロックの値と定期的に比較され、これらの差が受け入れられるかどうか、または所定の量よりも大きいかどうかを決定する。所定の量よりも大きい場合、タイムスタンプが修正される。さらに、現サンプルに先行する隣接セットのサンプルのタイムスタンプは、例えばそれらタイムスタンプが現サンプルまでの時間において等間隔となるように調整されることで調整される。それ以下の修正が不要とみなされる所定の差は、マスタクロックの分解能の倍数（例えば５～５０）であってもよい。また、サンプリング周波数の所定の閾値は、マスタクロック周波数よりも小さくてもよいしまたはマスタクロック周波数に等しくてもよく、好ましくはマスタクロック周波数の１／５よりも小さい。
【００１３】

現サンプルに先行するサンプルのセットのタイムスタンプを調整するのと同様に、タイムスタンプが将来のサンプルに対して推定される方法は、計算で使用されるサンプリング間隔の値を調整することによって調整できる。したがって、この値を修正することによって、推定タイムスタンプがマスタクロックの値からはずれない（または非常に速くはずれない）ことが希望される。この調整は、サンプリング間隔の精度に対する値におけるカルマンフィルタを使用して行うことができる。ここで、そのサンプリング間隔の精度に対する値は、推定タイムスタンプがマスタクロックからかなりはずれるのにかかる時間に従って設定される。

【００１４】

（患者のような）生理的なシステムを監視する際に使用するための１つの実施の形態では、このシステムは、ＥＣＧモニタ、酸素飽和モニタ、呼吸モニタ、血圧モニタおよび体温計、またはさらに言えば生理的なデータを取得のために使用されるいかなる他のトランスデューサまたはモニタからの信号も受信し、表示するのに適している。

【００１５】

好ましくは、このシステムは、マスタクロック、タイムスタンプ手段およびディスプレイを組み込んだデータ処理装置の周辺に配置され、損傷の危険がなく容易に携帯できるように衝撃に耐えるように作られてもよい。表示の明快さを改善するために、データは、「Ｂｅａｔ　ｔｏ　Ｂｅａｔ」時間スケールや「トレンド」時間スケールなどの短期間の連続した時間スケールとして参照される２つの異なった時間スケールの一つを選択的に表示されてもよい。ここで、「Ｂｅａｔ　ｔｏ　Ｂｅａｔ」時間スケールは、生理的環境において、時間軸が短期間のデータ、例えば数秒のデータ（一般的には１～６０秒）を詳細に示すような場合に用いられ、「トレンド」時間スケールは、時間軸が、より長いセクションのデータ、例えば数時間のデータ（一般的にはこれは１分から１日まで行ってもよい）を示すような場合に用いられる。

【００１６】

表示されるパラメータおよびその表示の方法は、２種類の表示間で変えられてもよい。例えば、最初の時間スケールでデータを表示する際に、低いサンプリング周波数でサンプルされるデータは、連続したトレース（その非常に低いサンプリング周波数を与えられたこの時間スケールで殆ど意味がない）よりもむしろ数値として表示できる。一方、「トレンド」時間スケールにおいて、たとえデータの残りが長い時間スケールにわたって観察されるとしても、トレースの連続的な視認を維持することができるように単一高周波トレースをより短い時間スケールで表示することはなお有用であり得る。

【００１７】

好ましくは、生理的環境において心拍数、血圧、酸素飽和および体温のようなシステムのための重要な値は、両方の表示モードのトレースと並んで数値として常に表示される。

【００１８】

表示の更なる改善として、信号の表示、すなわちトレースは、データ信号が受信される際に時間軸に対してスクロールされてもよい。これは、表示されるトレースを繰り返してリフレッシュする信号を表示する場合に通常のやり方と対照的である。

【００１９】

本発明は、データ信号を同期化する対応方法を提供する。また、本発明は、その方法を実行するプログラムコード手段を含んだコンピュータプログラムとして実現されてもよい。したがって、本発明は、そのようなプログラムを実行するコンピュータ読み取り可能な記憶媒体にまで及ぶ。

【００２０】

【発明の実施の形態】

本発明は、添付図面を参照して非限定的な例によってさらに説明される。本発明の実施の形態は、生理的パラメータの監視に適用されて説明される。但し、本発明は独立のクロックで実行する装置によって監視される任意のシステムに適用することができる。典型的な例としては、乗物、製造プラントまたは処理プラント、例えば環境のための制御システム

または監視システムを含む。
【００２１】
図１を参照すると、本発明の図示された実施の形態は、データ入力装置としてのディスプレイ（１）、キーボード（３）およびタッチパッド（５）を含み、生理的データが取得されるべき部分から、様々な種類のデータ収集装置を接続できるコネクタ（７）を含む、高耐久性ラップトップコンピュータに基づいている。
【００２２】
本発明のこの実施の形態は、心電図、血圧モニタ、呼吸モニタ、酸素飽和モニタおよび体温計のような装置から信号を受信するのに適しており、上述から理解されるように、一般的にはこれらの信号の全ては、これらの装置によって異なるサンプリング速度で取得される。
【００２３】
本発明のこの実施の形態は、互いに同期化されるこれらのパラメータの表示および記憶を行う。したがって、データ収集装置の各々は、他の装置のクロックに対してフリーランニングである独立のクロックを有するが、本発明は、マスタクロックに対して各データ収集装置からのデータの各サンプルのタイムスタンプを行う。本実施の形態では、これは、約１／１８秒の分解能を有するラップトップコンピュータのマスタクロックである。
【００２４】
本実施の形態で使用されるマスタクロックは、十分正確であるが、特にＥＣＧトレースの時間スケールに比べてかなり低い分解能を有する。さらに、本実施の形態は、バッチでのデータ処理を可能にするように設計されている。これを達成するために、装置から入ってくるデータは２つのクラスに分けられる。第１のクラスは、マスタクロックの分解能の１／１０よりも小さい周波数で到達し、実際には不規則な間隔で到達してもよい低速度データである。第２のクラスは、より高い周波数で到達する高速度データである。より高い周波数データは、通常一定の速度で発生する。
【００２５】
本実施の形態では、血圧測定または体温測定のような低速度で到達するデータは、マスタクロックからのサンプルでタイムスタンプされる。換言すると、データの各サンプルは、データのタイムスタンプの時間でマスタクロックの値に関連している。
【００２６】
高速度データは異なって処理される。受信された第１のサンプル（または第１のバッチの適切なサンプル）は、マスタクロックからタイムスタンプを与えられる。この生理的データを供給するデータ収集装置からのサンプル間の予想時間間隔は、データ収集装置の仕様に基づいて推定される。したがって、全く単純に、サンプリング速度が２５６ＨｚであるＥＣＧの場合、推定間隔は１／２５６秒である。次に、第１のサンプルに続くデータの次のサンプルは、前のサンプルのためのタイムスタンプに予想時間間隔を加えることで得られた推定タイムスタンプを与えられる。
【００２７】
一定の間隔（例えば、マスタクロックの分解能の低倍数、一般的には５～５０）でマスタクロックからはずれる推定タイムスタンプを可能にするために、サンプルに与えられたタイムスタンプは、マスタクロックの現値と比較される。バッチ処理において、これは、バッチによって最大の精度をもたらすためにそのバッチの最後の値で行われる。
【００２８】
サンプルに与えられるタイムスタンプおよびマスタクロックが、ぴったりと一致している、すなわちマスタクロックの分解能の低倍数内にある場合、このプロセスは持続する。しかしながら、この一致が不十分である場合、２つの手順が実行される。すなわち、
ａ）このサンプルのタイムスタンプは、マスタクロックからの現値に修正され、十分長い隣接セットの前（例えば、１秒等をカバーする）のサンプルは、それらサンプルが、現サンプルに与えられる新しいタイムスタンプまで等間隔となるように、そのタイムスタンプが調整される。

ｂ）さらに、タイムスタンプの推定で使用される時間間隔の値が修正される。よって、データ収集装置の仕様から計算される値を使用するよりもむしろ、この値はマスタクロックからのより低いはずれを得ようと試みるために修正される。この修正は、例えば、予想時間間隔の精度がタイミングエラーが発生したとみなされるのにかかる時間の長さに関連するカルマンフィルタサイクルを使用して、クロックの精度および推定時間間隔の精度に従って重み付けされることができる。しかしながら、調整は異なる方法で行ってもよい。

【００２９】

よって、データ収集装置からの入ってくるデータは、ソフトウェアで同期化され、これは、単一のマスタクロックを使用して異なるデータ収集装置を駆動する必要性を避ける。

【００３０】

同期データは、本実施の形態では、９６時間の連続して同期された患者データを可能にするハードディスクまたは１ギガバイトのＰＣＭＣＩＡディスクに記憶されるか、または遠隔の記憶装置に伝送されてもよい。さらに、データの同期によって、異なるデータ収集装置からの信号は、時間軸に対して整列された単一のディスプレイ１に表示できる。ディスプレイの例は、図２および図３に示される。

【００３１】

本実施の形態では、このデータは、２つの異なるモード、すなわち５秒のデータがグラフィカルに表示される「Ｂｅａｔ　ｔｏ　Ｂｅａｔ」モード（図２を参照）、および５時間のデータが表示される「トレンド」モードで表示されてもよい。ユーザは、２つのモード間を選択的に切り換えることができ、受信されたデータの全てがタイムスタンプされて記憶されるので、ユーザは、トレンドモードからＢｅａｔ　ｔｏ　Ｂｅａｔモードの対応する時間ポイントに切り換えることによって重要な事象にズームインできる。

【００３２】

さらに、本実施の形態では、表示は、右側に追加された新しいデータに対して時間軸に沿ってスクロールされる。これは、１つのトレースが例えば左から右に発生して表示されて、次にこのトレースが、古いトレースに上書きされる新しいデータによって左から右に再びリフレッシュされるといった臨床データの典型的な表示と対照的である。

【００３３】

Ｂｅａｔ　ｔｏ　Ｂｅａｔモードを示す図２をより詳細に参照すると、ＥＣＧの３つのチャネルが酸素飽和トレース２４および呼吸トレース２５とともにトレース２１、２２および２３として表示されることが分かる。その５つのトレースは、５秒のデータを示す時間軸上に重ねて垂直方向に並べられる。さらに、重要な生命徴候は、ディスプレイの右側に数を表す方法で示され、これらは、心拍数、血圧、酸素飽和および体温である。

【００３４】

このＢｅａｔ　ｔｏ　Ｂｅａｔモード表示は、図３のより長い時間スケールのトレンド表示と比較できる。図３では、トレース３１、３２、３３および３４は、５時間のデータを示している。この時間スケールは、１分から１日までカバーするデータを表示できるように、要求に応じて変えることができる。トレース３１は、毎分の鼓動の心拍数を示し、トレース３２は、水銀ミリメートルの血圧を示し（収縮期の血圧および拡張期の血圧が重ねて表示されるが、これらは２０分等毎に表示されるだけである）、トレース３３は、酸素飽和を示し、トレース３４は体温を示している。

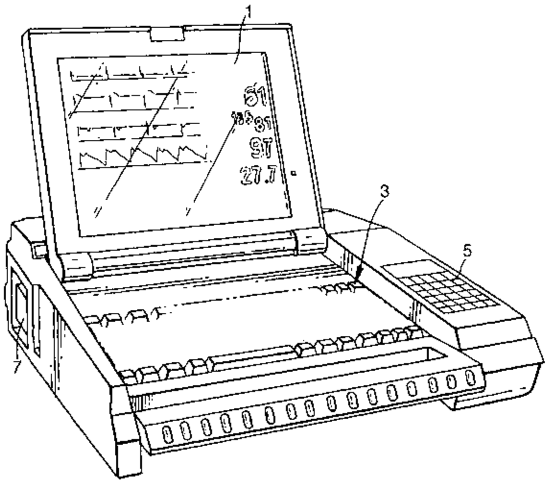
【００３５】

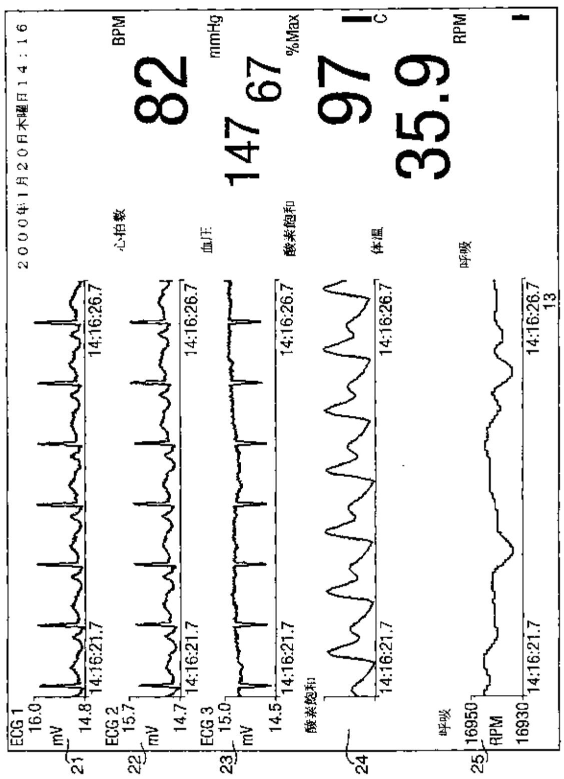
表示は「トレンド」モードであるが、それにもかかわらずＥＣＧトレース３５の単一チャネルがより速い時間スケール（すなわち時間軸にわたる５秒のデータ）で示されることにも注目すべきである。これは、患者の現在の状態の適切な監視を可能にする。呼吸は、３６でトレースとしても表示できる。Ｂｅａｔ　ｔｏ　Ｂｅａｔモード表示と同様に、重要なパラメータの数値はディスプレイの右側に示される。

【００３６】

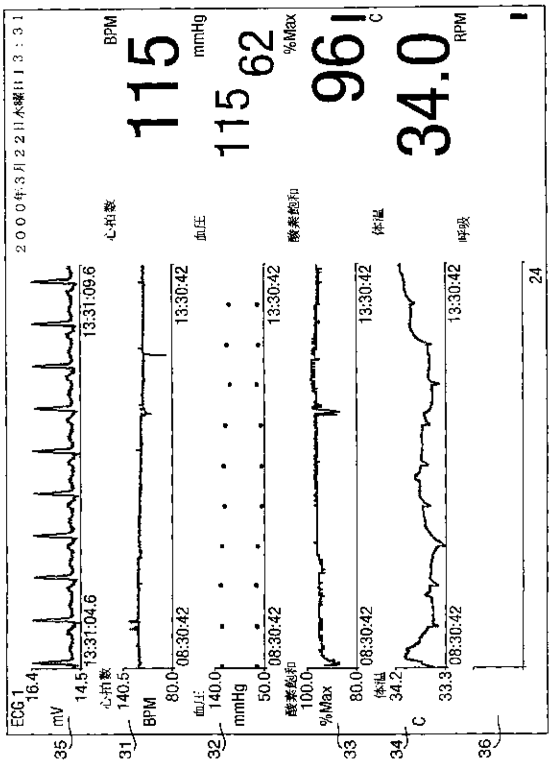
本システムは、同じタイムスタンプ原理を使用して異なる種類のデータ収集装置からの異なる生理的パラメータを取得するように構成できるということが理解される。

【図面の簡単な説明】
【図１】
本発明の実施の形態による取得・ディスプレイ装置を示す図である。
【図２】
図１の実施の形態の「Ｂｅａｔ　ｔｏ　Ｂｅａｔ」表示モードの例を示す図である。
【図３】
図１の実施の形態の「トレンド」表示モードの例を示す図である。
【符号の説明】
２１，３５　心拍数
２２，３１　血圧
２３，３２　酸素飽和
２４，３３　体温
２５，３４　呼吸

【図１】


【図２】


【図３】


ECG 1
16.4
14.5
mV
13:31:04.6
13:31:09.6
心拍数
140.5
80.0
BPM
08:30:42
13:30:42
血圧
140.0
50.0
mmHg
酸素飽和
100.0
80.0
%Max
体温
34.2
33.3
C
24
BPM
115
mmHg
115
62
%Max
96
34.0
RPM
呼吸
35
31
32
33
34
36

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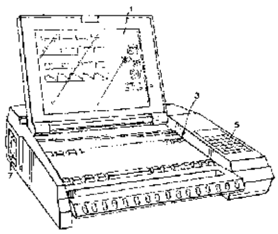
(54) Title: SYSTEM AND METHOD FOR ACQUIRING DATA



(57) Abstract: A system for acquiring, and displaying, data such as physiological data, from a plurality of data connection devices, each of which monitor one or more different parameters and output data at different sampling frequencies based on their own system clocks. The system receives the data signals at different sampling frequencies and associates each sample of each signal with a time stamp derived from a single master clock. Low rate and high rate data are treated differently. Low rate data is associated with the current value of the master clock, where as high rate data is time stamped by giving the first sample a time stamp equal to the current value of the current master clock, subsequent samples being given an estimated time stamp based on the expected interval between samples derived from the sampling frequency of the data collection device, and the timescale given to the first example. The estimated time stamp may be periodically corrected, and the estimation calculation can be improved by correcting the value used for the interval between samples. The different signals can be displayed together on a display aligned with respect to a time axis. The system can display, the data in two different timescales, one showing a few seconds of data and one showing a few hours of data. The data traces are scrolled across the time axis, new data being added to one end of the trace.

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SYSTEM AND METHOD FOR ACQUIRING DATA

This invention relates to the acquisition of data from a plurality of data collection devices each monitoring one or more different parameters, and in particular to the synchronisation of that data.

There are many different situations in which a system is monitored by a plurality of sensors. Often such sensors are part of different data collection devices, and monitor the same or different parameters of the system. In this situation each of the data collection devices may include its own clock controlling the sampling of the data signal it is monitoring. These clocks may be free running with respect to each other. Thus the output signals from the devices may not be synchronised and may be at widely differing rates.

For instance, it is normal when monitoring the condition of a patient to monitor a variety of physiological parameters such as the electrocardiogram (which can be multiple channel), blood pressure, respiration, oxygen saturation using pulse oximetry and temperature. Typically these are acquired by different data collection devices and all are acquired at different sampling rates. For example electrocardiograms (ECG) are typically collected at 256 Hz, pulse oximetry waveforms are typically acquired at 81.3 Hz, respiration waveforms at 64 Hz, temperature at 1Hz and blood pressure once every 10 or 20 minutes. All of these vital signs are of clinical significance and are usually displayed so that medical staff can easily monitor the condition of the patient. However, because all are measured at different rates, and typically by different pieces of apparatus with respective system clocks within them, displaying the different parameters together in a concise and synchronised way is difficult.

In order to overcome the problem of synchronizing the different signals, one solution has been proposed which is to drive all of the different monitors by the same clock signal. However, this requires that all of the monitors are, in essence, integrated which is expensive and inflexible, and further this makes existing equipment redundant.

The display of the data is also rendered difficult because parameters such as the ECG trace vary on a fast timescale compared to parameters such as blood pressure (which is only measured every 10 to 20 minutes). Thus the timing of samples in an ECG trace needs to be accurately recorded. However, the timing of samples of the blood pressure can be of lower accuracy without the loss of clinical significance.

Similar problems arise in other systems, such as plant monitoring and control, e.g. of chemical processing plants, monitoring and control of machines, such as engines or vehicle systems.

According to the present invention there is provided a system for acquiring data from a plurality of data collection devices each monitoring a parameter and outputting a data signal at a respective sampling frequency based on respective system clocks, the system comprising

data processing means having:

input means for receiving data signals from each of the plurality of data collection devices;

a master clock for providing a master clock signal; and

time stamping means for associating a time stamp derived from the master clock with each of the data signals.

Thus the invention allows data to be collected from a variety of different data collection devices, but the data samples are given a timestamp which is synchronised with a master clock.

The timestamp may have a higher resolution than the master clock. The master clock produces a new time value at regular intervals. The number of such intervals within a second is known as the tick-rate. The resolution on the time axis is the inverse of the tick-rate.

Preferably the time stamp associated with the samples is calculated in a different way depending on the sampling frequency of the data signal. For data signals (such as in a physiological environment the blood pressure or temperature) whose sampling frequency is below a predetermined threshold, each sample of the data is associated with a time stamp which is simply the value of the master clock signal at the time the data is given the timestamp. However for data signals whose sampling frequency is above the predetermined threshold (such as in a physiological environment the ECG, pulse oximetry or respiration waveforms) a first sample (or an appropriate sample in a first batch) of the data signal is associated with the value of the master clock signal at the time of time stamping, but subsequent samples are provided with an estimated time stamp. This may be based on a time interval calculated from the sampling frequency of the data collection device providing that signal (based on the known specifications of the data collecting device).

Preferably the estimate is periodically compared with the current value of the master clock to determine whether the difference between them is acceptable, or greater than a predetermined amount. If it is greater than the predetermined amount then the time stamp is corrected. Further, the time stamps of a contiguous set of samples preceding the current sample are also adjusted, for instance by adjusting them so that they are evenly spaced in time up to the current sample. The predetermined difference below which correction is regarded as unnecessary may be a multiple (between 5 and 50, for example) of the master clock's resolution and the predetermined threshold of sampling frequency may be less than or equal to the master clock frequency, preferably less than one fifth of the master clock frequency.

As well as adjusting the time stamps of the set of samples preceding the current sample, the manner in which the time stamp is estimated for future samples can be adjusted by adjusting the value of sampling interval used in the calculation. Thus by correcting that value it is hoped that the estimated time stamp will not diverge (or not diverge so quickly) from the value of the master clock. This adjustment can be achieved using a Kalman filter in which the value for the accuracy of the sampling interval is set in accordance with the time taken for the estimated time stamp to diverge significantly from the master clock.

In one embodiment for use in monitoring a physiological system (such as a patient) the system is suitable for receiving and displaying signals from an ECG monitor, oxygen saturation monitor, respiration monitor, blood pressure monitor and thermometer, or indeed any other transducer or monitor used for acquiring physiological data.

Preferably the system is based around a data processing device, which incorporates the master clock, the time stamping means and the display, and the system may be ruggedized so as to be easily portable without risk of damage.

To improve the clarity of the display the data may be displayed selectively on one of two different timescales which may be referred to as a short term continuous timescale, e.g. a "beat-to-beat" timescale in a physiological environment, as in which the time axis shows a short period of data in detail, e.g. a few seconds of data (typically from 1 to 60), and a "trend" timescale in which the time axis shows a longer section of data, e.g. a few hours of data (typically this may go from 1 minute to 1 day).

The parameters displayed and the manner of their display may be varied between the two types of display. For instance, on displaying data at the first timescale, data sampled at a low sampling frequency, can be displayed as a numerical value, rather than a continuous trace (which would have little meaning at this timescale given its much lower sampling frequency). On the other hand, in the "trend" timescale it may be useful still to display a single high frequency trace at the shorter timescale so that a continuous visual check of this trace can be maintained, even though the rest of the data is viewed over a long timescale. Preferably key values for the system, such as in the physiological environment the heart rate, blood pressure, oxygen saturation and temperature, are always displayed as numerical values alongside the traces in both display modes.

As a further improvement of the display the representations of the signals, namely the traces, may be scrolled with respect to the time axis as the data signals are received. This contrasts with the normal practice when displaying signals of refreshing the displayed trace repeatedly.

The invention provides a corresponding method of synchronizing data signals and the invention maybe embodied as a computer program comprising program code means for carrying out the method. The invention thus extends to a computer-readable storage medium carrying such a program.

The invention will be further described by way of non-limitative example with reference to the accompanying drawings in which:-

Figure 1 shows an acquisition and display apparatus according to an embodiment of the invention;

Figure 2 illustrates an example of a "beat-to-beat" display mode of the embodiment of Figure 1; and

Figure 3 shows an example of the "trend" display mode of the embodiment of Figure 1.

An embodiment of the invention will be described applied to the monitoring of physiological parameters, though the invention can be applied to any system being monitored by devices running on independent clocks. Typical examples include vehicles, manufacturing or processing plants, control or monitoring systems for instance for the environment.

Referring to Figure 1 the illustrated embodiment of the invention is based on a ruggedized laptop computer which includes a display (1) a keyboard (3) and touchpad (5) as data input devices and connectors (7) to which can be connected the various types of data collection device from which physiological data is to be acquired.

This embodiment of the invention is suitable for receiving signals from such devices as an electrocardiograph, blood pressure monitor, respiration monitor, oxygen saturation monitor and thermometer and, as will be appreciated from the discussion above, typically all of these signals are acquired by those devices at different sampling rates. This embodiment of the invention provides for the display, and storage, of these parameters synchronised with each other. Thus although each of the data collection devices has an independent clock which is free-running relative to the clocks of the other devices, the invention provides for the time stamping of each sample of data from each data collection device with respect to a master clock. In this embodiment this is the master clock of the laptop computer, which has a resolution of approximately $^1/_{18th}$ of a second.

The master clock used in this embodiment is sufficiently accurate, but has a rather low resolution, particularly compared to the timescale of the ECG trace. Further, this embodiment is designed to allow for the processing of the data in batches. In order to achieve this the incoming data from the devices is separated into two classes. The first class is low-rate data, which arrives at a frequency of less than $^1/_{10th}$ of the resolution of the master clock, and may actually arrive at irregular intervals. The second class is high-rate data which arrives at a higher frequency. The higher frequency data is generally generated at a regular rate.

In this embodiment the data arriving at low rate, such as blood pressure measurements or temperature, are time stamped with a sample from the master clock. In other words, each sample of data is associated with the value of the master clock at the time of time stamping of the data.

The high rate data is treated differently. The first sample received (or an appropriate sample in a first batch) is given a time stamp from the master clock. An expected time interval between samples from the data collection device providing this physiological data is estimated based on the specifications of the data collection device. Thus, quite simply, for an ECG where the sampling rate is 256 Hz, the estimated interval is 1/256 seconds. Subsequent samples of the data following the first are then given an estimated time stamp which is the time stamp for the previous sample plus the expected time interval.

In order to allow for the estimated time stamp diverging from the master clock, at regular intervals (e.g. a low multiple of the resolution of the master clock typically 5 to 50), the time stamp given to a sample is compared with the current value of the master clock. In batch processing this is done on the last value in the batch to give maximum accuracy through the batch. If the time stamp given to the sample and the master clock are in close agreement, i.e within a low multiple of the master clock's resolution, then the process continues. However, if the agreement is insufficient, two procedures are carried out:-

a) The time stamp of that sample is corrected to the current value from the master clock and a sufficiently long contiguous set of previous (e.g. covering one second or so) samples have their time stamp adjusted so that they are evenly spaced up to the new time stamp given to the current sample.

b) Also the value of the time interval used in the estimate of the time stamps is corrected. Thus rather than using the value calculated from the specifications of the data collection device, that value is adjusted to try to achieve lower divergence from the master clock. The correction can be weighted according to the accuracy of the clock and the accuracy of the estimated time interval, for instance using a Kalman filter cycle in which the accuracy of the expected time interval is related to the length of time it takes for a timing error to be deemed to have occurred. However, the adjustment can be made in different ways.

Thus the incoming data from the data collection devices is synchronized in software and this avoids the need to drive the different data collection devices using a single master clock.

The synchronized data is, in this embodiment, stored on a hard disk or a 1-gigabyte PCMCIA disk allowing 96 hours of continuous synchronized patient data or it can be transmitted to a remote store. Further, the synchronization of the data allows the signals from the different data collection devices to be displayed on the single display 1 aligned with respect to the time axis. Examples of the displays are shown in Figures 2 and 3. In this embodiment the data may be displayed in two different modes, a "beat-to-beat" mode in which five seconds of data are displayed graphically (see Figure 2), and a "trend" mode in which five hours of data is displayed (see Figure 3). The user can switch selectively between the two modes, and because all of the data received is time stamped and stored the user can zoom in on key events by switching from the trend mode to the corresponding time point in the beat-to-beat mode. Further, in this embodiment the displays are scrolled along the time axis with new data being added on the right hand side. This contrasts with a typical display of clinical data in which one trace is generated and displayed, e.g from left to right, and then that trace is refreshed, again, from left to right, by new data being overwritten on the old trace.

Referring in more detail to Figure 2, which shows the beat-to-beat mode, it can be seen that three channels of ECG are displayed as traces 21, 22 and 23 together with an oxygen saturation trace 24 and a respiration trace 25. The five traces are aligned vertically one above the other on a time axis showing five seconds of data. In addition important vital signs are shown in numerical fashion on the right hand side of the display, these being the heart rate, blood pressure, oxygen saturation and temperature.

This beat-to-beat mode display can be compared with the longer timescale trend display in Figure 3. In Figure 3 the traces 31, 32, 33 and 34 show data for a five hour period. This timescale can be varied as desired so that data covering from one minute to one day can be displayed. Trace 31 shows the heat rate in beats per minute, trace 32 shows the blood pressure in millimetres of mercury (and it can be seen that values of the systolic and diastolic blood pressure are displayed one above the other, but they only appear every 20 minutes or so), the trace 33 shows the oxygen saturation and trace 34 shows the temperature. It should also be noted that although the display is in the "trend" mode, nevertheless a single channel of ECG trace 35 is shown at the faster timescale (i.e. 5 seconds of data over the time axis). This allows proper monitoring of the current condition of the patient. The respiration can also be displayed as a trace at 36.

In a similar fashion to the beat-to-beat mode display, numerical values of the key parameters are shown on the right hand side of the display.

It should be appreciated that the system can be adapted to acquire different physiological parameters from different types of data collection device, using the same time stamping principles.

CLAIMS

1. A system for acquiring data from a plurality of data collection devices each monitoring one or more parameters and outputting a data signal at a respective sampling frequency based on respective system clocks, the system comprising

data processing means having:

input means for receiving the data signals from each of the plurality of data collection devices;

a master clock for providing a master clock signal; and

time stamping means for associating a time stamp derived from the master clock with each of the data signals.

2. A system according to claim 1, further comprising:

display for displaying a representation of the data signals aligned with respect to a time axis on the basis of said respective time stamps.

3. A system according to claim 1 or 2 wherein the time stamp has a higher resolution than the master clock.

4. A system according to claim 1, 2 or 3 wherein for data signals whose sampling frequency is below a predetermined threshold the time stamping means associates as the time stamp a sample of the master clock signal, and for data signals whose sampling frequency is above the predetermined threshold the time stamping means associates as an initial time stamp for a sample of the data signal a sample of the master clock signal, and for subsequent samples of the data signal an estimated time stamp.

5. A system according to claim 4, wherein the estimated time stamp is based on a

time interval calculated from the sampling frequency of the data collection device providing the data signal and the initial time stamp.

6. A system according to claim 4 or 5, wherein the predetermined threshold is less than or equal to the master clock frequency.

7. A system according to claim 4, 5 or 6 wherein the data processing means comprises a comparator, and wherein for data signals whose sampling frequency is above the predetermined threshold the comparator periodically compares the estimated time stamp being associated with the current sample with the master clock to determine the difference between them and, if the difference is greater than a predetermined amount, the data processing means corrects the estimated time stamp to correspond to the master clock signal.

8. A system according to claim 7 wherein, if the difference is greater than the predetermined amount, the data processing means adjusts the time stamps of a contiguous set of samples preceding the current sample.

9. A system according to claim 8, wherein the data processing means adjusts the time stamps of the contiguous set of samples preceding the current sample by an equal fraction of the difference such that they are evenly spaced in time up to the current sample.

10. A system according to claim 8 or 9, wherein the number of samples in the contiguous set is substantially the number of samples acquired in one second.

11. A system according to any one of claims 6 to 10 wherein, if the difference is greater than a predetermined amount, the data processing means produces the estimated time

stamp for subsequent samples based on an adjusted value of said time interval.

12. A system according to claim 11, wherein the data processing means comprises a Kalman filter for calculating the adjusted value of the time interval.

13. A system according to claim 11, wherein the data processing means comprises calculating means for calculating the value of the accuracy of the time interval in accordance with the time taken for the predetermined amount to be reached.

14. A system according to any one of the preceding claims which is operable with data collection devices whose system clocks are free-running with respect to said master clock.

15. A system according to any one of the preceding claims further comprise a data storage device for storing the data samples and time stamps.

16. A system according to any one of the preceding claims wherein the signals are physiological signals.

17. A system according to any one of the preceding claims wherein the input means comprises interfaces for receiving signals from at least two of: an ecg monitor, oxygen saturation monitor, respiration monitor, blood pressure monitor, thermometer, intra-cranial pressure monitor, partial oxygen pressure monitor and partial carbon dioxide pressure monitor.

18. A system according to claim 2 or any claim dependent thereon comprising a laptop computer incorporating the master clock, the time stamping means and the display.

19. A system according to claim 2 or any claim dependent thereon wherein the data processing means and the display are adapted to display a representation of the data signals selectively on one of two different timescales.

20. A system according to claim 19 wherein the two different timescales are a first timescale of a few seconds to a few minutes and a second timescale of one minute to a few days.

21. A system according to claim 20 wherein the first timescale is such that less than thirty seconds of the time axis is displayed.

22. A system according to claim 20 wherein the first timescale is such that less than ten seconds of the time axis is displayed.

23. A system according to claim 20, 21 or 22 wherein on displaying the representation of the data at the first timescale, data sampled at a low sampling frequency is displayed as a numeric value.

24. A system according to claim 20, 21, 22 or 23 wherein the second timescale is such that more than one hour of the time axis is displayed.

25. A system according to claim 20, 21, 22 or 23 wherein the second timescale is such that five or more hours of the time axis is displayed.

26. A system according to any one of claims 20 to 25 wherein on displaying the representation of the data at the second timescale, one trace of data sampled at a high

sampling frequency is simultaneously displayed at the first timescale.

27. A system according to claim 26 wherein the one trace of data is an ecg trace.

28. A system according to any one of the preceding claims wherein the displayed representations of the data signals are scrolled with respect to the time axis as the data signals are received.

29. A system for acquiring and displaying data from a plurality of data collection devices, the system being constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

30. A method of synchronising data signals from a plurality of data collection devices, each monitoring a parameter and outputting a data signal at a respective sampling frequency based on respective system clocks, the method comprising associating a time stamp derived from a master clock with each of the data signals.

31. A method according to claim 30 wherein the time stamp has a higher resolution than the master clock.

32. A method according to claim 30 or 31 comprising, for data signals whose sampling frequency is below a predetermined threshold, associating as the time stamp a sample of the master clock signal, and for data signals whose sampling frequency is above the predetermined threshold associating as an initial time stamp for a sample of the data signal a sample of the master clock signal, and for subsequent samples of the data signal an estimated time stamp.

33. A method according to claim 32 wherein the estimated time stamp is based on a time interval calculated from the sampling frequency of the data collection device providing the data signal and the initial time stamp.

34. A method according to claim 32 or 33, wherein the predetermined threshold is less than or equal to the master clock frequency.

35. A method according to claim 32, 33 or 34 wherein, for data signals whose sampling frequency is above the predetermined threshold, the estimated time stamp being associated with the current sample is periodically compared with the master clock signal to determine the difference between them and, if the difference is greater than a predetermined amount, the estimated time stamp is corrected to correspond to the master clock signal.

36. A method according to claim 35 wherein, if the difference is greater than the predetermined amount, the time stamps of a contiguous set of samples preceding the current sample are adjusted.

37. A method according to claim 36, wherein the time stamps of the contiguous set of samples preceding the current sample are adjusted by an equal fraction of the difference such that they are evenly spaced in time up to the current sample.

38. A method according to claim 36 or 37, wherein the number of samples in the contiguous set is substantially the number of samples acquired in one second.

39. A method according to any one of claims 34 to 38 wherein, if the difference is greater than a predetermined amount, the estimated time stamp for subsequent samples is

based on an adjusted value of said time interval.

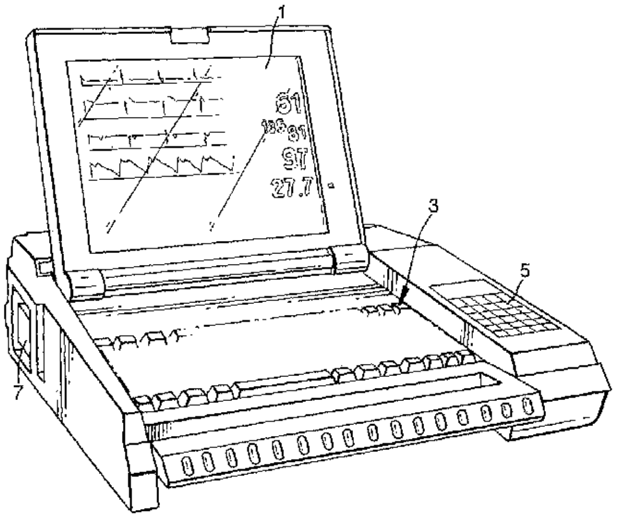
40. A method according to claim 39, comprising a Kalman filtering process for calculating the adjusted value of the time interval.

41. A method according to claim 39, wherein the value of the accuracy of the time interval is calculated in accordance with the time taken for the predetermined amount to be reached.

42. A method according to any one of claims 30 to 41 wherein the signals are physiological signals.

43. A method according to any one of claims 30 to 42 wherein the signals comprise signals from at least two of: an ecg monitor, oxygen saturation monitor, respiration monitor, blood pressure monitor, thermometer, intra-cranial pressure monitor, partial oxygen pressure monitor and partial carbon dioxide pressure monitor.

Fig.1.



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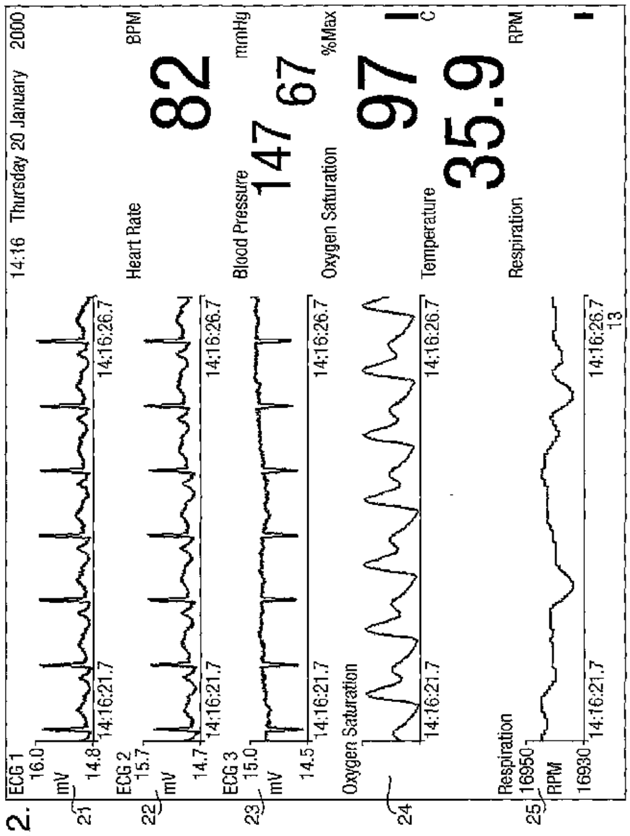

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mV
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ECG 2
15.7
mV
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15.0
mV
14.5
Oxygen Saturation
Respiration
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RPM
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22
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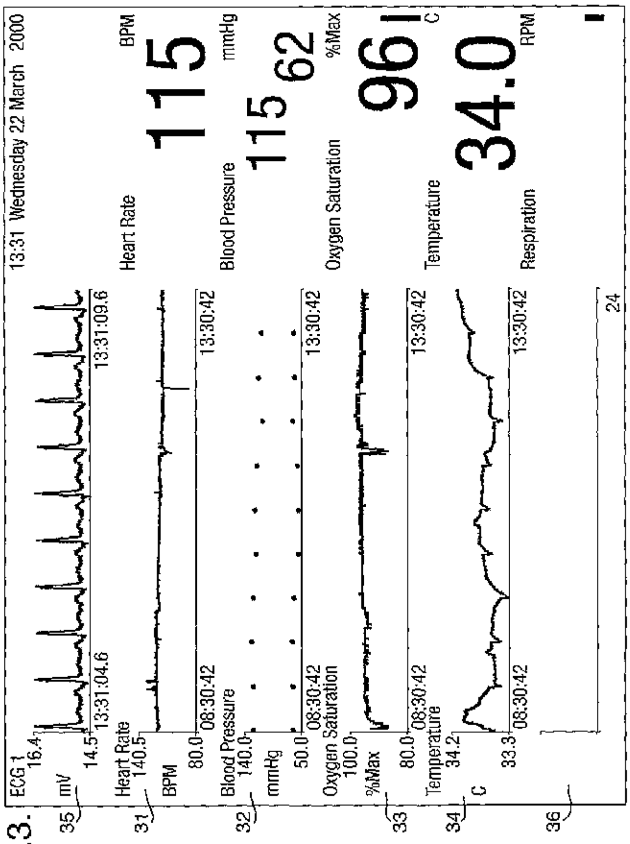
24
25

Fig.2.

3/3

Fig.3.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33.3
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33
34
36

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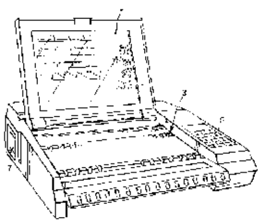

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(57) Abstract: A system for acquiring, and displaying, data such as physiological data, from a plurality of data connection devices, each of which monitor one or more different parameters and output data at different sampling frequencies based on their own system clocks. The system receives the data signals at different sampling frequencies and associates each sample of each signal with a time stamp derived from a single master clock. Low rate and high rate data are treated differently. Low rate data is associated with the current value of the master clock, where as high rate data is time stamped by giving the first sample a time stamp equal to the current value of the current master clock, subsequent samples being given an estimated time stamp based on the expected interval between samples derived from the sampling frequency of the data collection device, and the timescale given to the first example. The estimated time stamp may be periodically corrected, and the estimation calculation can be improved by correcting the value used for the interval between samples. The different signals can be displayed together on a display aligned with respect to a time axis. The system can display, the data in two different timescales, one showing a few seconds of data and one showing a few hours of data. The data traces are scrolled across the time axis, new data being added to one end of the trace.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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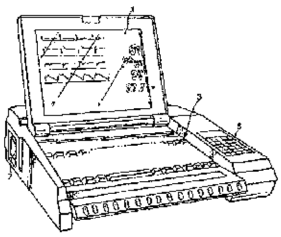
(54) Title: SYSTEM AND METHOD FOR ACQUIRING DATA



WO 01/97092 A2

(57) Abstract: A system for acquiring, and displaying, data such as physiological data, from a plurality of data connection devices, each of which monitor one or more different parameters and output data at different sampling frequencies based on their own system clocks. The system receives the data signals at different sampling frequencies and associates each sample of each signal with a time stamp derived from a single master clock. Low rate and high rate data are treated differently. Low rate data is associated with the current value of the master clock, where as high rate data is time stamped by giving the first sample a time stamp equal to the current value of the current master clock, subsequent samples being given an estimated time stamp based on the expected interval between samples derived from the sampling frequency of the data collection device, and the timescale given to the first example. The estimated time stamp may be periodically corrected, and the estimation calculation can be improved by correcting the value used for the interval between samples. The different signals can be displayed together on a display aligned with respect to a time axis. The system can display, the data in two different timescales, one showing a few seconds of data and one showing a few hours of data. The data traces are scrolled across the time axis, new data being added to one end of the trace.

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SYSTEM AND METHOD FOR ACQUIRING DATA

This invention relates to the acquisition of data from a plurality of data collection devices each monitoring one or more different parameters, and in particular to the synchronisation of that data.

There are many different situations in which a system is monitored by a plurality of sensors. Often such sensors are part of different data collection devices, and monitor the same or different parameters of the system. In this situation each of the data collection devices may include its own clock controlling the sampling of the data signal it is monitoring. These clocks may be free running with respect to each other. Thus the output signals from the devices may not be synchronised and may be at widely differing rates.

For instance, it is normal when monitoring the condition of a patient to monitor a variety of physiological parameters such as the electrocardiogram (which can be multiple channel), blood pressure, respiration, oxygen saturation using pulse oximetry and temperature. Typically these are acquired by different data collection devices and all are acquired at different sampling rates. For example electrocardiograms (ECG) are typically collected at 256 Hz, pulse oximetry waveforms are typically acquired at 81.3 Hz, respiration waveforms at 64 Hz, temperature at 1Hz and blood pressure once every 10 or 20 minutes. All of these vital signs are of clinical significance and are usually displayed so that medical staff can easily monitor the condition of the patient. However, because all are measured at different rates, and typically by different pieces of apparatus with respective system clocks within them, displaying the different parameters together in a concise and synchronised way is difficult.

In order to overcome the problem of synchronizing the different signals, one solution has been proposed which is to drive all of the different monitors by the same clock signal. However, this requires that all of the monitors are, in essence, integrated which is expensive and inflexible, and further this makes existing equipment redundant.

The display of the data is also rendered difficult because parameters such as the ECG trace vary on a fast timescale compared to parameters such as blood pressure (which is only measured every 10 to 20 minutes). Thus the timing of samples in an ECG trace needs to be accurately recorded. However, the timing of samples of the blood pressure can be of lower accuracy without the loss of clinical significance.

Similar problems arise in other systems, such as plant monitoring and control, e.g. of chemical processing plants, monitoring and control of machines, such as engines or vehicle systems.

According to the present invention there is provided a system for acquiring data from a plurality of data collection devices each monitoring a parameter and outputting a data signal at a respective sampling frequency based on respective system clocks, the system comprising

data processing means having:

input means for receiving data signals from each of the plurality of data collection devices;

a master clock for providing a master clock signal; and

time stamping means for associating a time stamp derived from the master clock with each of the data signals.

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Thus the invention allows data to be collected from a variety of different data collection devices, but the data samples are given a timestamp which is synchronised with a master clock.

The timestamp may have a higher resolution than the master clock. The master clock produces a new time value at regular intervals. The number of such intervals within a second is known as the tick-rate. The resolution on the time axis is the inverse of the tick-rate.

Preferably the time stamp associated with the samples is calculated in a different way depending on the sampling frequency of the data signal. For data signals (such as in a physiological environment the blood pressure or temperature) whose sampling frequency is below a predetermined threshold, each sample of the data is associated with a time stamp which is simply the value of the master clock signal at the time the data is given the timestamp. However for data signals whose sampling frequency is above the predetermined threshold (such as in a physiological environment the ECG, pulse oximetry or respiration waveforms) a first sample (or an appropriate sample in a first batch) of the data signal is associated with the value of the master clock signal at the time of time stamping, but subsequent samples are provided with an estimated time stamp. This may be based on a time interval calculated from the sampling frequency of the data collection device providing that signal (based on the known specifications of the data collecting device).

Preferably the estimate is periodically compared with the current value of the master clock to determine whether the difference between them is acceptable, or greater than a predetermined amount. If it is greater than the predetermined amount then the

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time stamp is corrected. Further, the time stamps of a contiguous set of samples preceding the current sample are also adjusted, for instance by adjusting them so that they are evenly spaced in time up to the current sample. The predetermined difference below which correction is regarded as unnecessary may be a multiple (between 5 and 50, for example) of the master clock's resolution and the predetermined threshold of sampling frequency may be less than or equal to the master clock frequency, preferably less than one fifth of the master clock frequency.

As well as adjusting the time stamps of the set of samples preceding the current sample, the manner in which the time stamp is estimated for future samples can be adjusted by adjusting the value of sampling interval used in the calculation. Thus by correcting that value it is hoped that the estimated time stamp will not diverge (or not diverge so quickly) from the value of the master clock. This adjustment can be achieved using a Kalman filter in which the value for the accuracy of the sampling interval is set in accordance with the time taken for the estimated time stamp to diverge significantly from the master clock.

In one embodiment for use in monitoring a physiological system (such as a patient) the system is suitable for receiving and displaying signals from an ECG monitor, oxygen saturation monitor, respiration monitor, blood pressure monitor and thermometer, or indeed any other transducer or monitor used for acquiring physiological data.

Preferably the system is based around a data processing device, which incorporates the master clock, the time stamping means and the display, and the system may be ruggedized so as to be easily portable without risk of damage.

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To improve the clarity of the display the data may be displayed selectively on one of two different timescales which may be referred to as a short term continuous timescale, e.g. a "beat-to-beat" timescale in a physiological environment, as in which the time axis shows a short period of data in detail, e.g. a few seconds of data (typically from 1 to 60), and a "trend" timescale in which the time axis shows a longer section of data, e.g. a few hours of data (typically this may go from 1 minute to 1 day).

The parameters displayed and the manner of their display may be varied between the two types of display. For instance, on displaying data at the first timescale, data sampled at a low sampling frequency, can be displayed as a numerical value, rather than a continuous trace (which would have little meaning at this timescale given its much lower sampling frequency). On the other hand, in the "trend" timescale it may be useful still to display a single high frequency trace at the shorter timescale so that a continuous visual check of this trace can be maintained, even though the rest of the data is viewed over a long timescale. Preferably key values for the system, such as in the physiological environment the heart rate, blood pressure, oxygen saturation and temperature, are always displayed as numerical values alongside the traces in both display modes.

As a further improvement of the display the representations of the signals, namely the traces, may be scrolled with respect to the time axis as the data signals are received. This contrasts with the normal practice when displaying signals of refreshing the displayed trace repeatedly.

The invention provides a corresponding method of synchronizing data signals and the invention maybe embodied as a computer program comprising program code means for carrying out the method. The invention thus extends to a computer-readable storage medium carrying such a program.

The invention will be further described by way of non-limitative example with reference to the accompanying drawings in which:-

Figure 1 shows an acquisition and display apparatus according to an embodiment of the invention;

Figure 2 illustrates an example of a "beat-to-beat" display mode of the embodiment of Figure 1; and

Figure 3 shows an example of the "trend" display mode of the embodiment of Figure 1.

An embodiment of the invention will be described applied to the monitoring of physiological parameters, though the invention can be applied to any system being monitored by devices running on independent clocks. Typical examples include vehicles, manufacturing or processing plants, control or monitoring systems for instance for the environment.

Referring to Figure 1 the illustrated embodiment of the invention is based on a ruggedized laptop computer which includes a display (1) a keyboard (3) and touchpad (5) as data input devices and connectors (7) to which can be connected the various types of data collection device from which physiological data is to be acquired.

This embodiment of the invention is suitable for receiving signals from such devices as an electrocardiograph, blood pressure monitor, respiration monitor, oxygen saturation monitor and thermometer and, as will be appreciated from the discussion above, typically all of these signals are acquired by those devices at different sampling rates. This embodiment of the invention provides for the display, and storage, of these parameters synchronised with each other. Thus although each of the data collection

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devices has an independent clock which is free-running relative to the clocks of the other devices, the invention provides for the time stamping of each sample of data from each data collection device with respect to a master clock. *In this embodiment this is the* master clock of the laptop computer, which has a resolution of approximately $^{1}/_{18th}$ of a second.

The master clock used in this embodiment is sufficiently accurate, but has a rather low resolution, particularly compared to the timescale of the ECG trace. Further, this embodiment is designed to allow for the processing of the data in batches. In order to achieve this the incoming data from the devices is separated into two classes. The first class is low-rate data, which arrives at a frequency of less than $^{1}/_{10th}$ of the resolution of the master clock, and may actually arrive at irregular intervals. The second class is high-rate data which arrives at a higher frequency. The higher frequency data is generally generated at a regular rate.

In this embodiment the data arriving at low rate, such as blood pressure measurements or temperature, are time stamped with a sample from the master clock. In other words, each sample of data is associated with the value of the master clock at the time of time stamping of the data.

The high rate data is treated differently. The first sample received (or an appropriate sample in a first batch) is given a time stamp from the master clock. An expected time interval between samples from the data collection device providing this physiological data is estimated based on the specifications of the data collection device. Thus, quite simply, for an ECG where the sampling rate is 256 Hz, the estimated interval is 1/256 seconds. Subsequent samples of the data following the first are then given an estimated time stamp which is the time stamp for the previous sample plus the expected

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time interval.

In order to allow for the estimated time stamp diverging from the master clock, at regular intervals (e.g. a low multiple of the resolution of the master clock typically 5 to 50), the time stamp given to a sample is compared with the current value of the master clock. In batch processing this is done on the last value in the batch to give maximum accuracy through the batch. If the time stamp given to the sample and the master clock are in close agreement, i.e within a low multiple of the master clock's resolution, then the process continues. However, if the agreement is insufficient, two procedures are carried out:-

a) The time stamp of that sample is corrected to the current value from the master clock and a sufficiently long contiguous set of previous (e.g. covering one second or so) samples have their time stamp adjusted so that they are evenly spaced up to the new time stamp given to the current sample.

b) Also the value of the time interval used in the estimate of the time stamps is corrected. Thus rather than using the value calculated from the specifications of the data collection device, that value is adjusted to try to achieve lower divergence from the master clock. The correction can be weighted according to the accuracy of the clock and the accuracy of the estimated time interval, for instance using a Kalman filter cycle in which the accuracy of the expected time interval is related to the length of time it takes for a timing error to be deemed to have occurred. However, the adjustment can be made in different ways.

Thus the incoming data from the data collection devices is synchronized in software and this avoids the need to drive the different data collection devices using a single master clock.

The synchronized data is, in this embodiment, stored on a hard disk or a 1-gigabyte PCMCIA disk allowing 96 hours of continuous synchronized patient data or it can be transmitted to a remote store. Further, the synchronization of the data allows the signals from the different data collection devices to be displayed on the single display 1 aligned with respect to the time axis. Examples of the displays are shown in Figures 2 and 3. In this embodiment the data may be displayed in two different modes, a "beat-to-beat" mode in which five seconds of data are displayed graphically (see Figure 2), and a "trend" mode in which five hours of data is displayed (see Figure 3). The user can switch selectively between the two modes, and because all of the data received is time stamped and stored the user can zoom in on key events by switching from the trend mode to the corresponding time point in the beat-to-beat mode. Further, in this embodiment the displays are scrolled along the time axis with new data being added on the right hand side. This contrasts with a typical display of clinical data in which one trace is generated and displayed, e.g from left to right, and then that trace is refreshed, again, from left to right, by new data being overwritten on the old trace.

Referring in more detail to Figure 2, which shows the beat-to-beat mode, it can be seen that three channels of ECG are displayed as traces 21, 22 and 23 together with an oxygen saturation trace 24 and a respiration trace 25. The five traces are aligned vertically one above the other on a time axis showing five seconds of data. In addition important vital signs are shown in numerical fashion on the right hand side of the display, these being the heart rate, blood pressure, oxygen saturation and temperature.

This beat-to-beat mode display can be compared with the longer timescale trend display in Figure 3. In Figure 3 the traces 31, 32, 33 and 34 show data for a five hour period. This timescale can be varied as desired so that data covering from one minute to one day can be displayed. Trace 31 shows the heat rate in beats per minute, trace 32 shows the blood pressure in millimetres of mercury (and it can be seen that values of the systolic and diastolic blood pressure are displayed one above the other, but they only appear every 20 minutes or so), the trace 33 shows the oxygen saturation and trace 34 shows the temperature. It should also be noted that although the display is in the "trend" mode, nevertheless a single channel of ECG trace 35 is shown at the faster timescale (i.e. 5 seconds of data over the time axis). This allows proper monitoring of the current condition of the patient. The respiration can also be displayed as a trace at 36.

In a similar fashion to the beat-to-beat mode display, numerical values of the key parameters are shown on the right hand side of the display.

It should be appreciated that the system can be adapted to acquire different physiological parameters from different types of data collection device, using the same time stamping principles.

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CLAIMS

1. A system for acquiring data from a plurality of data collection devices each monitoring one or more parameters and outputting a data signal at a respective sampling frequency based on respective system clocks, the system comprising

data processing means having:

input means for receiving the data signals from each of the plurality of data collection devices;

a master clock for providing a master clock signal; and

time stamping means for associating a time stamp derived from the master clock with each of the data signals.

2. A system according to claim 1, further comprising:

display for displaying a representation of the data signals aligned with respect to a time axis on the basis of said respective time stamps.

3. A system according to claim 1 or 2 wherein the time stamp has a higher resolution than the master clock.

4. A system according to claim 1, 2 or 3 wherein for data signals whose sampling frequency is below a predetermined threshold the time stamping means associates as the time stamp a sample of the master clock signal, and for data signals whose sampling frequency is above the predetermined threshold the time stamping means associates as an initial time stamp for a sample of the data signal a sample of the master clock signal, and for subsequent samples of the data signal an estimated time stamp.

5. A system according to claim 4, wherein the estimated time stamp is based on a

time interval calculated from the sampling frequency of the data collection device providing the data signal and the initial time stamp.

6. A system according to claim 4 or 5, wherein the predetermined threshold is less than or equal to the master clock frequency.

7. A system according to claim 4, 5 or 6 wherein the data processing means comprises a comparator, and wherein for data signals whose sampling frequency is above the predetermined threshold the comparator periodically compares the estimated time stamp being associated with the current sample with the master clock to determine the difference between them and, if the difference is greater than a predetermined amount, the data processing means corrects the estimated time stamp to correspond to the master clock signal.

8. A system according to claim 7 wherein, if the difference is greater than the predetermined amount, the data processing means adjusts the time stamps of a contiguous set of samples preceding the current sample.

9. A system according to claim 8, wherein the data processing means adjusts the time stamps of the contiguous set of samples preceding the current sample by an equal fraction of the difference such that they are evenly spaced in time up to the current sample.

10. A system according to claim 8 or 9, wherein the number of samples in the contiguous set is substantially the number of samples acquired in one second.

11. A system according to any one of claims 6 to 10 wherein, if the difference is greater than a predetermined amount, the data processing means produces the estimated time

stamp for subsequent samples based on an adjusted value of said time interval.

12. A system according to claim 11, wherein the data processing means comprises a Kalman filter for calculating the adjusted value of the time interval.

13. A system according to claim 11, wherein the data processing means comprises calculating means for calculating the value of the accuracy of the time interval in accordance with the time taken for the predetermined amount to be reached.

14. A system according to any one of the preceding claims which is operable with data collection devices whose system clocks are free-running with respect to said master clock.

15. A system according to any one of the preceding claims further comprise a data storage device for storing the data samples and time stamps.

16. A system according to any one of the preceding claims wherein the signals are physiological signals.

17. A system according to any one of the preceding claims wherein the input means comprises interfaces for receiving signals from at least two of: an ecg monitor, oxygen saturation monitor, respiration monitor, blood pressure monitor, thermometer, intra-cranial pressure monitor, partial oxygen pressure monitor and partial carbon dioxide pressure monitor.

18. A system according to claim 2 or any claim dependent thereon comprising a laptop computer incorporating the master clock, the time stamping means and the display.

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19. A system according to claim 2 or any claim dependent thereon wherein the data processing means and the display are adapted to display a representation of the data signals selectively on one of two different timescales.

20. A system according to claim 19 wherein the two different timescales are a first timescale of a few seconds to a few minutes and a second timescale of one minute to a few days.

21. A system according to claim 20 wherein the first timescale is such that less than thirty seconds of the time axis is displayed.

22. A system according to claim 20 wherein the first timescale is such that less than ten seconds of the time axis is displayed.

23. A system according to claim 20, 21 or 22 wherein on displaying the representation of the data at the first timescale, data sampled at a low sampling frequency is displayed as a numeric value.

24. A system according to claim 20, 21, 22 or 23 wherein the second timescale is such that more than one hour of the time axis is displayed.

25. A system according to claim 20, 21, 22 or 23 wherein the second timescale is such that five or more hours of the time axis is displayed.

26. A system according to any one of claims 20 to 25 wherein on displaying the representation of the data at the second timescale, one trace of data sampled at a high

sampling frequency is simultaneously displayed at the first timescale.

27. A system according to claim 26 wherein the one trace of data is an ecg trace.

28. A system according to any one of the preceding claims wherein the displayed representations of the data signals are scrolled with respect to the time axis as the data signals are received.

29. A system for acquiring and displaying data from a plurality of data collection devices, the system being constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

30. A method of synchronising data signals from a plurality of data collection devices, each monitoring a parameter and outputting a data signal at a respective sampling frequency based on respective system clocks, the method comprising associating a time stamp derived from a master clock with each of the data signals.

31. A method according to claim 30 wherein the time stamp has a higher resolution than the master clock.

32. A method according to claim 30 or 31 comprising, for data signals whose sampling frequency is below a predetermined threshold, associating as the time stamp a sample of the master clock signal, and for data signals whose sampling frequency is above the predetermined threshold associating as an initial time stamp for a sample of the data signal a sample of the master clock signal, and for subsequent samples of the data signal an estimated time stamp.

33. A method according to claim 32 wherein the estimated time stamp is based on a time interval calculated from the sampling frequency of the data collection device providing the data signal and the initial time stamp.

34. A method according to claim 32 or 33, wherein the predetermined threshold is less than or equal to the master clock frequency.

35. A method according to claim 32, 33 or 34 wherein, for data signals whose sampling frequency is above the predetermined threshold, the estimated time stamp being associated with the current sample is periodically compared with the master clock signal to determine the difference between them and, if the difference is greater than a predetermined amount, the estimated time stamp is corrected to correspond to the master clock signal.

36. A method according to claim 35 wherein, if the difference is greater than the predetermined amount, the time stamps of a contiguous set of samples preceding the current sample are adjusted.

37. A method according to claim 36, wherein the time stamps of the contiguous set of samples preceding the current sample are adjusted by an equal fraction of the difference such that they are evenly spaced in time up to the current sample.

38. A method according to claim 36 or 37, wherein the number of samples in the contiguous set is substantially the number of samples acquired in one second.

39. A method according to any one of claims 34 to 38 wherein, if the difference is greater than a predetermined amount, the estimated time stamp for subsequent samples is

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based on an adjusted value of said time interval.

40. A method according to claim 39, comprising a Kalman filtering process for calculating the adjusted value of the time interval.

41. A method according to claim 39, wherein the value of the accuracy of the time interval is calculated in accordance with the time taken for the predetermined amount to be reached.

42. A method according to any one of claims 30 to 41 wherein the signals are physiological signals.

43. A method according to any one of claims 30 to 42 wherein the signals comprise signals from at least two of: an ecg monitor, oxygen saturation monitor, respiration monitor, blood pressure monitor, thermometer, intra-cranial pressure monitor, partial oxygen pressure monitor and partial carbon dioxide pressure monitor.

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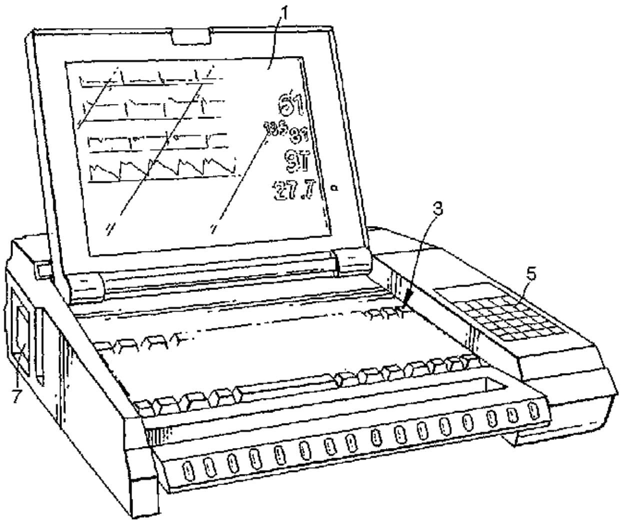
Fig.1.



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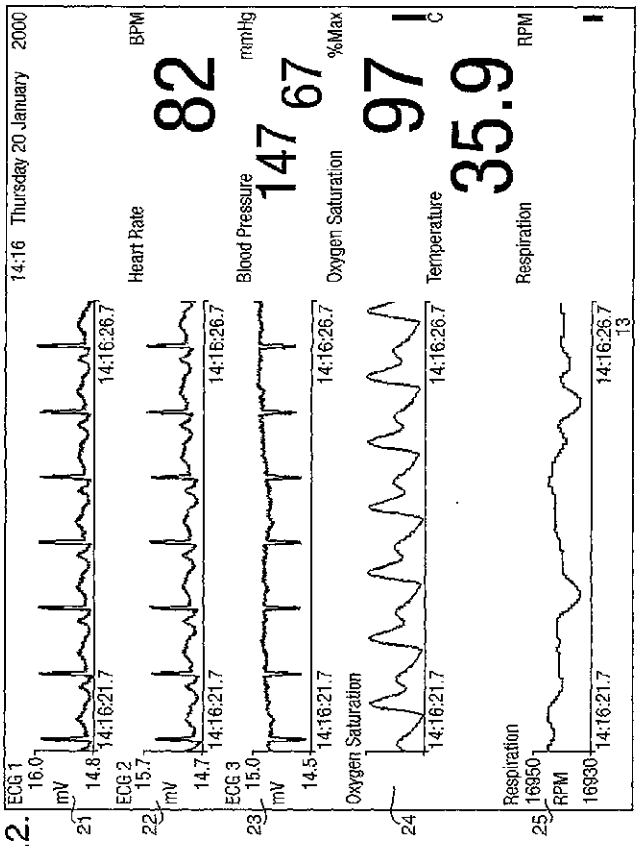
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mV
14.8
ECG 2
15.7
mV
14.7
ECG 3
15.0
mV
14.5
Oxygen Saturation
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21
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23
24
25

Fig.2.

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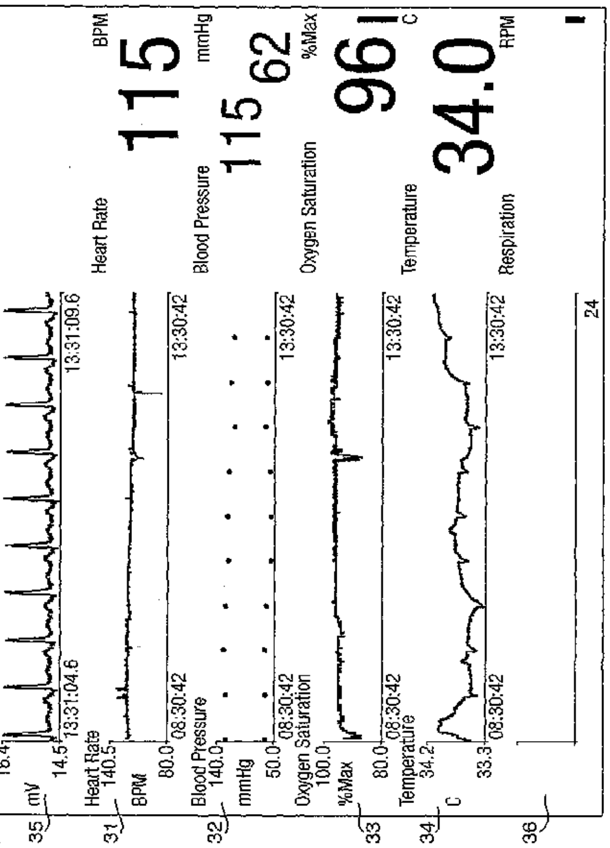
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Heart Rate
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BPM
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Blood Pressure
140.0
mmHg
50.0
Oxygen Saturation
100.0
%Max
Temperature
34.2
33.3
24
35
31
32
33
34
36

Fig.3.

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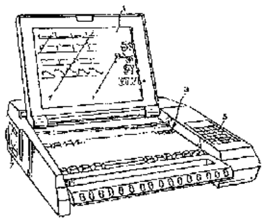

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(57) Abstract: A system for acquiring, and displaying, data such as physiological data, from a plurality of data connection devices, each of which monitor one or more different parameters and output data at different sampling frequencies based on their own system clocks. The system receives the data signals at different sampling frequencies and associates each sample of each signal with a time stamp derived from a single master clock. Low rate and high rate data are treated differently. Low rate data is associated with the current value of the master clock, where as high rate data is time stamped by giving the first sample a time stamp equal to the current value of the current master clock, subsequent samples being given an estimated time stamp based on the expected interval between samples derived from the sampling frequency of the data collection device, and the timescale given to the first example. The estimated time stamp may be periodically corrected, and the estimation calculation can be improved by correcting the value used for the interval between samples. The different signals can be displayed together on a display aligned with respect to a time axis. The system can display, the data in two different timescales, one showing a few seconds of data and one showing a few hours of data. The data traces are scrolled across the time axis, new data being added to one end of the trace.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

【国際調査報告】

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 01/02549

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61B5/00 G06F19/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06F A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, IBM-TDB, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 027 297 A (GARITTY JAMES P ET AL) 25 June 1991 (1991-06-25)	1,14,15, 29-31
Y	abstract	2,3,16, 17
A	column 1, line 50 -column 2, line 44	4-13, 18-28, 32-43
Y	US 5 578 063 A (BOCEK JOSEPH M ET AL) 26 November 1996 (1996-11-26) column 3, line 5 -column 12, line 37; figures 1-7	2,16,17
Y	US 5 682 328 A (ROEBER ET AL) 28 October 1997 (1997-10-28)	3
A	column 3, line 19 -column 5, line 31	1,29,30
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 November 2002	09/12/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Schenkels, P

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INTERNATIONAL SEARCH REPORT

Inte[rnatio]nal Application No
PCT/GB 01/02549

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 921 938 A (AOYAMA ET AL) 13 July 1999 (1999-07-13) column 1, line 27 -column 9, line 16; figures 1-6 ---	1-43
A	US 5 704 366 A (TACKLIND ET AL) 6 January 1998 (1998-01-06) abstract column 3, line 63 -column 7, line 33; figures 1-3 -----	1-43

INTERNATIONAL SEARCH REPORT
Information on patent family members

International Application No
PCT/GB 01/02549

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 5027297	A	25-06-1991	CA	2024682	A1	30-03-1991
US 5578063	A	26-11-1996	AU	704326	B2	22-04-1999
			AU	6801296	A	24-04-1997
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フロントページの続き

(81)指定国　AP(GH,GM,KE,LS,MW,MZ,SD,SL,SZ,TZ,UG,ZW),EA(AM,AZ,BY,KG,KZ,MD,RU,TJ,TM),EP(AT,BE,CH,CY,DE,DK,ES,FI,FR,GB,GR,IE,IT,LU,MC,NL,PT,SE,TR),OA(BF,BJ,CF,CG,CI,CM,GA,GN,GW,ML,MR,NE,SN,TD,TG),AE,AG,AL,AM,AT,AU,AZ,BA,BB,BG,BR,BY,BZ,CA,CH,CN,CO,CR,CU,CZ,DE,DK,DM,DZ,EC,EE,ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KP,KR,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MN,MW,MX,MZ,NO,NZ,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,US,UZ,VN,YU,ZA,ZW

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专利名称(译)	用于获取数据的系统和方法		
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外部链接	Espacenet		

摘要(译)

一种用于从多个以不同采样频率输出数据的数据连接设备获取和显示诸如生理数据之类的数据的系统。 该系统以不同的采样频率接收数据信号，并将每个信号的每个样本与从单个主时钟导出的时间戳相关联。 低速数据和高速数据分别进行处理。 当通过给低速数据加上与当前主时钟的当前值相等的时间戳作为高速数据来作为时间戳时，它将与主时钟的当前值相关联，下一个采样来自数据采集设备的采样频率。 根据获得的样本与第一个样本的时间尺度之间的预期间隔，给出估计的时间戳。 [选择图]图2